RSG

RE-INTRODUCTION NEWS

Newsletter of the Re-introduction Specialist Group of IUCN's Species Survival Commission (SSC)

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Letter from the IUCN/SSC Re-introduction Specialist Group Chairman
MARK. R. STANLEY PRICE

This edition of RSG's newsletter, *Re-introduction News*, is a special issue that is dedicated to reptile and amphibian re-introductions. The recent declines in amphibian populations worldwide is also an issue of major concern because in many cases they serve as indicator species. These large scale disappearances should be a warning sign that conditions on our planet may not be very healthy. The wide array of articles in this issue shows the commitment of herpetologists worldwide to restore populations of reptiles and amphibians. It is a pleasure to say that 100% of those asked to contribute to this issue have done so!

This issue has been generously funded by the Toronto Zoo, Scarborough, Ontario, Canada and I would like to thank the General Manager and Chief Executive Officer, Calvin J. White; RSG Member, Bob Johnson and other Toronto Zoo Management Staff for providing support. It is very encouraging that the Toronto Zoo is committed to reptile and amphibian restorations and sees production of this issue of the RSG's newsletter as a significant support for their conservation actions.

The Re-introduction Practitioners Directory is now published and RSG has received the first copies. This directory was prepared as a joint project between the National Commission for Wildlife Conservation and Development (NCWCD), Riyadh, Saudi Arabia and the RSG in Nairobi, Kenya. I would like to take this opportunity to thank Prof. Dr. Abdulaziz H. Abuzinada, Secretary General, NCWCD and Philip J. Seddon, Research Co-ordinator & RSG Bird Section Chair, National Wildlife Research Center, Taif, Saudi Arabia, for providing funds and working closely with RSG on this project. This directory will hopefully prove to be a useful networking tool for re-introduction practitioners, researchers, students and interested individuals alike. Details for obtaining this directory are shown on page 27 of this newsletter.

Mark Stanley Price

Letter from the General Manager & Chief Executive Officer, Toronto Zoo
CALVIN J. WHITE

Around the world scientists, conservationists, zoos and other wildlife-related organizations are working to preserve wildlife and the habitats and ecosystem processes that sustain them. Increasingly wildlife populations are managed in smaller and smaller habitat patches. Zoos with their experience in managing small populations contribute not only to public awareness of conservation and education issues, but zoos also provide a supply of genetically and demographically managed animals for release to the wild.

We at Toronto Zoo are proud of our support of recovery plans and projects for the re-introduction of endangered species. All of these projects involve many zoos working together with local communities, parks and reserves, universities, the Canadian Wildlife Service and the United States Wildlife Service to preserve biodiversity. Toronto Zoo is pleased to support the efforts of the RSG. Within the RSG, wildlife managers and conservationists are collaborating with government agencies to share resources and expertise to establish, test and to improve reintroduction techniques and guidelines. The RSG provides a framework for scientific collaborations which support wildlife populations *in-situ*. I am pleased that Toronto Zoo has been able to support the dedicated members of the RSG. We would like to acknowledge the ongoing work of Mark Stanley Price and Pritpal S. Soorae "Micky" who have worked so diligently to assemble the reports for this newsletter.

As we approach the new millennium, the efforts of the RSG will become increasingly vital in preserving the earth's natural ecological diversity. As conservation advocates we face many challenges, but we can not lose sight of what is at stake. The collective contribution of agencies and professionals committed to wildlife, such as the RSG, will make a difference in the years to come.

c j white

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!!NEWS FLASH!! **Re-introduction Practitioners Directory is now out. Please see page 27 for further**

GENERAL ISSUES

Amphibian and reptile re-introductions in western Europe: preliminary report

Since its creation in 1990, the European Amphibian and Reptile Species Survival Group (EARSSG), has been highly active in both the European Union (EU) and in the Council of Europe (CoE) regions. The group has been most involved in the western European countries that have belonged for the longest period of time to the EU and CoE and this review is largely confined to these countries as shown in table 1. Activities have been most extensive in the following countries: Germany, Italy, Switzerland, the Netherlands, Norway, Denmark, Sweden, UK, and to a smaller extent France, Spain, Portugal, Austria, Liechtenstein, Belgium, and Eire. Official re-introduction projects for reptiles and amphibians have been particularly prevalent in the following western EU and CoE countries (in approximate order of greatest activity): Denmark, Germany, UK, Sweden and the Netherlands.

The group appointed a formal contact point with the IUCN Re-introduction Specialist Group in 1996 and data from a preliminary appeal for information on projects has been collated. However, many projects have been carried out locally and occasionally without involvement of national government officials or nature conservation organizations. Collating hard data requires a good level of communication with those who are involved in the actual projects and this is sometimes difficult partly due to the lack of formal publication of findings.

Most attention to threatened and rare species has concentrated on two toad species. The captive-rearing of sea-turtle eggs and the rescue and reburying of nests is also carried out but this is arguably restocking rather than re-introduction. The Mallorcan midwife toad is an island endemic believed to have been reduced to small enclaves as a result of habitat change and the effects of introduced predators. In northern Europe, localized rarity may be more problematic due to 'edge of range' effects. A number of new projects are planned or underway including those for Hierro giant lizards *Gallotia simonyi* (Spain) and European pond terrapin *Emys orbicularis* and Dice snake *Natrix tessellata* (Germany).

Projects are usually authorized by government nature conservation organizations in consultation with local communities and voluntary organizations. The integration of local people may be critical as they can have the expertise and knowledge of local factors which can influence project success, and also the long-term ability to monitor re-introduced populations and to manage the habitat sustainably.

The level of monitoring of projects has been variable. In many cases projects have often not been running long enough for definite conclusions to be drawn. This is especially true for long lived tortoises and in situations where the effect of releases is harder to assess, e.g. for

Table 1. Amphibian and reptile species re-introduced to the wild in western Europe		
SPECIES	**LATIN NAME**	**COUNTRY**
AMPHIBIANS		
Fire-bellied toad	*Bombina bombina*	Sweden, Germany
Green toad	*Bufo viridis*	Sweden, Germany, Switzerland
Mallorcan midwife toad	*Alytes muletensis*	Spain (Mallorca)
Yellow-bellied toad	*Bombina variegata*	Germany
Italian spadefoot toad	*Pelobates fuscus insubricus*	Italy
Natterjack toad	*Bufo calamita*	UK, Eire
Great crested newt	*Triutirus cristatus*	UK
Green tree frog	*Hyla arborea*	the Netherlands, Austria, Switzerland, Germany, Lichenstien
REPTILES		
Smooth snake	*Coronella austriaca*	UK
Asp	*Vipera aspis*	Switzerland
Northern viper (adder)	*Vipera berus*	UK
Green lizard	*Lacerta virdis*	Germany
Sand lizard	*Lacerta agilis*	UK
Hermann's tortoise	*Testudo hermanni*	France
Loggerhead turtle	*Caretta caretta*	Greece, Italy*
Green turtle	*Chelonia mydas*	Cyprus*
* - headstarting/nest rescues (see text)		

secretive snakes.

There are also problems involving less experienced zoos and universities who may try to obtain charismatic animals that attract interest and funding. Cases of poor practice in captive-breeding projects with animals being used for experiments of little conservation relevance are also prevalent. Other problems also arise from animals that have been bred together for successive generations and/or kept in cages in close proximity to congenerics with species-specific parasitic fauna. There are also cases of animals having been used for experimental trials with exotic species and which have been released into the wild risking the spread of infection. The food of captive-bred species is also commonly of unscreened origin (especially where stock are kept out of the country of release) and this also risks spread of disease vectors to release sites. Thus animals with possible undiagnosed diseases and having disease vectors or from inbred stock may be released into the wild without proper evaluation.

Promoting high standards in re-introductions is a priority for the future. This is to ensure that only really necessary and properly thought out projects are authorized. Problems can also occur when animals are taken out of their country of origin and follow up on resulting progeny becomes difficult. These animals may also be freely distributed or even exchanged with animal collectors and they can also be used for unofficial releases by enthusiastic amateurs. Where possible wild - wild transfer or work by local breeding centers within or at the edge of natural habitats and reserve areas should be encouraged.

Contributed by Tom Langton, on behalf of the IUCN/SSC European Amphibian and Reptile Species Specialist Group (EARSSG) / Director, Herpetofauna Consultants International, Suffolk, UK.

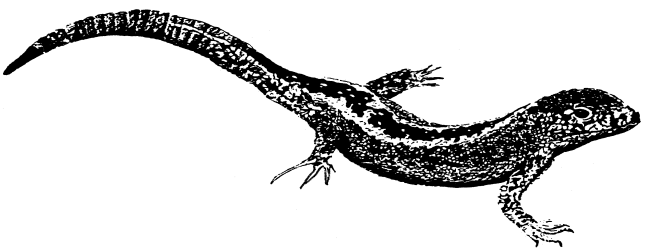
Herpetofaunal re-introductions for species conservation in the U.K.

The main target species for re-introductions in the UK have been the Sand Lizard *Lacerta agilis*, Natterjack Toad *Bufo calamita*, Smooth Snake *Coronella austriaca* and the Great Crested Newt *Triturus cristatus*. This account will concentrate on outlining the work on the sand lizard and smooth snake.

Sand Lizard

In the north-west of its European range the Sand Lizard is largely or wholly confined to lowland dry heath and coastal sand dunes; this association reflects its need for insolated habitats with a ground cover of structured vegetation and exposed sand for successful egg incubation. It became the most threatened of the U.K. herpetofauna as such habitats were lost to agriculture, forestry and urbanization. The surviving fragments were further degraded by scrub and bracken encroachment, recreational use, erosion, and particularly by the deliberate fires resulting from urban pressures.

To help counter this species' serious decline, the loss of colonies, and a shrinking of its range, a number of re-introduction projects were implemented – initially to heathland using adult stock rescued from urban development sites; then also using juveniles bred and reared in large, natural, outdoor vivaria; and most recently to coastal sand dunes. Receptor sites were selected from within the general area of their past UK. distribution, but by no means restricted to their precise recorded sites. Habitat



Sand lizard* Lacerta agilis © *Keith Corbett

status has been the overriding criterion and this has usually required degrees of prior management and of course the removal or minimization of the known causes of decline.

Judging the success, or otherwise, on the establishment of successful and regular breeding, and to a lesser extent on the naturally gradual spread of the population, we can assess these projects as remarkably successful. Of 27 such projects to heathland and 4 to sand dunes, 28 have worked well – with 4 of these still extant and healthy after 28 years. Of the 3 failures, one was the result of a calculated gamble on sub-optimal habitat, the other two were due to the site managers' failure to input agreed habitat measures. Two more projects worked well for a number of years and were then lost via three fires – ironically on a National Nature Reserve.

An interesting exception to these conservation led projects was the experimental release of 39 adult lizards into a large dune system on a Scottish island, c.350 Km north of their natural UK range though with a mild, Gulf Stream influenced climate. A breeding population remains 27 years on!

Methodologies have been gradually refined over this period but overall these re-introductions are now approved as a routine conservation technique for this species, e.g. Within its recent National Recovery Program. Another 5 projects are now being pursued within the relevant UK. Biodiversity Action Plan.

Smooth Snake

The Smooth Snake is confined to our southern heathlands and has declined generally because of the same habitat based threats affecting the Sand Lizard. It is by far the rarest of our herpetofauna and inexplicably it has not yet been included for official biodiversity plan actions because it is elevated at the trophic level and has larger home ranges. It is notably more secretive than our other reptiles and very few specimens have become available via rescues from site development projects. There are also many practical problems which have thus far precluded any captive-breeding programs.

Nevertheless, two re-introductions have been carried out and a third has just been started. In the first two projects a significant proportion of these snakes, released into large sites, were found to have stayed very close to and to have bred successfully in the release area. This species is known to live in the wild for upwards of 25 years and so the 14 and 4 positive years of each project has to be recognized as provisional, but so far the results bode well for their future.

Contributed by Keith Corbett, Herpetological Conservation Trust, Dorset, UK.

AMPHIBIANS

TOADS, FROGS AND TREE-FROGS

Puerto Rican crested toad: status and re-introduction strategies

The Puerto Rican crested toad *Peltophryne lemur* is now only found in two areas of Puerto Rico. Genetic studies of mitochondrial DNA indicate that there is significant variation between the northern and southern populations.

The breeding sites in the north is in man-made concrete cattle troughs and none of these sites are protected. No toads have been seen in the north since 1988 and some consider the species to be extirpated from it's northern range. If so, only one southern population remains. All information on reproduction events in natural ponds is available from the only remaining breeding location in Guanica State Forest on the south coast. No more than 1,000 adult toads have ever been seen and in the last 15 years, this number has declined to about 200 adults, not all of which participate in breeding events. Breeding is stimulated by rainfall that exceeds 7 inches in 24 hours and ensures enough pond water for the 18 - 21 days from egg laying to metamorphosis. Under the protection of Forest Manager Miguel Canals, the parking lot in which the toads breed is closed to cars during the breeding season.

The long-term survival of the crested toad is dependent upon protection of existing breeding sites and establishment of satellite populations in case of catastrophic loss of the present pond. Captive-breeding provides an additional source of tadpoles and toadlets for release into satellite ponds and a genetically diverse backup population in the event of extirpation of the species due to stochastic events. Releasing tadpoles increases the likelihood of imprinting on the natal pond habitat and allows selection to occur at a stage in which large losses can be buffered by relatively high numbers.

New ponds, whether naturally formed during rains or man-made to fill during rain, would receive tadpoles from two sources. Some tadpoles are translocated from the present breeding pond to adjacent ponds outside the migratory range of the crested toad, and other ponds receive captive-bred tadpoles returned to Puerto Rico for release. The ponds to receive tadpoles would allow the comparison of the success of translocations of tadpoles from the Guanica pond with releases of captive-bred animals.

Over 4,000 toadlets and over 15,000 tadpoles have been released to the wild. Releases are restricted to protected areas from which the toad has been extirpated. All toads receive veterinary clearance prior to release. The small size of released toadlets makes follow-up on the success of introductions or releases difficult but nonetheless important. To date the only measure of success has been the presence or absence of toadlets at release sites. Given the need to locate a natal pond for breeding, success in the short term

should not be anticipated. The success of re-introduction programs must be considered in a longer time frame and after a number of releases.

Research projects on this species include radiotracking post-reproductive toads to determine habitat use and movement. Toads moved an average of 125 meters a night for the first four days and traveled a maximum distance of two kilometers. After the initial period of intense movement, toads moved no more than 10 meters and often returned to the same hole even after several nights of foraging. Holes in limestone were preferred refugia although deep crevices were used during the initial post reproductive migration period.

