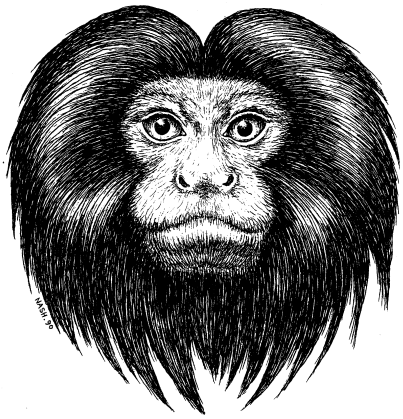
MESO & SOUTH AMERICA

Re-introduction and translocation as conservation tools for golden lion tamarins in Brazil

*NOTE: In this article, the origin of the released golden lion tamarins (*Leontopithecus rosalia*) will be distinguished by using the term re-introduction for captive-born animals (or wild-born animals that spent significant time in captivity). The term translocation is used for those wild-born golden lion tamarins transferred from forests threatened with deforestation into protected habitat. By the IUCN (1998) definition, both activities should be considered re-introductions since the tamarins were nearly all released into habitat from which the species had been extirpated.*

The golden lion tamarin was almost extinguished in the wild because of habitat destruction and intense hunting pressure, mainly for the zoo and pet market. By 1975, estimates suggested that only 100-200 individuals might survive. The emergence of a self-sustaining captive population of golden lion tamarins in the early to mid-1980s, the establishment of the Poço das Antas Biological Reserve for the species in 1975, and the beginning of a long-term study of the behavioral ecology of the wild lion tamarin population in Poço das Antas in 1983, converged to make possible the re-introduction of captive-born golden lion tamarins into native Brazilian forest, beginning in 1984 (Kleiman *et al.*, 1986; Beck *et al.*, 1991). The translocation, initiated in 1994, followed a full census of the species in 1991-1992 and was initiated to protect the genetic diversity of numerous tamarin groups living in isolated forest fragments threatened with deforestation.



Golden lion tamarin (*Leontopithecus rosalia*) © *Stephen Nash / Conservation International*

The re-introduction and translocation programs for the golden lion tamarin have had somewhat different rationales and emphases, although both are considered projects that combine research and conservation. The re-introduction in and around Poço das Antas was carefully planned to provide new genetic stock from the captive population and to increase the size of the wild population. By contrast, the translocation was an emergency measure to save the genetic variability from several isolated and severely threatened wild groups, in addition to establishing a new population.

Methods

Since 1984, 146 zoo-born and seven confiscated wild-born animals have been released primarily on privately owned ranches around Poço das Antas Reserve. The earliest releases were inside Poço das Antas Reserve and involved pairs and intact family groups; later releases were all of intact family groups to promote more rapid reproduction. The earliest releases provided considerable pre-release training in traditional zoo cages to reduce deficits in locomotion, foraging, and locomotor skills common to captive-born animals. Beginning in 1986, tamarins were instead provided with one to two summers of free-ranging experience in wooded habitats on zoo grounds as pre-release training; all re-introduced tamarins now have such free-ranging experience prior to release.

Currently, field researchers make daily visits to provide food, observe behavior, and provide special treatment, if necessary, following the initial re-introduction of tamarin family groups. As the re-introduced lion tamarins begin to eat natural foods and to expand their home range, the visits are progressively reduced from daily to three days a week, then to weekly, and finally monthly. Thirteen of the 50 groups in the re-introduced population are now totally independent of provisioning and management, and eight groups are provisioned only two or three days a week.

In 1994, six groups of wild-born golden lion tamarins were translocated into protected habitat devoid of tamarins in Fazenda União. They were never provisioned, but were monitored regularly to follow their adaptation to the new environment. Presently, visits to translocated groups are mainly for behavioral monitoring. Several individuals within each family group of both the re-introduced and translocated populations carry radiocollars to facilitate monitoring.

Results

After 17 years, the re-introduced population as of December 2000 numbered 359 animals in 50 groups, including surviving "founders" and their offspring (Beck *et al.*, in press) (see Table 1). About 35% of the current estimate of 1,000 golden lion tamarins surviving in the Atlantic Forest are the re-introduced captive-born individuals and their descendants. The total translocated population and their offspring numbered 120 animals in 16 groups in December 2000 (Kierulff *et al.*, in press).

Both the re-introduction and translocation programs have contributed to the protection of habitat for golden lion tamarins. Re-introduced groups have been established in forest fragments on 21 private ranches adjacent to the Poço das Antas Biological Reserve, which represents about 19% of the total forest remaining with protected golden lion tamarins. The translocated groups were released into a 24 km² forest, which was decreed a Federal Biological Reserve (União Reserve) in April 1998. This also represents 19% of the total area currently containing golden lion tamarins.

"Pre-release training has no discernible effect on post-release survival (Beck et al., in press)."

Evaluation of Success

Success can be measured by the survival of the released animals and their rate of successful reproduction. The mortality of re-introduced golden lion tamarins is high in the first year (70%), but then levels off to match the age-specific mortality typical of wild populations. However, in lion tamarins born in the wild to re-introduced parents, mortality is considerably lower in all age-classes than for captive-born re-introduced tamarins (Beck *et al.*, in press). For the original translocated lion tamarins, mortality has been low, with the average annual survival rate of monitored adults being approximately 82%.

The main single cause of loss among the re-introduced population is theft and vandalism by humans. There are also problems of adaptation to the new environment, readily noticeable after the release of captive-born tamarins, e.g. deficits in food-finding, locomotion, and orientation cause losses from other factors (starvation, injury, and predation for example) (Beck *et al.*, 1991). For the translocated population, mortality mainly has been due to social strife and predation.

It took 12 years for the number of golden lion tamarins in the re-introduced population to exceed the number actually re-introduced, whereas it took only three years for the number of golden lion tamarins in the translocated population to exceed the number translocated.

Costs

Efforts to rehabilitate and re-introduce captive animals are extremely expensive to develop, although the costs are reduced as techniques are refined (Kleiman *et al*., 1991). Translocation and re-introduction share many techniques, but in general re-introduction requires more intensive management over longer periods and is therefore more expensive. Kleiman *et al.* (1991) estimated that after the first 6 years of the re-introduction project, each surviving re-introduced tamarin cost US$22,000. These costs also included the total costs of program research and development, including zoo management, methodology development, associated studies of ecology and behavior of the wild and re-introduced tamarins, population monitoring, local community conservation education programs, and

Table 1. Golden lion tamarin re-introduction program

Year	Number re-introduced	Cumulative number re-introduced	Number re-introduced still alive	Number wild-born still alive	Total alive
1984	14	14	9	1	10
1985	12	26	15	1	16
1986	0	26	2	3	8
1987	21	47	22	5	27
1988	20	67	37	12	49
1989	7	74	29	22	51
1990	7	81	24	34	58
1991	11	92	27	51	78
1992	34	126	42	62	104
1993	7	133	31	87	118
1994	3	136	24