More recently AZA (American Zoo & Aquarium Association) SSP (Species Survival Plan) has integrated our action plan with that of USFWS Recovery Plan's criteria for recovery of *Peltophryne lemur*:

- establish 6 breeding populations viable for 10 years, and,
- establish and maintain 5 captive populations as hedge vs. extinction.

To accomplish these recovery criteria, the following actions are required:

1 Prevent further population decline and habitat loss.
2 Propagation for re-establishment in the wild.
3 Establishment of 3 northern and 3 southern populations.
4 Island-wide education.

With financial support from the American Zoo and Aquarium Association Conservation Endowment Fund and grants from individual zoos, current efforts are focussed on conservation education. In the past year and in collaboration with the US Fish and Wildlife Service, we have identified and prioritized 5 additional pond construction and release sites; distributed life-size models of the toad for identification and education; distributed conservation posters in Spanish, one for the northern habitat and one for the southern habitat; distributed bumper stickers, magnets, and certificates of appreciation for those who learn about the toad; an educational video on toad life history and conservation.

Most importantly toads and the equipment and training necessary to hold and breed the species have been returned to Puerto Rico to the University of Puerto Rico UPR campus and to the Mayaguez Zoo. Students and zoo staff have been trained and equipped with the equipment necessary to hold and breed the toads in Puerto Rico.

Masterplan meetings to determine priorities and shifting needs of various partners are held every three years to determine results and failures and to set new strategies. A meeting of NGOs, Puerto Rican DNR, USFWS, AZA and students worked on a framework to guide us for the next 5 years.

Masterplan Meeting Priorities

The following are the major points of action:-

- Monitor northern population to determine if and where toads are located in the north.
- Habitat protection and acquisition.
- Establish working group to co-ordinate conservation priorities.
- Develop amphibian monitoring program: 1) short-term; 2) long-term.
- Develop toad field identification manual.
- Install information signage at breeding and field sites.
- Study basic biology and habitat evaluation - the chemistry and ecology of existing ponds must be characterized to test the suitability of future breeding sites (satellite ponds), and to monitor long-term changes which may negatively impact on the existing breeding ponds.
- Collect 25 northern toads if they are found - initiate permit, evaluate tadpole ID as they are located and provide funding for field workers looking for toads.
- Breed northern toads currently in captivity.
- Develop outreach display with models and graphics.
- Develop educators kit.
- Apply legal enforcement - determine what regulations currently apply and how to enforce them, who is responsible for what aspects of enforcement and what is current use of lands where toads are found.
- Evaluate other lands for releases in North and South.
- Research: 1) survival of releases and 2) disease/ genetics of wild populations.

Contributed by Bob Johnson, Curator of Amphibians and Reptiles, Toronto Zoo, Canada

The recovery program for the Mallorcan midwife toad, Mallorca, Spain

The Mallorcan midwife toad was originally described from fossil and sub-fossil remains. It was not until 1980 that live specimens of the toad were discovered, living in remote mountain gorges in the north of Mallorca. The species, believed to be widespread until about 2000 years ago, was excluded from large areas of otherwise suitable habitat by introduced predators and competitors from the European continent, such as the viperine snake *Natrix maura*, green toads *Bufo viridis*, green frogs *Rana perezi* and small mammals, particularly mustelids. The largest remaining wild populations live in six separate gorges, and as a result are reproductively isolated. As a consequence of this severe fragmentation of an already small breeding nucleus, the IUCN classifies *Alytes muletensis* as 'critically endangered' in the 1996 Red List of Threatened Species.

As with any wildlife conservation project, the primary aim of the Mallorcan midwife toad recovery program is to secure the long-term future of the species in the wild. The Mallorcan midwife toad recovery program seeks to achieve this objective by adopting an integrated approach with the co-operation and collaboration of a number of separate organizations including: the Mallorcan

Department of Agriculture and Fisheries - the Conselleria d' Agricultura i Pesca (CDAP), the Durrell Wildlife Conservation Trust (DWCT), the Durrell Institute of Conservation and Ecology (DICE) at the University of Kent, Barcelona Zoo, Stuttgart Museum, Marineland - Palma de Mallorca and The Open University.

The different aspects of the program include;

1 captive-breeding of the species at a number of European institutions,
2 comparative analysis of parasitological and bacteriological status of captive and wild populations,
3 reintroduction of captive-bred animals into specially selected sites,
4 *in-situ* monitoring of all natural and reintroduction sites on an annual basis, to establish the relative success of re-introductions and to determine the size and status of the various populations,
5 public education and media coverage in Mallorca and mainland Spain with the aim of increasing awareness of this unique amphibian and its plight, and
6 laboratory based research into the biology and behavior of the toad and their larvae, with particular emphasis on the avoidance of introduced predators.

The first re-introduction of captive bred toads occurred in 1989, when, at the request of the Mallorcan government, tadpoles were returned to the island and released at two sites chosen by the CDAP. Since then releases of both young toads and larvae have occurred on an annual basis, using animals from a number of the institutions breeding them. The expansion of the reintroduction project had, in the past, been limited by the availability of suitable new sites for release. This problem has been solved in recent years, by utilizing man-made 'cisterns' - water holes built centuries ago for mountain sheep and goats. These cisterns are used in at least two instances by natural populations of toads, and have so far also proved successful release sites for captive-bred stock.

All re-introductions have been into isolated sites that do not already contain toad populations, but are within the known historical range of the species. Sites are selected, assessed and prepared by CDAP staff using 'site criteria points'. A site which fully conforms with these carefully designed criteria will, in theory, provide an introduced toad population with the best chance of establishing and growing.

The success of the recovery program, which has now been running for fifteen years, is best demonstrated by the following facts:

1 25% of the current wild population now originates from captive-bred toads.
2 The distribution of the toad has increased by 100% since the instigation of the recovery program. From its estimated range of approximately 100km² in the early 1980's, the species is now believed to occupy a range in the region of 200km².
3 Twelve new breeding sites have been established since 1988 through re-introductions of captive-bred toads,
4 Ten further sites are ready for re-introductions now, pending the availability of selected captive-bred toads or larvae for release.

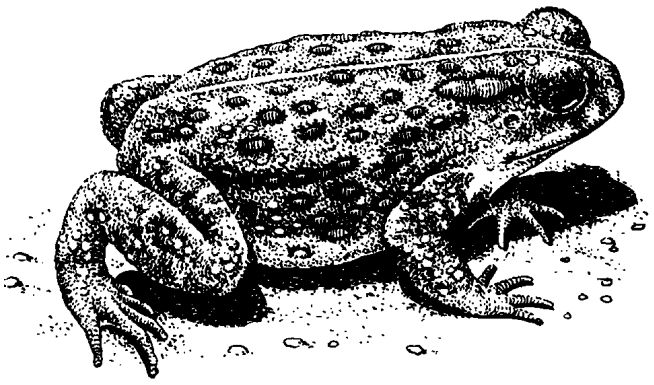
Contributed by Kevin R. Buley and Richard C. Gibson, Herpetology Department, Durrell Wildlife Conservation Trust, Trinity, Jersey, Channel Islands U.K.

Conservation of the natterjack toad in England and Wales, looking specifically at the role of translocations

The natterjack toad *Bufo calamita* has been the subject of conservation interest in Britain since the early 1970s. The species is threatened in Britain and has undergone a severe decline in abundance and range during this century. It is now found in around 50 sites in England, Scotland and Wales. Losses of populations can be attributed to many different factors. Direct habitat loss, often due to development, and changes in management either through intensification of agriculture or conversely site neglect resulting in a lack of management (notably the reduction of light grazing) are perhaps the most obvious causes. However atmospheric pollution resulting in acidification of breeding ponds, competition from other amphibian species (notably the common toad *Bufo bufo*) and the loss of natural processes (e.g. tidal inundation or stabilization of dune systems) have caused the loss or decline of some populations.

Early attempts at managing habitats together with several decades of autecological research have provided good information about the ecology and the management requirements of these animals. Against this background, a project was initiated through English Nature's Species Recovery Program (SRP) to take forward natterjack conservation in England and Wales between 1992 and 1995. This was carried out by Jonathan Denton, Trevor Beebee and Susan Hitchings at Sussex University. This paper is based on their final report and on subsequent work by John Buckley of the Herpetological Conservation Trust to develop the national Species Action Plan.

Targets were set for the SRP project in each of the following areas: Research, Habitat Management,



Natterjack toad* Bufo calamita © *English Nature

Translocation and Miscellaneous. The project met all its targets (see below) and was considered a success. This paper reviews the situation at the end of 1998, nearly 4 years after the completion of the project, in the context of the Species Action Plan and of the conservation projects initiated prior to the SRP project

Research

1) Spawn and tadpole mortality from predation and pH:

Being small, natterjack tadpoles are very susceptible to predation by invertebrates and can be wiped out completely when predator numbers are high. This is why natterjacks breed most successfully in ephemeral pools, which are less favorable for dytiscid water beetles (adults & larvae), odonate nymphs and notonectids. Low pH, a feature of many heathland ponds, also causes high mortality. These parameters were studied in experimental ponds (each saucer shaped, 5 m in diameter with a maximum depth of 80 cm). These ponds included concrete lined and rain fed ponds (pH 7.0-8.5); ponds sustained by ground water near the natural breeding pond (pH 5.5 - 6.5) and ponds created in an area of acid ground water (pH 4.5 - 5.0) toxic to the development of natterjack embryos.

Experiments were carried out to look at the effects of pH, of adding fish (rudd *Scardinius erythrophthalmus*, carp *Cyprinus carpio* and perch *Perca fluviatilis*), of the presence of macrophytes and of the addition of cattle dung.

Concrete ponds (with or without fish) supported high levels of natterjack tadpole survival, perhaps as they maintained near neutral pH and had low predator numbers. The presence of carp and perch were beneficial to tadpole survival since these species decimated invertebrate numbers; however rudd were effective predators of toad tadpoles (both natterjack and common toad) as well as invertebrates. Dense beds of macrophytes result in a reduced tadpole survival, at least in some circumstances, by increasing numbers of predators. Small quantities of cattle dung can enhance tadpole growth rates in otherwise highly oligotrophic or dystrophic pools. Acidic ponds are highly toxic, and killed most natterjack spawn, and also harbor large numbers of tadpole predators. Addition of quick lime (c. 3 kg in the acidic experimental ponds) raised the pH to 6.5 - 7.5 and effectively eliminated acid-induced mortality of embryos and tadpoles.

2) Terrestrial habitat requirements of toadlets including the impact of grazing by domestic stock:

Comparisons were made between the survival of natterjack toadlets in areas of heathland habitat subject to different management regimes. Square plots (20 x 20 m) were studied in open ground with bryophytes, in a recently clear-felled area of woodland with grass and in bare sand - these were in both grazed and ungrazed areas. A further study was carried out in a recently mown area of *Callunetum* (ungrazed) and in grazed and ungrazed pond basins.

Toadlet survival was low (probably <5% on average over the first year) on all squares though toadlet survival over winter seemed not to be affected by size of toadlets on entering hibernation. Toadlets were attracted to pond basins (a habitat rarely used by adults) but also survived and grew in habitats used by adult toads, especially open bryophyte and clear-fell areas. Grazed and ungrazed habitats seemed, in general, to be equally suitable. It is possible that grazing does not affect natterjack preferences but rather makes the site less suitable for competitor species (e.g. common toads).

3) Population genetics:

Genetic variation was studied by allozyme analysis using tadpoles taken from seven widely separated natterjack sites. These showed that British natterjacks are genetically highly depauperate compared with populations in continental Europe. This may be due to a relatively small founding population or through the colonizing animals already having been selected for a narrow range alleles. Only small differences were found between sites, suggesting that there is probably no actual constraint on the feasibility of moving animals between different areas or for restocking. However, genetic data from different geographic areas 'clustered' thereby suggesting that the policy of only allowing translocation within any geographic area had a sound genetic basis. There was no evidence of inbreeding depression, and so no cause for immediate concern, however the lack of variation implies there is little capacity to adapt to changing circumstances.

Habitat management

Significant progress was made on habitat management on ten sites, exceeding the target set (seven to nine sites). This focused on sites in need of significant management to restore notable areas of land. Physical removal of scrub and trees provided open habitats favored by the species; large machinery (e.g. tractor or excavator mounted rakes) provided very efficient means of removing scrub, while much tree removal was undertaken by hand or chain saw. These actions are expensive and resource intensive and it is important to ensure that these are not only beneficial in the short-term. Establishing a system of sustainable management to carry on after the end of the Recovery Program, often through grazing, is therefore essential. Grazing also offers other benefits. Grass snakes *Natrix natrix* are predators of natterjacks and this may be significant in small populations. Low intensity grazing seems to discourage snakes from using an area. Elsewhere control of visitor pressure or activities such as beach cleaning are allowing the return of natural dune building processes which will benefit the species in the longer term.

Maintenance of breeding ponds is important. Creation of small ponds, often as a small cluster, will safeguard and enhance populations. New ponds also assist the spread of breeding natterjacks over a wider area. As well as creating ponds existing ponds need to be managed. Lessons had been learnt prior to the SRP project that ponds should not be too deep or too permanent; although successful in the first years, they often failed due to large predator numbers or use by other species of amphibian. Some ponds benefit

from re-profiling, to ensure that they are not too deep. In others control of invasive plants, e.g. sea club-rush *Scripus maritimus*, by hand, using herbicide and/or subsequent grazing is important to maintain natterjack breeding areas.

Translocation
A target was set to establish at least five (ideally seven) new natterjack populations, concentrating on areas with the most significant declines. Prior to the SRP project methods for translocation had been trialed. Six translocations had been done, that had been successful and five unsuccessful attempts had been tried. Spawn or tadpoles are introduced in each of two or three consecutive years; exceptionally toadlets are used, e.g. in areas where the pond is unlikely to contain water for long enough to allow metamorphosis during the first few years.

Eight translocations were started during the SRP project. Management of receptor sites often required the provision of new water bodies. Concrete ponds were provided at five sites and ponds using natural water tables were created at the other three. Initially (i.e. at the end of the SRP project) all but one seemed to be going successfully, with short-term monitoring indicating that tadpoles survived and were able to leave the water. Subsequently it appears that four of these were not successful, and management is being changed to address this. Reasons for failure though are not always clear, as in all cases both aquatic and terrestrial habitats were considered suitable. In one site it is possible that wood ants may have predated emerging toadlets, in another the lack of cover around the margins of concrete ponds may have caused excessive toadlet mortality through desiccation.

Translocation might not always successfully establish a population, even if all known problems are addressed. It may take a release of animals to identify the constraints (e. g. as a 'bio-assay'). Once a decision has been made to translocate, intensive management including hand rearing, refilling ponds, etc, may be appropriate, especially during the early years following a translocation. Self sustaining populations should, in the longer term, be achieved by habitat management.

Further translocations are identified in the Species Action Plan. Translocations provide a valuable means of restoring range and bringing animals back to former sites and to representative habitats. However it is important not to stretch resources too far through translocations and to ensure that there is a long term commitment to the maintenance of the translocated population.

Miscellaneous
The SRP project also allowed other work to be undertaken. A Conservation Handbook for the species was produced, primarily for habitat managers, to describe management and translocation methods and the habitats needed for the species. A follow-up plan for the 10 years following the SRP project was written. This provided the basis for the national Species Action Plan which is now being implemented.

Overall conclusions
Ideally conservation should involve a minimal amount of intervention, e.g. occurring through natural re-colonization or the restoration of natural processes such as dune accretion/erosion. In practice, especially where semi-natural systems are highly fragmented and in areas with intensive use of land, nature conservation relies on human interference. This is both to set conservation objectives and to provide the necessary management to achieve and sustain these.

The SRP project provided a focus for intensive conservation work. The employment of a full time officer allowed a sustained conservation effort in different parts of the country and provided the continuity of effort necessary to undertake detailed applied research. However management of sites is an on-going commitment and sustainable methods, e.g. grazing, should be employed where possible. It is important that gains made for the species are not lost when such projects reach their conclusion.

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Contributed by Tony Gent, English Nature, Northminster House, Peterborough, UK

The European tree-frog re-introduction in Latvia

The European Tree Frog *Hyla arborea* (Linnaeus, 1758) is listed in the 1996 IUCN Red List of Threatened Animals as a near threatened species. As a strictly protected species it is included in Appendix II of the Bern Convention on the Conservation of European Wildlife and Natural Habitats.

The northern boundary of the tree frog's range in the recent past went through the territory of Latvia and historical records of the late 18th and 19th centuries confirm this distribution. Several observations have been reported during the first decades of this century but there were no further reports for the last few decades. The crucial factor influencing the disappearance of the Tree frog population in Latvia, was the considerable reduction of wetlands, which followed the intensive development of agricultural lands in the 1860's. This land-use reform trend continued till the Second World War. This caused a fragmentation of the population in the northern part of the species range further making it vulnerable to anthropogenic pressure. The closest stable European Tree Frog populations are found in southeastern Belarus (mainly south of 54°N) and southern Sweden (as far north as 58°N). A small localized population is also reported from southern Lithuania near the Belarus

border. The restoration of tree frog populations in Latvia started in 1988 when the Laboratory of Ecology was founded in the Riga Zoo. It was decided that only neonates would be used for re-introduction because they are considerably more adaptable to environmental changes when compared to adults.

The adult specimens needed for breeding were caught in southern Belarus during the months of October/November. The frogs were placed in boxes filled with wet sphagnum moss and placed in a refrigerator (average temperature 5°C) to initiate hibernation. The hibernation period was continued until January/February. The artificial daylight period was gradually lengthened thus imitating the natural day length of the breeding period. The animals were also regularly exposed to UV light.

Breeding was stimulated with hormone injections during late March and early May. The females were injected with a synthetic analogue of hypothalamus hormone Luliberin - Surphagon (produced by Bapex Company, Latvia). The females received 15 to 20 mg in the morning and the males received 10 mg in the evening. If spawning did not occur after the first injection, the procedure was repeated 24 hours later. Each female produced 200 to 1,000 eggs.

Hatching started after about 8 to 10 days and the larvae were placed into aquariums at a stocking density of 2 - 3 larvae/litre. Nightly temperatures were maintained at 20°-23°C and daytime temperatures at 24° - 27°C. The natural photoperiod was imitated using luminescent lamps. The tadpoles were fed *ad libitum* with boiled nettles, meat, aquarium fish food and powdered pollen. They began to metamorphose and were placed in low tanks with very shallow water where they stayed until their tails were fully reabsorbed. Complete metamorphosis took 30 to 60 days from hatching and juveniles were fed with laboratory bred *Drosophila*, *Gryllus* and *Musca domestica*. After a period of 2 to 4 weeks they were taken to the re-introduction site which is located in southwestern Latvia (56° 30'N) where the climatic conditions are similar to those in Belarus and southern Sweden tree frog population sites. In 1991, in accordance with the governmental resolution the Nature Protected Area was established at this site and currently exceeds 300 ha. The area is covered by abandoned agricultural farmland, typical wetland forest communities and a large number of small ponds (both natural and abandoned fishponds) and sites flooded by beavers.

The froglets were released in June/July and the release site was the same each year to enable monitoring of the population. During the years 1988 - 1992, a total of 4,110 juveniles were released and monitoring of the distribution and breeding was done on an annual basis. Tree frog sites were determined mainly on the basis of male breeding calls in spring and observations of tadpoles and juveniles in autumn. Monitoring data shows that tree frogs hibernate in Latvia and the males can reach sexual maturity in two years and females in three years. Tree frogs are widely dispersing around the initial re-introduction site and colonizing new habitats and breeding sites. As of 1998, tree frogs can be found in at least 50 sites and breeding was recorded in 10 ponds. Tree frog populations can be found as far as 14 km from the original reintroduction site. There are also records of a population in northern Lithuania which is 47 km from the original site. The author considers this localized population as having originated from the Latvian population.

The results indicate that the restoration of stable tree frog population in Latvia has been successfully completed in 10 years of re-introduction effort. The future plans are to carry on further monitoring as well as the establishment of a second re-introduction site north of the initial release site. In 1997 this work was rewarded with a prize of the Council of Ministers of the Republic of Latvia as a contribution in conservation of biodiversity.

Contributed by Juris Zvirgzds, Riga Zoological Garden, Riga, LATVIA

Translocation of the Maud Island frog in the Marlborough Sounds, New Zealand

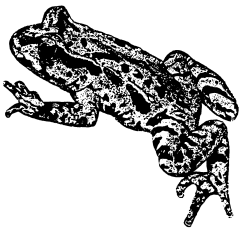
There are four extant species of native frog in New Zealand, all are members of the genus *Leiopelma* and are considered to be the most primitive of all living frogs. There are two species which are found in some forested habitats in the North Island namely *Leiopelma hochstetteri* and *Leiopelma archeyi*. The other two species are now confined to small, rodent-free, offshore islands in the Marlborough Sounds, South Island.

Of these two species *Leiopelma hamiltoni* is the rarest of all the species and comprises of about 300 individuals confined to a tumble of rocks, less than 600m^2 on the remote 150ha Stephens Island. The other species is the Maud Island frog *Leiopelma pakeka* which is restricted to Maud Island where about 20,000 individuals inhabit the rocky floor of a relict patch of forest. Subfossil frog remains throughout the South Island suggest that the ancestors of *Leiopelma hamiltoni* and *Leiopelma pakeka* were more widely distributed before the colonization of the 'mainland' by mammalian predators. With *Leiopelma hamiltoni* and *Leiopelma pakeka* confined to one island each, the Department of Conservation is keen to establish the species on other predator-free islands.

In 1995 research was commissioned to identify suitable habitat for the transfer of *Leiopelma pakeka* from Maud Island. The preferred site was on 59ha Motuara Island, also within the Marlborough Sounds. The island was originally covered in tall forest but was cleared for farming early this century. It is only in the past 60 years that the island has been gazetted as a scenic reserve and the forest is now rapidly regenerating. In 1990, the Pacific rat *Rattus exulans* was eradicated from the island. It was on the southwest slopes of the island that a deep rocky substrate was discovered beneath a canopy of nikau palm and kohekohe. The temperature, humidity and vegetative cover appeared very similar to that on Maud.

In 1997 approval was given for the transfer of 300 frogs from Maud to Motuara. Preparation on Motuara involved construction of a boardwalk over the rocks so that release

of the animals and monitoring of their progress could occur with minimal disturbance to the habitat. Collection of the frogs from Maud was guided by herpetologists within the department. The frogs were collected over a period of three nights by a team of 10 searchers - the 40mm long, cryptically marked individuals were detected as they sat amongst the leaf litter and on mossy rocks and tree trunks. Each animal was weighed and measured and given an individually distinguishing toe-clip before being stored in an inflated re-sealable plastic bag with a wet folded tissue. These bags of frogs were then stored in chilly bins where the temperature could be monitored.



Leiopelma hamiltoni
© Tony Jewell

With the transfer of any native species for conservation purposes within New Zealand there is great public interest to the extent that biologists may find the management of people even more of a challenge than the endangered wildlife. It can also be a similarly rewarding experience. This was certainly the case when it came time to shift these animals. The frogs had a one hour boat trip and a further hour by road to Picton, accompanied by the media, representatives of the company which sponsors the frog recovery work in New Zealand and representatives of Ngati Kuia, the Maori tribe with affiliations to Maud. From Picton there was another boat trip to a bay near Motuara where the party was met by representatives of Te Atiawa which is the local tribe. A brief ceremony was held on the beach whereby guardianship of the frogs was formally passed from one tribe to the next. Despite the heat there was then an opportunity for youngsters from local schools to inspect the boxes and their treasure before staff spirited the frogs away to the nearby island.

Since release of the frogs there has been regular monitoring of their survival and population estimates based on capture/recapture data. This monitoring involves painstaking nocturnal searches along the boardwalk, crawling on hands and knees and peering into the rocks and leaf litter. Unfortunately for the searchers the frogs are most active on cold wet nights. Results to date show that survival is high, some animals raised young in the first year and some have successfully colonized areas peripheral to the release site. Dataloggers continue to compare temperature and humidity on Maud and Motuara.

The apparent success of this transfer raises hopes for similar management of the much rarer Stephens Island frog. That population is being monitored intensively to determine whether removal of animals for transfer to another island would affect its viability.

Contributed by Peter Gaze, Department of Conservation, Nelson, New Zealand

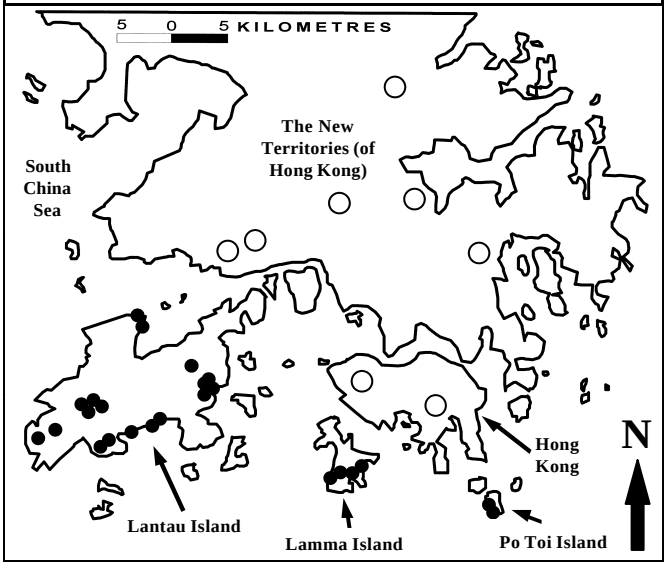
Romer frog re-introduction into a degraded tropical landscape, Hong Kong, P. R. China

The Special Administrative Region of Hong Kong (22° 09'N, 113°50'E; 1076 km²), Peoples Republic (P.R.) China, includes the most densely populated urban conurbation in the world. The area has experienced centuries of human impact, and the original forest cover disappeared over 400 years ago. Despite past and ongoing human impacts, Hong Kong is host to 23 species of amphibians; 22 of them are anurans, and one - *Philautus romeri* (Rhacophoridae) or Romer's frog - is endemic.

The endemic Romer's frog *Philautus romeri* is a tiny frog (adults are less than 2 cm long) and was discovered in 1952 by John D. Romer. This population was found breeding in a small cave on Lamma Island. They were apparently wiped out when the roof collapsed in 1953. The frogs were not rediscovered on Lamma until 1984 and, since then, have been recorded at few other localities. Extensive field work by a staff member, Michael Lau, has involved visits to 165 sites throughout Hong Kong. This survey showed that *Philautus romeri* has a relict distribution being and is confined to the islands of Lamma, Lantau and Po Toi in Hong Kong (Fig. 1). It does not occur on other islands or along the coast of southern China. The habitats of a fourth island population on Chek Lap Kok (close to the northern coast of Lantau) were eliminated in 1993 when the island was leveled during construction of a new airport.

Extensive collections were made from Chek Lap Kok during 1992 in an attempt to rescue the frogs: 230 adults were collected which also included several clutches of eggs and tadpoles and this formed the basis of a captive-breeding population maintained at The University of Hong Kong. Thirty adults were also sent to Melbourne Zoo, Australia, where a second breeding population was established. The frogs survived well in captivity and over 180 egg clutches were produced by The Hong Kong University population alone. The Melbourne Zoo program was successful also, and a total of 706 captive-bred frogs were sent back to

Fig.1. Distribution of *Philautus romeri* in Hong Kong: ● - original location and ○ - re-introduction sites



Hong Kong.

Research funding from the Royal Hong Kong Jockey Club Charities Ltd. allowed us to attempt the re-introduction of *Philautus romeri* to parts of Hong Kong where it had been eliminated. Studies of the frog's habitat revealed that it was a forest-floor species which bred in unpolluted standing or slow-flowing waters. We do not know what caused the range restriction of *Philautus romeri*, but its confinement to island habitats was probably due to a combination of forest clearance plus habitat destruction and degradation (by pollution). In addition, *Philautus romeri* tadpoles and eggs are susceptible to predation by the introduced mosquito-fish *Gambusia affinis*, and this frog is only able to breed in area which the fish has not yet colonized.

With the support of a number of organizations (Agriculture & Fisheries Department of Hong Kong Government, Kadoorie Farm & Botanic Garden, and The Hong Kong Zoological & Botanical Gardens), 8 release sites which appeared to offer suitable conditions for *Philautus romeri* were identified. There were 6 sites on the mainland, and 2 on Hong Kong Island (Fig. 1). A total of 1,170 frogs and 1,622 tadpoles were released in 1993 at 3 sites and during 1994 at 8 sites. At least 90 individuals per site were introduced to provide an adequate founder population. *Philautus romeri* can breed in small water bodies, and thus some release sites were 'engineered' by the addition of suitable containers or the construction of small pools to provide fish-free habitat. The success of re-introduction was monitored each year during the breeding season when calling males can be detected and tadpoles provide evidence of reproduction. As of 1998, populations were persisting at 7 of the 8 release sites. *Philautus romeri* lives for approximately 3 years in the wild, but females are reproductively active for only 2 breeding seasons. The persistence of re-introduced populations for 4 - 5 years is therefore indicative of successful establishment. However, the size of each population remains small and only one has expanded its range significantly.

Philautus romeri are tiny and extremely cryptic. Annual monitoring at some sites failed to detect any animals in some years, even though visits in subsequent years revealed their continued presence. There is some evidence that interaction with other amphibians may limit the population size of adult *Philautus romeri* at release sites, since larger frogs of other species prey upon them. This is the first time a breeding and release program has been used to conserve a tropical frog, and the preliminary results are promising.

Contributed by David Dudgeon and Michael W. N. Lau, The University of Hong Kong, Hong Kong SAR, China.

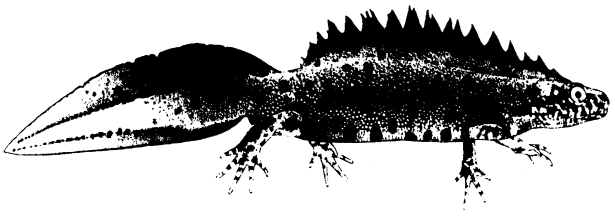
NEWTS AND AXOLOTL

Great crested newt re-introductions in Britain

The great crested newt *Triturus cristatus* is a dark brown or black colored salamandrid with an orange and black belly pattern, with a maximum length of up to 170 mm. It has an extensive range in northern Europe but has rapidly declined with the drainage, infilling and neglect of breeding ponds and agricultural intensification. Stocking of fish is also being increasingly recognized as a problem. Re-introduction of the species for pro-active conservation purposes has been confined to a few cases. Before its protection and, to an extent, afterwards people took newts to stock their garden ponds, but it became clear eventually that the long-term viability in garden ponds was limited for various reasons.

In the 1980's, with the destruction of wild colonies, newts were relocated at a number of sites where habitat had been restored, created or otherwise managed to allow newts a better chance of colonizing (e.g. desilting of old ponds). The results of these releases has been hard to assess but in at least some cases the newts have survived and bred. In some cases they are known to have failed because of subsequent problems at the release site (e.g. fish introduction). The careful monitoring of such sites over the next decade will allow a clearer insight into the long-term viability of this technique.

However, the movement of great crested newts *Triturus cristatus* in Britain (England, Scotland and Wales) to enable building development has now reached a rate that is alarming conservationists. Since 1981 legislation has, in theory, protected both the animal and its habitat. However, partly because the habitat is not designated (this would require notification by Government of around 2,000 known sites), it can in practice often be destroyed for building and road development as long as the animals are removed and



Great Crested Newt* Triturus cristatus © *Ed Wade

released elsewhere. This legal 'loophole' has been exploited in increasing frequency with newt translocations from just a few sites per year in the 1980's increasing to a point where dozens of translocations occur each year in the 1990's. Licenses are issued by government agencies but figures are not routinely published.

Two of the largest known populations of the species are in protected areas. Both are being disturbed to assist development projects, including the largest known colony of some 60,000 newts in a disused brickpit in Cambridgeshire. With over 400 translocations having taken

place, little long-term monitoring effort has been carried out nor is it required by law. This problem is being partly resolved with help from national amphibian volunteer groups who are pressing for best practice standards to be adopted. However it is not all bad news. There are some signs in projects where newts have been moved that they have accepted their new habitat and that newts have survived and bred for several years after release. This is not too surprising as the species' main habitat in northern Europe is largely large artificial farm ponds and mineral quarries that have replaced natural wetlands over the last three hundred years, and with care these conditions can be reconstructed.

Perhaps the main point is that these re-introductions are being carried out as a consequence of development (i.e. habitat destruction) and are not part of a conservation initiative. In most cases, the best that can be hoped for is no net loss of occupied habitat. The re-introduction of great crested newts as a pro-active conservation tool has yet to be attempted or studied to any great extent. The Species Action Plan published by the UK Government in 1995 (as part of its commitment to the Biodiversity Convention) advocates an extensive program of pro-active 'recolonization' through habitat creation, restoration, and/or species translocation.

The long-term impact of wildlife legislation in maintaining the conservation status of the species however can only be judged over a longer timescale. Research suggests that two out of every three great crested newt colony losses may go unreported and so a general decline still cannot be ruled out. Indeed this is likely without further tightening and refining of legislation and associated procedures.

Contributed by Tom Langton, Director, Herpetofauna Consultants International, Suffolk, UK.

The axolotl augmentation project at CIBAC, Mexico

The well known paedomorphic salamander, the axolotl *Ambystoma mexicanum* only lives in a few remaining channels of the Xochimilco lake system in the southern part of Mexico City. Even so, a hundred years ago it was very abundant in that area but has recently gone through a large population decline possibly due to contamination and the introduction of an exotic carp species in the 1950´s.

Its ancestor once lived in a lake covering the entire Mexican Basin but due to development and drainage that lake is now restricted to a few isolated freshwater areas. These areas contain other paedomorphic species like *Ambystoma taylori* in lake Alchichica, Puebla *Ambystoma andersoni* in lake Zacapu and *Ambystoma dumerilii* in lake Pátzcuaro, both in Michoacán. All these species are crucial for studies on the evolution and ecology of paedomorphosis. These lakes are surrounded by urban communities and are thus under high risk of disappearance. The establishment of breeding sites for endemic species beside the lakes would be a safeguard against extinction. The preservation of the axolotl is also crucial because it is an important species for the scientific community. Since it was first taken to Europe in 1863 it has served as a worldwide model laboratory animal for studies of embryology, endocrinology and regeneration.

The government of Mexico City has contributed a facility, El Centro de Investigaciones Biologicas y Acuicolas de Cuemanco (CIBAC), to the Autonomous Metropolitan University (UAM) of Xochimilco. This facility is located on the canals and is dedicated to the protection of the aquatic fauna of Xochimilco. In 1995 UAM´s axolotl colony was transported there and a breeding program initiated. This facility has an indoor lab which uses treated city water as well as two outdoor breeding ponds connected to the channels. One of these ponds is covered with a mesh to prevent birds and large insects from predating the eggs and larvae. The larvae have a higher survival rate when raised in channel water as opposed to city water which will make eventual release much easier on the larvae. Floating cages placed in the axolotariums separate adult mating pairs and allows viewing of spawning and larvae development. The larvae feed on rotifers and other zooplankton that flow naturally through the net cages. The causes of the axolotl population decline are not yet well understood, and at CIBAC, we will monitor our released animals in a controlled study to determine possible causes.

This augmentation experiment will consist of two stages. The first stage will consist of measuring the comparative success of egg release vs. larval release in relation to the introduced carp. Two dead-end channels will be fenced off and one will be left with carp and in the other carp will be removed. These channels will be divided into two parts. Eggs will be introduced into one chamber and larvae into the other and, if costs permit, the experiment will be replicated in a different part of the lake to see if water quality is a factor in their survivorship. Every four months the chambers will be searched for surviving larvae.

The second phase will involve monitoring the axolotl movements in the lake. It appears that some channels appear to have no axolotl while they persist in others and even though water quality has improved the axolotl have not repopulated certain areas. Ten wild-caught adults will be radio-tracked to monitor their movements, territorial ranges and possible factors affecting adult mortality and the data obtained from this experiment will determine the location of future release sites.

We realize that the reasons for the population decline of axolotl may still exist in the lake and will interfere with attempts at re-introduction. With these experiments we can find out the reasons for decline and take appropriate steps to address the problem.

Contributed by Dr. Virginia Graue, Autonomous Metropolitan University (UAM), Mexico.

REPTILES

TORTOISES

Re-introduction of the Western swamp tortoise, Australia

The Western Swamp Tortoise *Pseudemydura umbrina* is the smallest Australian freshwater turtle (males up to 150mm & females up to 135mm shell length) and is only known to occur in the south-western corner of Western Australia, in seasonal swamps on clay or sand over clay soils of the Swan River Valley near Perth.

During winter and spring, the tortoises are active in the shallow waters and feed on live invertebrates and tadpoles. During the dry summer and autumn months, they aestivate in naturally occurring holes or under leaf litter. In late spring, when the swamps dry out, the females lay one clutch of 2 - 6 eggs in an underground nest. Hatchlings emerge the following autumn with a body mass of 3 - 6g. The hatchlings must grow to about 20g in their first winter and spring to have a chance of surviving their first summer. The tortoises take 8 - 20 years to mature and have a potential life span similar to humans.

The type specimen of *Pseudemydura umbrina* was collected in 1839 and described in 1901, but it was only in the 1950s that the species was rediscovered in two small swamp areas just north of Perth. Both sites were protected in 1962 when Ellen Brook Nature Reserve (EBNR, 65 ha) and Twin Swamps Nature Reserve (TSNR, 155 ha) were gazetted. Populations were estimated at 30 (Ellen Brook Nature Reserve) and 200 (Twin Swamps Nature Reserve) tortoises in the 1960s. Although the Ellen Brook Nature Reserve population remained at a level of about 30 individuals until the late 1980s, the Twin Swamps Nature Reserve population had, by then, declined to 4 individuals. Habitat loss and degradation outside the protected area, increased predation by the introduced European Red Fox and low water levels at Twin Swamps Nature Reserve in below average rain fall years seem to have been the main causes of the decline of the species.

After a concerted effort by the Western Australian Department of Conservation and Land Management, Perth Zoo and The University of Western Australia during the late 1980s, a successful captive breeding operation was established. The Western Swamp Tortoise Recovery Team was formed in 1991 and a Recovery Plan was published in 1994. Recovery actions include captive-breeding, habitat management, control of exotic predators, habitat acquisition and restoration, re-introduction and public education.

No captive-bred tortoises are released into the last remaining stable wild population at Ellen Brook Nature Reserve. The strategy to increase this population is to exclude foxes by an electrified fence, to acquire former habitat on adjacent areas, to restore the habitat and to include it into the reserve. Recent monitoring data indicate that this allows the population to slowly increase naturally. Re-introduction of captive-bred tortoises started at Twin Swamps Nature Reserve in 1994.

Measures to alleviate the causes for the previous decline of the species at that site include:-

- The construction of a fox-proof fence and exclusion of foxes and dogs;
- supplementing bore water into one swamp during dry winters and springs to extend the duration of swamp life;
- changes in the drainage patterns of several swamps to increase flooding; and
- fire management, including controlled fuel-reduction burning.

Since 1994, captive-bred juvenile tortoises of about 100g body mass have been released at Twin Swamps Nature Reserve on an annual basis (Table 1). Some adults and 21 hatchlings have also been released. To monitor the progress, about 10 - 15 juvenile tortoises are radio-tracked at any one time, with various individuals being tracked for variable periods (since the tortoises lose the glued on transmitters from time to time when they shed their carapacial scutes). In addition to radio tracking, mark-recapture is used to estimate the population size.

Despite the fact that foxes and dogs have been successfully excluded from Twin Swamps Nature Reserve since 1994, mortalities of juveniles due to predation still occur. The main predator of juvenile tortoises at Twin Swamps Nature Reserve now seems to be the native Australian raven *Corvus coronoides*. This was unexpected, since ravens were not known to predate on *Pseudemydura umbrina* in the past and are not known to do this at Ellen Brook Nature Reserve. Ravens are subsidized by human activities and their numbers have increased in the whole area due to land development. Predation by ravens seems to be the single most important mortality of released juvenile tortoises. Raven predation on juvenile tortoises is concentrated at the time in spring when the water in the swamps dries up.

All three injured tortoises (Table 1) survived raven attacks, with two of them losing a front leg. At least two of the three recorded mortalities during aestivation seem to have been preceded by injuries, presumably caused by raven attacks when the swamps dried out. It is also interesting to note that 12 of the 15 injuries and deaths involved tortoises which were released in the same year, suggesting that inexperienced and naive tortoises are more prone to predation than those which have already survived their first year in the wild. The raven problem is being addressed. Raven control by shooting and trapping took place sporadically during the winter and spring of 1996 and 1997, but due to the large number of ravens in the area predation on juvenile tortoises remained high. In the spring of 1998, raven shooters patrolled the swamp area from dawn to dusk during the critical week when the water disappeared. This scared the ravens away (no raven was

Table 1. The number of released juveniles 100g and the number of recorded mortalities and injuries per year at TSNR

Year	Number released	Recorded mortalities during active period	Recorded mortalities during aestivation	Recorded injuries
1994	10	0	0	0
1995	18	3	0	1
1996	7	1	0	2
1997	25	5	1	0
1998	18	0	2	0
TOTAL	**78**	**9**	**3**	**3**

actually shot) and no losses of tortoises were recorded in the spring of 1998, suggesting that constant patrolling during the critical time is the most efficient way to reduce mortality of released, juvenile tortoises.

Although recaptures of released hatchlings demonstrate good growth rates, the number of recaptures more than a year after the release is very low. This suggests that the release of larger juveniles is a more efficient strategy to build up tortoise numbers. Movements of radio-tracked tortoises indicate that they establish home ranges and that they are able to find areas with standing water (e.g. the swamp which is supplemented with bore water during dry winters and springs as in 1997 and 1998). The juveniles show good growth rates and the largest ones are now close to reaching maturity, but no breeding of these captive-bred tortoises has yet been recorded.

Conclusions

Re-introduction of captive-bred Western Swamp Tortoises has a central place in the conservation of this critically endangered species. The unexpected problem of raven predation demonstrates that close post-release monitoring and flexibility to adjust management actions are imperative. Given this, re-introduction can be an efficient strategy to re-establish wild populations of the species.

However, a re-introduction program with a long-lived, late-maturing species like *Pseudemydura umbrina* clearly requires long-term monitoring before success can be claimed. Even if the re-introduction at Twin Swamps Nature Reserve proves to be successful, the small size of the two nature reserves and populations may still not allow the down listing of the species from the critically endangered category. The main challenge for the conservation of the Western Swamp Tortoise in the future will be to secure and/or restore further habitat areas to re-establish additional wild populations.

Contributed by Gerald Kuchling, Principal Investigator, Western Swamp Tortoise Recovery Team, The University of Western Australia, Australia.

Re-introduction of Hermann's tortoise in France

The Hermann's tortoise *Testudo hermanni hermanni* is the only indigenous species of tortoise occurring in France. In the past, wild populations were observed along the Mediterranean rim, from Spain to Italy, though unfortunately, development of agriculture and urbanization jeopardized their existence. This species is now only located in the Plaine and Massif des Maures (Var), as well as in Corsica. Its typical habitat is the Mediterranean garrigue with cork and evergreen oaks, heathers and other small bushes. Its distribution area is very fragmented and most populations are threatened by forest fires, collecting for the pet trade, road network development and constructing clearings using mechanical equipment.

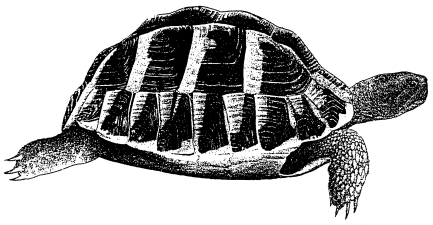
In Massif des Maures, the decline of traditional cultivation (olives and chestnuts) has favored the growth of trees and bushes which cause the disappearance of nesting areas, thus forcing the use of remaining sites by several females each year. Predation on eggs and juveniles is very high and is mainly caused by badgers, stone martens, boars and magpies. Rats also injure tortoises during hibernation. Any population recovery is thus very difficult due to limited migration, late sexual maturity (around 12 years old) and low fecundity (3 - 6 eggs/female/year).

The Massif de l'Esterel is located at the western extremity of the natural distribution area of this species. Up to 1964, a succession of major forest fires entirely destroyed its tortoise population. Urbanization of the vicinity and natural barriers, such as rivers and mountains, prevent recolonization. Today this area is a property of the French government and is managed and protected by the National Office of Forestry and is remarkable for its high biodiversity and endemic species.

SOPTOM (Society for Observation and Protection of Tortoises) was created in 1985 by B. Devaux, J.P. Pouvreau and D. Stubbs. Its aim is to protect and study Hermann's tortoise and has been commissioned to re-introduce the Hermann's tortoise into this restored and well protected habitat. A breeding, research and education center was built in 1998, near the village of Gonfaron, to re-introduce animals into the wild and to inform and sensitize visitors on wildlife protection. The origin of most tortoises are from the pet trade and are mainly donated by individuals who have kept them as pets for several years. Tortoises are re-acclimatized to natural conditions by maintaining them for several months in large enclosures with natural vegetation. In these large enclosures the animals are exposed to natural weather variations and undergo hibernation and aestivation processes.

Starting in April 1999, we will release 600 tortoises in the Massif de l'Estérel for the first time and we will be able to undertake a long-term post release observation of these animals. This research will include population dynamics, as well as several scientific experiments to better understand how captivity and release conditions can affect

dispersal. This program will be realized with the help of many volunteers and the collaboration of several scientists and is entirely funded by SOPTOM. We hope that this natural area and its new tortoise population will become a good example of international collaboration for wildlife protection and will lead to numerous research projects. We encourage you to contact us for any detail, advice and collaboration.



***Hermann's tortoise* Testudo hermanni**
© Barbara Livoreil

Contributed by Barbara A. Livoreil, Ph.D., Scientific Officer SOPTOM, Gonfaron, France

Captive-breeding and rearing of giant tortoises in Galapagos for recovery of two threatened populations

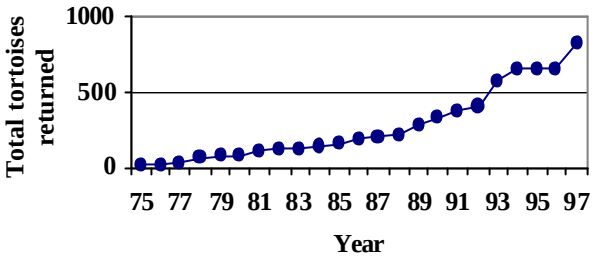
The giant tortoises on the Islands of Española *Geochelone hoodensis* and Pinzon *Geochelone ephippium* in Galapagos have been foci of cooperative recovery actions involving the Charles Darwin Research Station and the Galapagos National Park since 1964 and 1970 respectively.

Española is a relatively low, arid island which was impacted by two distinct threats: removal of tortoises by whalers prior to this century and competition with feral goats that overpopulated the island for many years. Tortoises numbered fewer than 20 on Española and less than 200 on Pinzon when conservation efforts were begun in the 1960s. Goats were never established on Pinzon, but black rats have preyed heavily on hatchling tortoises for most of this century largely preventing recruitment of juvenile tortoises into the population. Clearly without enhanced recruitment the futures of the Española and Pinzon tortoises were bleak.

Goats were removed from Española by 1978 through the combined efforts of the Galapagos National Park Service and Charles Darwin Research Station, but the tortoise population was judged to be in danger of extinction without an active captive-breeding program. The program was initiated with the transfer of 12 females and 2 males to captivity on the Island of Santa Cruz. A third individual was added through the return of a large male from the San Diego Zoological Society. Tortoises were maintained in captivity, artificial nest sites were provided, eggs were incubated in artificial chambers, and young were reared to the age of 1 or 4 years before being transferred back to their native island.

Removal of rats from Pinzon was not judged to be feasible in the 1960-70 period, and because the rats constituted no danger to adult tortoises or their eggs, a captive-rearing program was initiated that involved collection of eggs near hatching or hatchlings as they exited the nests. Hatchlings were transferred annually to the captive facility on the Island of Santa Cruz, reared there to the age of 3 - 5 years when they were judged to be large enough to resist predation by rats and returned to their native island.

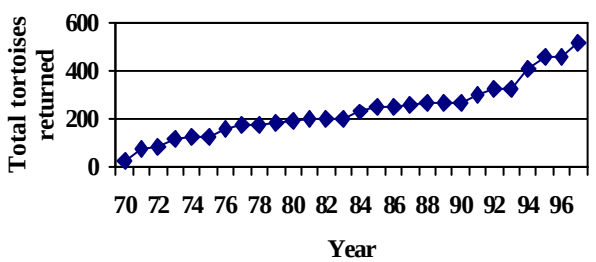
Fig. 1. Tortoises returned to Española Island through captive-breeding



The efforts directed at tortoises on Española and Pinzon have been underway for nearly 30 years and have resulted in hundreds of tortoises being returned to their native habitats (Figs 1-2) with documented high survival of the liberated individuals. The programs differed in that the program for Española involved maintenance of all breeding stock in captivity, construction of artificial nesting areas, and incubation of eggs in artificial conditions whereas the program for Pinzon left adults in their native habitats, allowed eggs to be deposited in nest sites selected by the females, and facilitated incubation under totally natural conditions. For Pinzon, only the juveniles were subjected to artificial rearing conditions during their first 3 - 5 years of life.

The costs and risks were greater for the Española effort but through continual refinement the program can be judged to have been a success; it continues at present. No mortality has occurred with adults from Española in captivity for more than 20 years; hatching rates have been continually improved with better handling practices; and distortion of sex ratios has been avoided even though incubation temperatures have been shown to determine the sex of hatchlings in this species as in most species of turtles. In part, this pitfall was avoided originally by the pragmatic necessity of using solar incubators that caused variable incubation temperatures from month to month

Fig. 2. Tortoises returned to Pinzon Island through captive-rearing



clutches into 2 treatment groups of eggs with half incubated at low temperatures resulting in males and half at higher temperatures resulting in females.

With several aspects of the Pinzon effort focused on free ranging adults, natural nests, and hence natural incubation conditions, the pitfall of unnaturally skewed sex ratios was avoided, but the numbers of eggs collected each year depended on the logistical mobilization of trained park wardens to find nests at the proper times and transfer the young tortoises to captivity. The young tortoises produced from this effort came from a much larger number of potential parents than the Española tortoises. The success of this project hinged on understanding the threat, assessing what activities were possible with available technologies and resources, and on maintenance of continuity over more than two decades to accomplish a significant improvement in the size and age-structure of the population. Threats to tortoises have been removed from Española and the possibility exists for future efforts to eradicate rats on Pinzon if the proper mix of control technologies and funding can be directed to the program. Considerable gains have been made with these two primary recovery efforts and efforts in the future will focus increasingly on other populations.

Contributed by Thomas H. Fritts, Howard L. Snell, Craig MacFarland, Cruz Marquez, and Linda Cayot, Charles Darwin Research Station, Puerto Ayora, Galapagos, Ecuador.

TUATARA

Re-introduction of northern tuatara to Mutohora Island, Bay of Plenty, New Zealand

Introduction

The tuatara is the sole living representative of the Order Sphenodontida and once occurred throughout the two main islands of New Zealand, but over the past 150 years have become extinct there, as well as on at least 10 offshore islands, and now only remains on about 25 offshore islands. Habitat destruction and predation by cats, rats, pigs and other mammals introduced by Maori and Europeans are the main causes of extinction.

To ensure the survival and enhancement of remaining tuatara populations, the Department of Conservation (DOC) commissioned the production of a Tuatara Recovery Plan and established a Tuatara Recovery Group. Northern tuatara *Sphenodon punctatus punctatus* are one of three different types of tuatara covered by the recovery plan. Objective 12 of the Plan's recovery strategy proposes restoration of northern tuatara on an island where controlled public access is permitted. Moutohora Island in the Bay of Plenty, North Island, New Zealand was selected as the site to undertake this recovery objective.

Source Population and Transfer Methods

Moutoki Island (fig. 1), the source island, is a small forested island 8 kilometers north-west of Moutohora. It is a Wildlife Refuge administered by DOC. Ngati Awa, a local Maori tribe are owners of the island. They were fully consulted over the transfer and consented to it taking place.

Adult tuatara, being nocturnal animals, were hand captured over three nights (15th - 17th October, 1996) on Moutoki. Each was then measured, sexed and marked. They were placed individually into short lengths of plastic Novacoil pipe and then into cardboard transfer boxes, for transport to Moutohora. Each box contained 4 - 6 animals/ box. They were transported by boat to Moutohora where they were released. Twenty had transmitters attached to them immediately before they were released.

Release Site

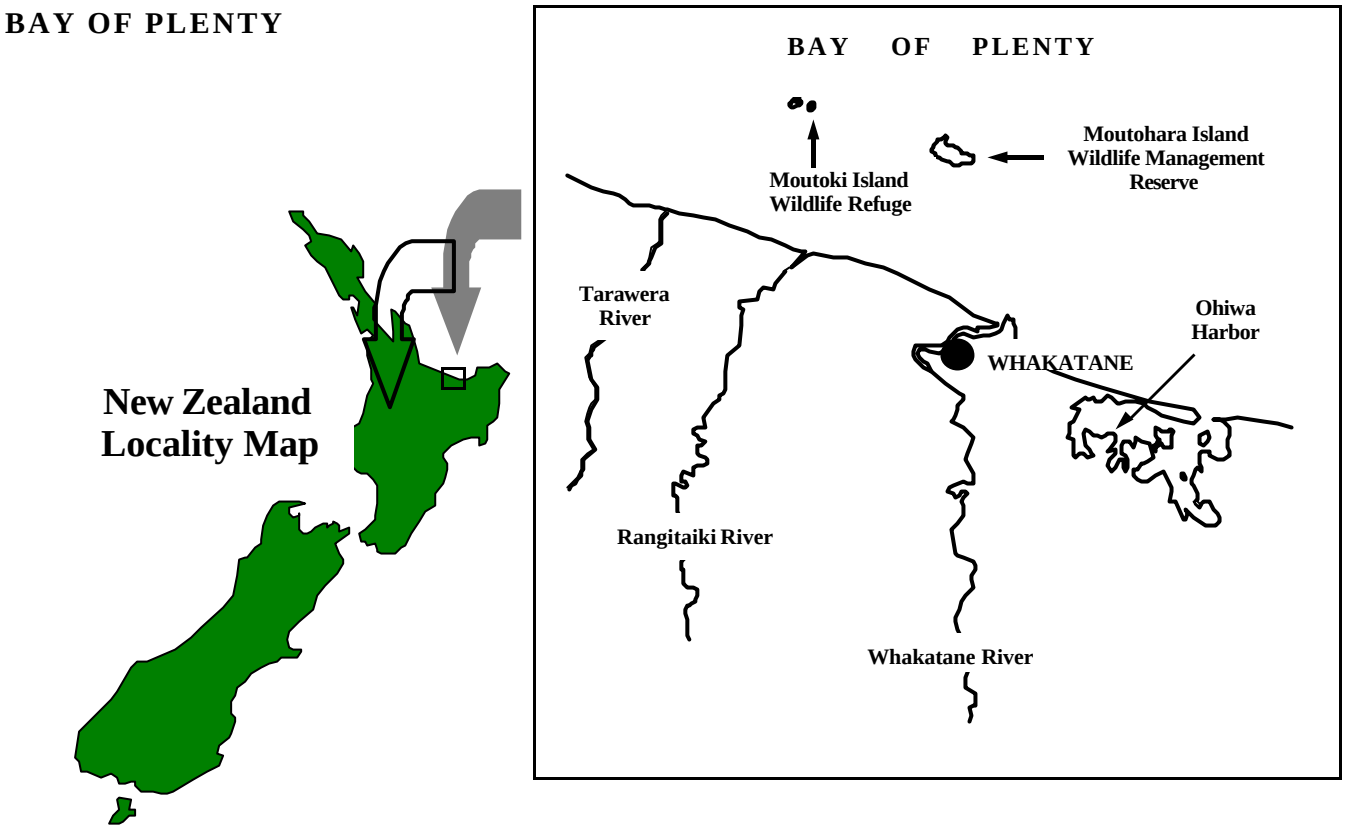
Moutohora Island, a 143 hectare forested island lies 8.5 kilometers north of Whakatane in the Bay of Plenty (Fig 1). It is a Wildlife Management Reserve administered by DOC. Historically tuatara were present on the island and Ngati Awa remembers their presence, but with large scale vegetation clearance, farming and the presence of cats, rats, rabbits and goats they were gone by the late 1880's. All animal pests have now been removed from the island and the vegetation has subsequently regenerated rapidly. The island is large enough to support a total population of about 12,000+ tuatara at an average density of 100 tuatara per hectare. Over time this potentially will become one of the largest populations of northern tuatara. As part of research associated with the introduction, a number of artificial burrows were set up on the island in August 1996 prior to the release.

Four release sites were chosen on Moutohora in order to research the habitat preference of the released tuatara: two in mid successional kanuka *Kunzea ericoides* - mahoe *Melicytus ramiflorus* forest; and two in early successional kanuka forest. One site in each of the two vegetation types had high grey-faced petrel *Pterodroma macroptera gouldi* burrow density while the other had low petrel burrow density. Twenty of the 32 tuatara were released into previously prepared artificial burrows, one animal per burrow, while the other twelve were placed into either natural petrel burrows, or on to the open ground. Eight tuatara (5 females/3 males) were released at each of the four separate sites.

Transferred Population

Thirty-two adults (12 males, 20 females), of which 20 had transmitters attached to them, were released onto Moutohora and their survival was monitored. As these animals were adults we were able, prior to release, to sex individuals relatively accurately from external examination. The sourcing of animals from one small island raises the possibility that the transfer population are made up solely of closely related individuals. It was not possible to take blood samples from the released animals to check their genetic relatedness at the time of transfer. To alleviate this concern to some degree, the sex ratio of

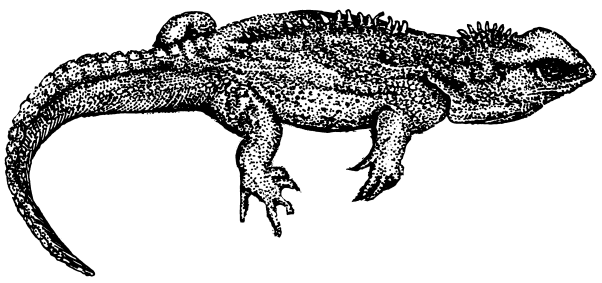
Figure 1. The location of Moutohora Island Wildlife Refuge (release site) and Moutoki Island (tuatara capture site).



adults to be transferred was biased towards females because they usually breed, on average, just once every four years.

The males have an annual reproductive cycle and in any one season, a single male can mate with several females. Prior to their release, a proportion of the females are likely to have mated with males which were not transferred to the island (tuatara do not form permanent pair bonds), thus the genetic diversity of the transfer population is likely to be increased by any ensuing young. About one quarter of the females were expected to lay during the spring or early summer following their release. Since tuatara eggs take between 12 and 15 months to hatch, the first young were not expected until some time after December 1997.

Tuatara were liberated during spring at the end of the cool winter months when they are generally relatively inactive. As a consequence they were expected to remain at their release sites and feed at a moderately low rate. They were



Tuatara* Sphenodon punctatus punctatus © *Keith Owen

sites with the females remaining locally, as only males tend to forage away from their preferred burrows. The population was expected to remain local (to release sites) and with functioning transmitters attached most individuals would be easy to relocate. During spring - early summer (October - December) some females may move up to 50 metres to search for suitable nesting areas. They were expected to return to their original territories within two weeks of laying.

Post-Release Monitoring

Survivorship and dispersal of the transferred tuatara has now been monitored for two years. This has involved a series of visits to Moutohora between October 1996 and November 1998. The results of the monitoring show that the majority of the tuatara are still alive after two years. Since release they have not shifted far from the four release sites and nearly all have increased their capture weights. The use of artificial burrows has declined from 20 to 2. The majority of transmitters worked well although some animals had shed their harnesses. Some were re-caught and harnesses re-attached, while the few that remained without transmitters were re-captured when they were more conspicuous in spring.

In March 1997 there was some indication of courting taking place but as yet there is no indication whether young have been produced. Twenty eight (88%) of the tuatara have been observed since the release and the remaining four are presumed well and living near their original release locations.

Conclusion
Confirmation that a self-maintaining population of tuatara has established will take some time, as tuatara live for at least 60 years, and females breed, on average, just once every four years. The transfer will be judged to have been a success if by October 2001 at least 2-3 juvenile tuatara are found. This represents a minimum standard. Subsequent releases may be necessary if more than 40% of the transferred tuatara die within five years of their release.

The re-introduction of tuatara to Moutohora has not foreclosed future options for indigenous fauna re-introductions to the island. This is important as Moutohora is managed for ecological restoration rather than for favored species. If the transfer is successful, this will enhance the island's biodiversity. In the future closely supervised parties will be able to visit and see tuatara (and other wildlife) on Moutohora so that they could learn about the island's restoration program.

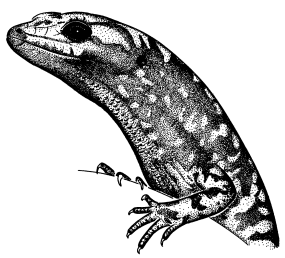
Contributed by Keith L Owen, Technical Support Officer, Department of Conservation, Rotorua, New Zealand.

SKINKS, IGUANA AND LIZARDS

Re-introduction strategies for New Zealand skinks

Introduction
The New Zealand biota suffers from a problem shared by archipelagos elsewhere: severe depletion by introduced predators. The first introduced predator, the Pacific rat *Rattus exulans*, arrived 1 - 2000 years ago, but between 1000 and 100 years ago a further 10 species were added. Apparently resulting from the depredations of introduced organisms, at least two endemic species of lizards have disappeared and many of remaining 61 species are reduced to fragments of their former range.

These declines, and new initiatives to reverse them, are exemplified by the nine species of skinks in *Cyclodina*. The largest *Cyclodina* skink was huge (perhaps 400mm in length), but is known only from recent subfossil deposits in the northern North Island. Its disappearance coincides with extinctions of invertebrates, frogs and small flightless birds which most likely occurred following the arrival of Pacific rats. Five other species have highly restricted ranges, and four of them are now confined to a handful of offshore islands despite evidence from deposits in caves of previous widespread distribution. All five species are nocturnal or crepuscular inhabitants of burrows and crevices, often on islands heavily used by burrowing seabirds.



Whitaker's Skink* Cyclodina whitakeri © *David Towns

Remedial action
In 1992 a recovery plan was approved for two *Cyclodina* species: robust skink *Cyclodina alani* and Whitaker's skink *Cyclodina whitakeri* (see Table 1). A replacement plan (due for publication in 1999) now covers the six rarest species in the genus. Recovery of four of these with very high conservation rankings involved removal of introduced vertebrates (usually rodents) and re-introductions of the skinks to islands within their former range (Table 2).

One species, Whitaker's skink, has been the subject of intensive post-release monitoring for over 10 years on 18 ha Korapuki Island (see *Re-introduction News* 1995, No 11). In summary, Whitaker's skinks revealed:

1 At least 64% survival of the release group (28) to year one, with subsequent losses (including emigration) <5% per annum.
2 Adults have reached at least 16 years with no sign of reproductive senility.
3 The nett rate of increase is only 5-9% per annum; at present rates of increase the release population will take 12-16 years to double.
4 Seven years periodic monitoring were required to determine that the population was self-sustaining.

These data have contributed to the following strategies for releases and monitoring for other species of *Cyclodina*.

Table 1. Planning procedures used by the Department of Conservation (DOC) and applied to the re-introduction of New Zealand skinks

RELEVANT/ PLAN POLICY	EXPLANATION
Conservation management strategies	10 year strategic plans for all public lands administered by DOC. Site based and legally binding.
Management plans and restoration plans	Site based, include ecosystem/community restoration goals. Management plans are legally binding.
Translocation guidelines	Internal (DOC) guidelines for translocation and re-introduction based on IUCN Guidelines.
National and international (IUCN) conservation rankings	National species priority assessment includes rankings for undescribed species, sets DOC priorities for recovery planning
Recovery plans	Often multi-species plans, minimum duration five years, statements of DOC policy, subject to funding availability, not legally binding

Re-introduction strategies
Re-introductions of *Cyclodina* skinks have been based on three principles, each of which may benefit from further testing:

1 The distances over which species are translocated have been kept to a minimum. There have been practical reasons for this. Physiological studies have revealed unusual cutaneous water loss problems, and very narrow thermal ranges over which some species are active. Short distance transfers (<10 km) should ensure the best possible match of local microclimates. Also, with short distance transfers, the animals are subjected to the stresses of captivity for the shortest possible time.
2 Translocations have predominantly been direct ("hard") transfers of wild-caught animals. Coupled with the short distance moved, this has had the advantages of avoiding offsite holding facilities and reducing the risk of contact with foreign diseases/ parasites.
3 The group used has usually been about 30 individuals. The group size chosen was a compromise between the ideal population, the potential to significantly affect the parent population, and the need to avoid a small, inbred translocated group. Populations of more than 20 should reflect most of the genetic variation of a parent group, but this assertion requires validation for lizards. The Whitaker's skink population established on Korapuki Island was from random captures of adults (1:1 sex ratio) and juveniles.

Criteria for success
The annual reproductive output of some *Cyclodina* species is only one/female/year. Consequently, considerable monitoring is required to detect any increase in population size. Assuming a successful translocation is one where the released population is at least self-sustaining, costs of monitoring could be reduced through the use of staggered monitoring targets:

- **Five years after release:** Locate the released population and search for new individuals present. The goal is to identify whether the released population survived and is breeding. It will likely be too early to determine whether the population is expanding.
- **Ten years after release:** Attempt to capture at least as many lizards as were released, identify the proportion of new versus original animals, and calculate population estimates. If estimates are unreliable, capturing as many animals as were released still indicates that the population is self-sustaining (births are replacing deaths and the population is at least stable).
- **Fifteen years after release:** Intensive surveys to determine either rate of expansion of the released group, or to identify whether the population is self-sustaining (if this was not possible previously).

Table 2. Habitat expansion through re-introductions of four rare species *Cyclodina* skinks with high IUCN threat rating or high Department of Conservation (DOC) priority rating. Number of re-introductions (locations) to date in parentheses.

Species	Rating	Approximate available habitat (ha)	New habitat available (ha)
Cyclodina alani	Vulnerable	35	373 (4)
Cyclodina macgegori[1]	Vulnerable	16	369 (14)
Cyclodina n. sp. "Mokohinau"	Category A	9	155 (1)
Cyclodina whitakeri	Vulnerable	20	343 (3)

[1] Includes eradication of a sympatric mouse population

Conclusion
Re-introductions of lizards to islands have the potential to increase the conservation status of up to 37% of the New Zealand lizard fauna but intensive studies of rare *Cyclodina* skinks have produced a sobering message: **don't expect quick results when establishing new populations**. The low reproductive output of these species doubtless contributed to their present precarious state. The same low output will ensure that the time to reach carrying capacity of *Cyclodina* skinks re-introduced to small islands (<50 ha) should be measured in decades and on large islands (>100 ha) should be measured in centuries.

Contributed by David Towns, Science and Research Unit, Department of Conservation, Auckland New Zealand; Richard Parrish, Northland Conservancy, Department of Conservation, Whangarei, New Zealand.

The recovery strategy for the Jamaican iguana, Jamaica

It is remarkable for a species once considered extinct to be rediscovered and then given a second chance for survival. Such is the case with the Jamaican iguana *Cyclura collei* regarded by many as "the world's most endangered lizard" and now the subject of an extensive and ambitious international conservation effort. Feared extinct for nearly 50 years, a live specimen had not been seen since the 1940's when the species was thought to have perished as the result of hunting and predation by the introduced mongoose. But in June 1990, a dog belonging to pig hunter Edwin Duffus captured an adult male iguana. That event not only confirmed the species' existence, but sent shock waves throughout the world conservation community.

The Jamaican iguana owes its survival to the remoteness of the rugged limestone forests of the Hellshire Hills region of southeastern Jamaica. Located just outside of Kingston, the Hellshire Hills is a small (10 km x 15 km) peninsula of dry tropical forest that has remained in almost pristine condition. The area supports a wide variety of Jamaican endemic plants and animals, and represents an

outstanding example of the Caribbean natural heritage matched by very few dry forests anywhere in the West Indies. Thus far, the Hellshire has provided protection for the iguana due to its remoteness, inaccessibility, and lack of water. Increased human activity is rapidly changing this situation, and the next few years will be critical for the future of the Jamaican iguana.

Soon after the rediscovery, the Jamaican Iguana Research and Conservation Group was formed. Led by Dr. Peter Vogel (University of the West Indies) and Rhema Kerr (Hope Zoo), the group began to actively survey the Hellshire Hills. During this fieldwork a number of important findings occurred, not the least of which was the discovery of two active nesting sites in 1991. Further surveys confirmed the existence of a remnant population of iguanas in this habitat; however, the observations suggest that this population exists at a very low density and certainly well below what the habitat could support.

With few exceptions, most iguanas observed appeared to be large, old adults, which suggested an aging population with low reproductive success and recruitment. This can be attributed to predation by the introduced Indian mongoose *Herpestes auropunctatus* which are abundant in the Hellshire Hills, and appear to be the single-most important factor contributing to the iguana's decline by depressing juvenile recruitment. The problem is exacerbated by charcoal burners who frequent iguana habitat, and often bring along dogs which are well known to attack iguanas. As the charcoal burners move deeper into the forest to extract charcoal, the iguanas are displaced.

To assess the various threats to this small population, and evaluate the risk of extinction, a PHVA workshop was conducted in 1993 under the auspices of the IUCN/SSC Conservation Breeding Specialist Group (CBSG) and organized by the Fort Worth Zoo. The consensus of the workshop participants was that unless high juvenile mortality associated with mongoose predation was reversed or offset, this small population was headed for extinction. Worse, the loss of breeding female iguanas (certainly possible if feral dogs attacked the nest sites as they congregated to lay eggs) could have a devastating effect on the population.

The ultimate goal of the Jamaican iguana recovery program is to re-establish a viable population of iguanas in their natural habitat. Based on the workshop, a three-pronged conservation strategy was proposed that would prevent the rapid extinction of the Jamaican iguana. First, 50% of hatchling iguanas would be collected at the nest sites for headstarting at the Hope Zoo; iguanas would be re-introduced once they had reached sufficient size to avoid mongoose predation. Second, an active predator control program to reduce the mongoose numbers would be implemented to increase survivability of hatchlings. Third, a captive breeding program, both in Jamaica and the U.S., would be established in order to provide a hedge against loss of the wild population, and to serve as a genetic reservoir.

After five years of headstarting at the Hope Zoo, it was felt that a release of Jamaican iguanas on a trial basis should be attempted. Prior to re-introducing iguanas however, several concerns were raised. Is a "hardening facility" in the Hellshire Hills necessary to acclimate headstarted iguanas, or will they adapt readily to local conditions? Can captive raised iguanas find suitable food sources and locate appropriate refugia? In other words, are Jamaican iguanas "hardwired" such that their natural instincts will provide the necessary survival ability? Successful re-introduction programs with other reptiles suggest that they are "hardwired", and due to the logistical problems associated with constructing a pre-release enclosure in the Hellshire Hills, the decision to attempt a "hard release" was made.

In April 1996 the first two 1991 hatched headstarted iguanas were fitted with radio-transmitters and released into the Hellshire Hills (photo 1). Though this event marked a significant milestone in the program's development, it was actually the beginning of a whole new set of challenges. Radio-transmitter attachment techniques that had proved successful with iguanas in other habitats simply did not stand up to the ruggedness of the Hellshire Hills sharp limestone karst terrain. In 1997 an innovative form-fitting vest was designed to secure the radio-transmitters which was used on another six iguanas released in June. Unfortunately they did not hold up long as needed. In 1998 a tough Cordura material was used, resulting in a vest that withstood the demands of the iguana's habitat. A total of twelve headstarted iguanas was released in February and June of that year, bringing the number of iguanas released since 1996 to 20. However, the challenge to perfect a transmitter vest is never ending, and negotiations are underway with the Nike corporation to develop a new "stretch Cordura" material that offers great promise for the future.

Photo 1. Jamaican iguana* Cyclura collei *being released with transmitter vest attachment © Rick Hudson

Data from these releases are encouraging. Iguana movements are monitored by radio-tracking and preliminary data indicate that 100% of the iguanas released thus far have survived naturally, without any form of pre-release conditioning or supplementation.

Perhaps the most exciting finding is the observation of a small female at the nesting site in 1998 believed to be one of those released in 1997. This is significant because it indicates that released females will return to their natal nest site, a factor that is probably crucial to their breeding successfully in the wild. It is for this reason that all iguanas are released at one of the two known nest sites. Not unexpectedly, released females tend to localize and settle down near the nest site depressions while males will often disperse out of the core iguana area.

A full-time exotic animal control specialist is now employed full time to trap mongoose, and after a year and a half it now appears that these predators can be substantially reduced in the core iguana area. While these results are encouraging for the short-term future of this project, and serve to bolster our confidence in our ability to successfully restore the Jamaican iguana to its native ecosystem, much work remains to be done. Field observations and data collection have been ongoing since 1991, and even after eight years, it remains difficult to accurately estimate the number of iguanas surviving in the Hellshire Hills. However, based on the number of nesting females observed from year to year, the total adult number could very possibly be as low as fifty, and certainly no higher than a few hundred.

To categorize this re-introduction as a true success story, we must have long-term survival data. Such information can only be obtained through continued field research, which necessitates sustained funding. Fortunately this program has many of the key elements already in place needed to insure continued success. First, there is a dedicated team of conservation biologists in Jamaica that are truly committed to the survival of their native iguana. Without this component, implementing such a comprehensive conservation endeavor would be impossible. Second, the Natural Resources Conservation Authority (NRCA), the University and other conservation NGOs provide salaries to essential field personnel. And third, the extensive involvement of the American Zoo Association (AZA) and many of its member-institutions. Over 20 AZA zoos have contributed financial, technical and logistical support to this project, and to date nearly $100,000 has been raised through the efforts of zoos.

As we struggle to answer the basic questions concerning iguana restoration techniques, a critical question must be answered by the Jamaican government who ultimately will determine the long-term success of this project. In "bottom line" terms the key element in saving the Jamaican iguana is protecting their remaining habitat. Will the Hellshire Hills ecosystem be established as a protected reserve or national park? Until that happens, iguana releases will continue to re-enforce the existing population.

Another important goal is to re-establish a satellite population of iguanas on one of the offshore Goat Islands, part of their former range. Lending international support to this effort is the IUCN/SSC West Indian Iguana Specialist Group (IUCN's newest specialist group) which designated the Jamaican iguana as one of their highest priorities for conservation.

Today this program is considered a model for future recovery plans for endangered large iguanines, a remarkable feat when one considers the time frame: from rediscovery to re-introduction in just seven years, 1990-1997. Promising as this may sound, true success can only be judged with time, and only time will tell if one of Jamaica's national treasures will survive into the next millennium.

Contributed by Rick Hudson, Chair, AZA Lizard Advisory Group, IUCN/SSC West Indian Iguana Specialist Group, Fort Worth Zoo, Texas, USA.

Successful establishment of translocated St. Lucia whiptails on Praslin Island, St. Lucia, West Indies

The St. Lucia whiptail lizard, *Cnemidophorus vanzoi* (Teiidae), is a single island endemic and the sole representative of its genus in the Lesser Antilles. It is a ground dwelling, diurnal, primarily insectivorous macroteiid. Prior to 1995, this lizard inhabited two small offshore islands in St. Lucia; the Maria Islands (13º14.38'N, 60º56.3'W) comprised of Maria Major (10.2 ha) and Maria Minor (1.8 ha) located 1000m off the south-east coast of St. Lucia. The Maria Islands are a Nature Reserve established 1983 and managed by the St. Lucia National Trust.

Due to the perceived risk from fires and introduced predators from the main island, a translocation of lizards was conducted as a conservation strategy. The project was carried out by the St. Lucia Forestry Department and the Durrell Wildlife Conservation Trust, UK. Praslin Island (13º52.2.'N, 60º53.1'W) located 200m off the east coast of St Lucia, 21 km north of the Maria Islands was selected as the translocation site.

Praslin Island (1.1 ha) is privately owned but currently leased to the St. Lucia Forestry Department. In 1991 a feral population of goats was removed and a rat eradication program was successfully conducted in 1993. Vegetation on Praslin Island found the site to be suitable for lizards. Estimated lizard abundance on Maria Major was adequate to supply a founder population.

In May 1995, 42 *Cnemidophorus vanzoi* were translocated from Maria Major to Praslin Island, as two separate events. The composition of the initial translocated population was 13 adult males, 12 adult females, 2 juvenile males and 1 juvenile female. Shortly after translocation, a single mongoose was discovered on Praslin Island and following removal, only one adult male was seen on the island. A further 14 lizards (7 adult males, 6 adult females, and 1 juvenile female) were translocated. There have been no subsequent translocations.

Morphometrics, demographics, genetics and abundance of the translocated population were investigated during the wet and dry season between October 1997 - March 1998.

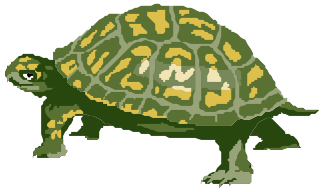
Mean population size is estimated at 155 ñ 26 individuals but a significant seasonal difference in abundance is observed (monthly estimates range from 72 – 196 individuals). The mean sex ratio of 1.0 and mean age ratio of 1.7 did not vary significantly by month or season on Praslin Island. Although a significant seasonal difference in condition indices (length-corrected mass of adults with intact tails) was observed in adult females and juvenile males; the overall condition was not significantly different from the founding population. A high frequency of tail autotomy suggests intense intraspecific competition as the island only infrequently supports rats *Rattus rattus*. The seasonal changes in abundance, body mass and condition index observed on Praslin Island suggest resource limitation during the dry season or selective aestivation.

Microsatellite DNA investigation using eight polymorphic loci examined showed the heterozygosity had not significantly deceased since the founding event (Rst=0.009, Gst=0.02) but that the population is not panmictic (Hardy-Weinberg equilibrium, p=0.001). A total of 21 alleles were detected (mean alleles/locus=2.63) suggesting an effective founding population size of ten pairs. Using the potential range of founding pairs, a high growth rate (r=0.97-3.95) was calculated for the translocated population.

Our studies on the Praslin lizards has clearly shown that the founding of new populations of the species is possible at least in one of the islands off St. Lucia. A third population of rare St. Lucia whiptails has now been established on Praslin. The high growth rate calculated for the population suggests that it is reproducing successfully in its new environment. No significant changes in condition or size have been detected in the translocated population three years after the release of the first animals.

Praslin Island has become an important model for the study of reptile translocations and the data collected in our study will provide the necessary elements to evaluate the need and feasibility of creating more populations of the species in St. Lucia. In the meantime, more offshore islands can be cleared of black rats to restore these to a state, within which, if considered appropriate, other populations could be established.

Contributed by Hannah C. Dickinson and John E. Fa, Durrell Wildlife Conservation Trust, Trinity, Jersey, Channel Islands U.K.



SNAKES

Re-introduction of the Virgin Islands Boa to the Puerto Rico Bank, The Caribbean

Introduction

In 1993, after several years of successful breeding at the Toledo Zoological Gardens (TZG), 23 Virgin Islands boas *Epicrates monensis* were released to an offshore cay of Puerto Rico. This joint effort between the TZG and the Departamento de Recursos Naturales y Ambientales (DRN) and the U.S. Fish and Wildlife Service (FWS) has been funded by the AZA Conservation Endowment Fund and the FWS and has had outstanding early success.

Re-introduction was a reasonable strategy to assist in the recovery of the Virgin Islands boa. Captive-breeding and re-introduction was one of the critical tasks in the FWS Recovery Plan, and the major elements deemed to be important in the success of a captive-breeding and release program have easily been fulfilled. There has been ongoing research in the genetics and reproductive biology of the captive population, the basic natural history of the species has been documented, habitat preservation and management is continuing, and there has been adequate preparation for the re-introduction in terms of choice of candidates (e.g. genetic background, sex ratio, age class, behavioral attributes). In addition, re-introductions to the wild only involved those individuals originating from a source population which was closest to the release site.

Site Selection and Preparation

Our site in Puerto Rico was selected for a re-introduction attempt because it was government owned, had adequate stands of closed canopy littoral forest, had densities of *Anolis* comparable to habitats supporting Virgin Islands boas, and was small enough that rodent eradication could be accomplished. Topography was also a consideration in the selection of release sites as major hurricanes are a frequent feature of yearly weather patterns in the Antilles and hurricane storm surges can inundate low lying cays. Although boas coexist with rats on the large islands of the Puerto Rico Bank, e.g. Isla Culebra, Isla Mona, Puerto Rico, and St. Thomas, our extensive surveys have never detected boas on any of the smaller islands where rats are present. This may be due to the fact that rats are far more abundant on most of the smaller cays than in equivalent habitat on the larger islands. In anticipation of re-introduction efforts, we initiated rodent poisoning programs on three islands determined by principal components analysis to have habitats and food resources similar to those islands with extant Virgin Islands boa populations.

Rats were eliminated by placing 8 - 10 blocks of anticoagulant poison- bromadiolone, currently available as Contracâ and Makiâ paraffin blocks- at each interstice of a 10 m^2 grid, which covered the entire island. 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. In addition to grid poisoning, bait blocks also were placed at sites likely to be visited by rats, such as in hollows of trees, under rocks, in debris piles, and along the shoreline. This poisoning strategy was previously tested by the TZG and the Division of Wildlife, U.S. Virgin Islands and resulted in successful rat eradication on Dog Cay, Kalkun Cay, and Steven Cay, U.. S Virgin Islands with no harm to the native biota. Pre-and post-poisoning activity by rats at the site was monitored by removal trapping along three 100m trapline transects. The pre-poisoning rat index of 0.160 rats/trap/h at the site calculated from trapping on 1 - 3 September 1991, dropped to an activity level of 0 rats/trap/h on the next two visits after poisoning. To detect bw 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.

Preparation of snakes for re-introduction

Captive-born adult and subadult snakes destined for release are quarantined at the TZG for 30 days where they are examined by staff veterinarians and screened for disease and parasites. During this period they are fed live *Anolis cristatellus* to ensure that the snakes find natural food to be palatable. None of the snakes destined for re-introduction has ever refused to eat these lizards. After feeding successfully on natural prey, the snakes are tested for hunting ability in a 2 m x 2 m x 1.5 m mesh enclosure containing live *Anolis cristatellus*. The anoles are able to escape if the snake is unsuccessful in its predatory attempts. Of the 23 snakes tested for the August 1993 release, only two were unsuccessful in capturing *Anolis* the first night. These two snakes were not released. Neonates were released within one week of birth. There were no attempts to feed them in captivity prior to their release.

Evaluation of re-introduction strategies

During August 1993, 28 captive born boas from seven different zoos (Buffalo, Denver, Ft.Worth, Milwaukee, San Antonio, Virginia, and Toledo) were released on the cay. Completion of rodent eradication and monitoring of *Anolis cristatellus* densities in June 1993 had indicated that the site had adequate food resources for a re-introduction attempt. The release sites on the cay (a small depression forest dominated by *Pisonia subcordata*, and a littoral forest dominated by *Coccoloba uvifera* and *Conocarpus erectus*) were representative of habitat elsewhere on the Puerto Rico Bank where high densities of boas were present. The snakes released were offspring of adults captured on a nearby island. Released adults and subadults were individually identified using passive integrated transponders (InfoPet Identification Systems, Inc., Burnsville, Minnesota); neonates were identified by photographs of the dorsal body pattern. Six adult animals were implanted with SM-1 radiotransmitters (AVM Instrument Co., Ltd., Livermore, Clifornia), for monitoring.

Data on activity patterns and foraging behavior are presently being collected for the released snakes. The initial releases included radiotracking individuals implanted with transmitters to assess to what degree captive-raised individuals duplicated behavior of wild snakes. Transmitter-implanted snakes were intermittently monitored by TZG and DRN personnel from August to October 1993, until battery failure. A program of quarterly monitoring for the first year, funded by the FWS, established minimum survival estimates for the first snakes released of 82.6 % through August 1994, 48% through August 1995, and 21.7% through August 1997. These are gross underestimates of survival, as it may take years to relocate a snake after it has been released. Six of seven neonates released in August 1993 survived at least one year. To obtain a truly representative analysis of behavior and survivorship, annual monitoring will continue through 2003. In addition, reproduction occurred at least twice in the re-introduced population during the first breeding season, and six of the seven offspring known to have been born on the cay were recaptured least one year after their birth. In August 1994 a gravid female was recaptured and she gave birth to five healthy young two days later. At least 8 of 9 neonates known to have been born on the cay have survived more than 1 year. Gravid females were also encountered in 1997 and 1998.

The best strategies to elect for a conservation program are highly dependent on the natural history of the organism and the degree and types of threats faced by the wild population. Given the considerable dissent on the efficacy of re-introduction as a conservation strategy, it would seem that a conservative approach for recovery efforts for a species would be one which attempts to mitigate as many threats as possible. We have attempted a multifaceted approach for the Mona/Virgin Islands boa conservation program.

While it is too early to claim success for the re-introduction phase of the project, we have established that:

1 Captive-born *Epicrates monensis* can learn to hunt and capture their natural prey after release;
2 Captive-born *Epicrates monensis* will readily reproduce after release; and
3 Captive-born neonate *Epicrates monensis* released on the site have a first-year survival rate which surpasses that of the wild population.

FWS, DRN, and TZG management personnel have a seven-year history of successful cooperation in recovery efforts for this species. With continued commitment from these agencies, future management actions should be successful as well.

Contributed by Peter Tolson, Director of Conservation and Science, Toledo Zoo, Toledo, Ohio, U.S.A

Breeding and releasing Indian rock pythons, Ahmedabad, India

The Sundarvan Nature Discovery Center of the Center for Environment Education promotes the use of live snakes as a medium to create environmental awareness. Its activities include educational snake shows, animal exhibition, nature interpretation, material development and conducting nature camps. Sundarvan has been recognized as a mini-zoo under the Central Zoo Authority (CZA) of India.

In 1996, Sundarvan was successful in breeding the Indian Rock Python *Python molurus molurus* in a 3m x 1.5m cage. The lengths of the male and female were 2.72m and 3.6m respectively. The cage has an earthenware pot into which the snakes retire, besides a large tree branch and a water tub. On 23rd May 1996 a total of 16 eggs were discovered and after a 54 day incubation period hatched but some of the hatchlings had to be removed manually from their egg shells (photo 1). The full details of this project were published in the January 1997 issue of ZOOSPRINT.

Indian python* Python molurus molurus *hatchlings being manually removed by Park Supervisor M. Kesubha

With the approval of the CZA, 4 baby pythons were transferred to the Kamala Nehru Zoological Park in Ahmedabad during 1997. A detailed plan of release, for the remaining juveniles, in the wild areas of Gujarat was prepared and necessary approvals obtained from the CZA and the state Forest Department. The IUCN/SSC Re-introduction Specialist Group in Nairobi, Kenya, made available the latest IUCN/SSC Re-introduction Guidelines and also commented on the proposal.

Our pre-release planning included: sub-species verification, veterinary screening, recording morphometric parameters and individual patterns on the head. A couple of months before release the snakes were regularly taken out of their enclosure and allowed to move about in the park so that they became slightly acclimatized to the outside environment. These animals could track down prey (live mice) and capture it in their enclosure. Post-release monitoring in our plan was envisaged on the basis of sighting records by locals and forest staff. Unfortunately, due to resource constraints direct monitoring could not be envisaged in this venture.

The Chief Conservator of Forests (wildlife) recommended Shoolpaneshwar Sanctuary, Rajpipla (East) as one of the sites for release. On 12th November 1998, 6 pythons were released with the help of forest officials deputed by the Deputy Conservator of Forests (D.C.F.), Mr. Sanjeeve Tyagi. The two release sites in the forest were selected on the basis of their potential as python habitats and each had a water body close by with adequate vegetation cover.

The following persons were actively involved with this project: A. J. Urfi, Keshubha Jethwa, Natubha Jethwa, Babu Bhai, Madansinh Sisodia, Jagroprasad Pal, E. K. Nareshwar, Rajindersinh Jadeja, Kandarp Kathju, M. G. Gajjar and V. B. Bhatt. We are grateful to K. V. Sarabhai, Director of CEE, for encouragement.

Contributed by Dr. A.J. Urfi, Coordinator Sundarvan, Ahmedabad, Gujarat, India.

CROCODILES AND ALLIGATORS

Reintroduction program of the Orinoco crocodile in Venezuela

The Conservation Program of the Orinoco crocodile *Crocodylus intermedius* was started in the 1970´s by a private initiative, with the support of governmental institutions. The first breeding facilities were built at Agropecuaria Masaguaral (Guárico State), and since then an increasing number of breeding centers have been established over the years. Since then four more facilities have been founded, namely the Biological Station EL Frio, in Apure state; National Experimental University of the Llanos Ezequiel Zamora (UNELLEZ), in Portuguesa state; Agropecuaria Miranda, in Guárico state and Limnological Institute of the Orient University, in Bolivar State.

The main objective of the program is the breeding of crocodiles for re-introduction into parts of its historical range. This is subsequently followed up with post-release monitoring to study the adaptation of the re-introduced crocodiles into the wild. Crocodiles are bred in a captive-breeding facility as well as the collection of one-month old hatchlings from the wild for raising on farms. Once they reach a desirable length of approximately 1m they are released in selected points within the known distribution areas. The main areas of release are the Caño Guaritico Wildlife and Aquatic Refuge, Apure State; Cinaruco Capanaparo National Park, both in the Apure state and the Aguaro Guariquito National Park, in Guárico State (Table 1).

***17 year old captive male Orinoco crocodile* Crocodylus intermedius**
© Alvaro Velasco

At pre-release the crocodiles are measured, weighted and veterinary screening is conducted. The crocodiles are marked with scale cutting in order to identify individuals after release and to compare baseline information after their release in the wild. Once the crocodiles are released the second component of the conservation project begins. This component was initially funded by the Foundation for the Defense of the Nature (FUDENA), Wildlife Conservation Society (WCS) and since 1996 by the Wildlife Service of this Ministry. The work consists in monitoring the released individuals by means of mark-recapture methods, and also measuring and weighting them. This data give us information on survival and adaptation into the wild which is useful to evaluate the success of these re-introduction activities.

Generally the individuals have adapted well to their new habitats and growth has been within the expected parameters. The first observed response of the released crocodiles was an adaptation period during which there was no growth or increase in weight which was probably brought up by release stress. After a period of time the crocodiles continued with their normal development. In 1997 the first nests from crocodiles released in El Frio Biological Station were found, but all the eggs were infertile. In 1998, two nests with fertile eggs, were found, and these were collected and incubated. This was the first generation of crocodiles originating from re-introduced individuals.

The WCS has also funded another study which is radio-tracking some crocodiles in the Cinaruco Capanaparo National Park. This date will be useful in evaluating the degree of adaptation of the animals and their mobile ranges. In conclusion, we can say that programs of this type involve considerable expense and time but with patience satisfactory results can be obtained. We recommend that the conservation value of crocodiles re-introduction programs should be continuously evaluated to make sure objectives are being met and any changes in management plans made accordingly and in time.

Contributed by Alvaro Velasco B., Ministerio del Ambiente y de los Recursos Naturales Renovables, Venezuela.

Supplementation of Farm-Raised Alligators in Louisiana, USA

Management programs involving raising captive crocodilians for commercial and conservation purposes have been successful for numerous species worldwide. American alligators *Alligator mississippiensis* will breed in captivity, but hatch rates are low and emphasis has shifted to "ranching" programs, wherein eggs are collected from the wild.

Natural mortality rates of alligator eggs and juveniles are high; thus ranching allows utilization of resources otherwise lost. The program in Louisiana provides an economic incentive for landowners to conserve and manage their wetlands. Because adult alligators are harvested each September (in addition to egg ranching from the same wetlands), the Louisiana Department of Wildlife and Fisheries (LDWF) requires that a portion of the juveniles raised from ranched eggs be returned to the collection site. The alligator rancher must release alligators between 36" and 60" (0.92 m - 1.52 m) to the wild, representing a percentage of his hatch rate based on estimated mortality/survivorship curves for wild alligators.

This article summarizes prior and ongoing studies by the LDWF on the survival, growth, reproduction, and dispersal of farm-raised alligators released to the wild. Portions have been previously published by us in the scientific literature.

Before 1986 the farming program in Louisiana was

Table 1. Number of Orinoco crocodiles *Crocodylus intermedius* released by year and locality

Locality	1990	1991	1992	1993	1994	1995	1996	1997	1998	TOTAL
Caño Guaritico W.A.R.	30	56	99	247	64	128	0	10	250	**884**
Cinaruco Capanaparo N.P.	0	12	364	200	0	0	0	0	0	**576**
Aguaro Guariquito N.P.	0	0	0	0	30	78	76	47	0	**231**
Hato El Cedral	0	0	0	4	0	0	0	0	15	**19**
Cojedes River	0	0	0	0	0	20	0	0	0	**20**
Tucupido River	0	0	0	18	0	0	0	0	0	**18**
TOTAL	**30**	**68**	**481**	**451**	**94**	**226**	**76**	**57**	**265**	**1,748**

limited, and early farmers were supplied hatchlings from eggs collected on state-owned lands. Soon the demand grew, and the LDWF developed guidelines and quotas whereby "ranchers" could obtain eggs from private wetlands. A variable return rate was established based on the estimated 17% survival from hatching to 48" (121.9 cm) predicted for wild juveniles. More alligators must be returned if the total length is smaller, and fewer animals if the length is larger. Re-introductions are made in warm months, and alligators are marked with monel web tags and tail notches. Total length and sex are also recorded. The alligators are transported to the wetlands from which the eggs were collected for release into appropriate juvenile habitat (shallow ponds in the marsh interior).

To compare growth and survival of released alligators to wild populations, LDWF personnel caught and marked 5,669 juvenile alligators in the wild, of which 495 were farm re-traps and 368 were wild re-traps. We concluded "catch and release" efforts were more useful for comparative growth data than for evaluation of survival, because few native wild marked juveniles have been later harvested as adults.

During September harvest, trappers are issued forms to report harvest of marked alligators, and re-traps are also obtained by having LDWF staff work in alligator processing sheds. Many re-traps obtained have incomplete data, most commonly due to lost or mis-read web tags. Through 1998, some 6,100 re-traps of sub-adults and adults were obtained in harvests. The average interval between release and recapture for the released alligators harvested in 1997 (retaining web tags) was nearly four years.

We evaluated stomach contents of juvenile alligators to determine if released alligators (which are provided food in captivity, often as a dry palletized feed) would be capable of foraging for food. Released and native alligators had similar food habits. Farm-released alligators consumed more large prey items (birds and mammals). Lateral fat bodies were significantly heavier in re-introduced alligators. A preliminary analysis of growth from alligators collected through 1991 was published using mark-recapture methods for 274 "re-traps" over four years. Alligators were paired by sex, size class, source (released or native wild), and as to whether they had overwntered. In most groups, the released alligators grew significantly better than wild alligators matched for sex and size. In the remaining groups the re-introductions grew as well as their counterparts.

Through 1996 a total of 2,866 usable re-traps were available for growth analysis over 8 years; results paralleled the initial study, with superior growth rates in released alligators maintained after several winters. The accelerated growth and rapidity with which the released alligators learn to forage for food should enhance their survival.

Blood samples were collected during our "tag and release" work on native wild and re-introduced alligators. No differences were seen in corticosterone (stress hormone) levels between groups; another indicator of the well being of the juvenile alligators after release. Our "tag and release" program provided substantial data to compare growth, but long term survival of released individuals is better evaluated by recoveries of marked alligators in the annual harvests after they have grown to adult sizes, which comprise about 85% of the harvest.

We chose three land companies as study areas for preliminary survival analysis. These areas total 165,000 ha in southwestern Louisiana, and comprise 20 - 30% of the entire wetlands in the egg ranching program. Several survival models were tested on tag recovery data. The best "goodness of fit" was the minimum known alive model which estimated the probability of surviving to a specified harvest season following release and then being caught. The preliminary survival calculations estimated survival to four years post release to be 85.3%. Numerous factors preclude documentation of all known re-traps; thus survival of released alligators is likely greater than our estimates, which are uncorrected for differential harvest between sexes or tag loss. Of approximately 6,100 farm releases harvested statewide since 1988, some 3,200 were recovered in the two most recent seasons. Premature analysis would have underestimated the survival rate of released alligators.

In the future we will evaluate dispersal from the release site. We have observed that over time, many re-introduced alligators have moved significantly, possibly to find breeding opportunities or nest sites as they approach maturity. We have numerous recaptures of farm-releases on wetlands where releases to the wild have not been made. Most young crocodilians have high mortality rates, and to minimize these losses egg ranching has evolved as a conservation tool for many species. Numerous international wildlife management programs have incorporated release of "head-start" captive-raised crocodilians to enhance recruitment of natural populations or to restock depleted habitats. Some management programs suggest 5 - 10% of the eggs or hatchlings collected to be released as juveniles to replace natural recruitment. Some programs recommended this not be mandated unless an impact on the population is seen.

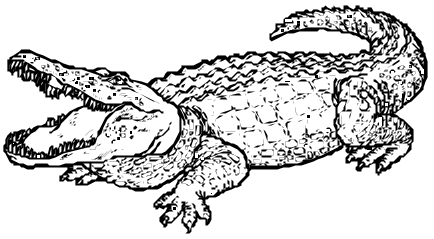
However, supplementation's are not always successful and in some habitats or for certain species may not be appropriate, and need not be mandated as part of every sustained utilization program. This may be due in part to limited habitat available (i.e. a river and its fringes) with no separation of adult and juvenile habitat, leading to high intraspecific competition. In coastal Louisiana, vast wetlands with separate juvenile and adult habitat may promote survival of re-introduced juvenile alligators. We have suggested that tropical habitats with distinct wet and dry seasons may not be suitable for release due to habitat loss in dry seasons.

Recent collections documented reproductive maturity/

nesting in released juveniles which were harvested as adults. Reproductive tracts from released females which were harvested documented over 35 specimens having attained sexual maturity and ovulation. These findings were vitally needed to ensure that re-introduced juveniles will later breed and maintain population recruitment.

These results suggest the "release to the wild" program appears successful thus far in Louisiana. Close monitoring will continue for many years by department personnel. Recent annual nesting surveys show a significant increase in nesting/population in coastal Louisiana, while supporting the harvest of over 2.6 million eggs since 1986 and some 27,000 or more adults annually. However, while our program appears successful, supplementation's may not be indicated or needed under other management practices. Future research will address selecting relocation sites, release season, optimum size, and quotas needed to maintain populations.

Ruth M. Elsey, Louisiana Department of Wildlife and Fisheries, Rockefeller Wildlife Refuge, Grand Chenier, Louisiana, USA.



RE-INTRODUCTION PRACTITIONERS DIRECTORY 1998

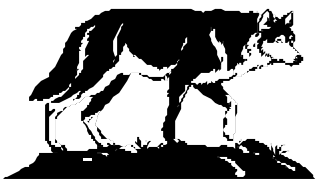
The Re-introduction Practitioners Directory (ISBN: 9960-614-08-5 / 97 pages) was produced and published by the IUCN/SSC Re-introduction Specialist Group (RSG) in conjunction with the National Commission for Wildlife Conservation and Development (NCWCD), Saudi Arabia. This directory was compiled and edited by Pritpal S. Soorae, RSG and Philip J. Seddon RSG Bird Section Chair.

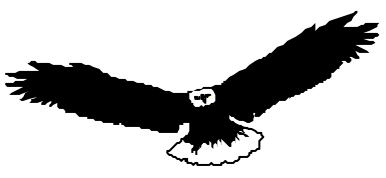
This directory was produced to provide re-introduction practitioners, researchers, students and interested individuals a means of establishing contact between re-introduction projects so as to encourage collaboration and exchange of ideas between projects. The directory covers animal (mollusks, bivalves, insects, fish, amphibians, reptiles, birds and mammals) and plant re-introduction projects by regions (East Europe, North and Central Asia; Oceania; West Europe; North America and the Caribbean and Africa). The contact addressees are listed by organization,

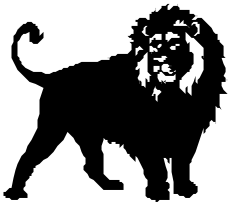
CARNIVORE RE-INTRODUCTIONS

Issue No. 18 (July 1999) will focus on carnivore re-introductions. This issue is being done in conjunction with Mike Phillips, RSG Carnivore Section Chair and Executive Director of the Turner Endangered Species Fund (TESF), Montana, USA.

Please contact the Editor immediately if you are interested in submitting an







RSG BULLETIN BOARD

RSG's Australasia/Marsupial Section Chair, Doug Armstrong, has developed a new RSG web-site for his section. The site can be accessed at:-
http://www.massey.ac.nz/~DArmstro/

Please access the following Website to obtain information on the history of the Species Survival Commission (SSC). The site is:

Esther Wenman, Head Keeper of Herps at the Zoological Society of London (ZSL) is involved in a a conservation and re-introduction program in Egypt for ***Testudo kleinmanni*** (CITES 1, 'Red Data endangered', probably extinct in Egypt) which was initiated in 1997, under the auspices of The EEAA (Egyptian Environmental Affairs Agency) and ZSL. A pilot re-introduction program involving ten radio tagged tortoises into an area of former habitat, within The Zaranik Protected Area, took place in October 1998. Post-release monitoring is being organized by ZSL. For further details contact Esther Wenamn at:-

The World Association of Wildlife Veterinarians (WAWV) will hold a joint meting with the European Section of the Wildlife Disease Association (EWDA) and the European Association of Zoo and Wildlife Veterinarians (EAZWV) at the World Veterinary Congress in Lyon, France from September 23rd - 26th 1999.
http://www..uniud.it/DSPA/wildvet/wawv/wawv.htm

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We welcome comments and contributions. Please send them to:

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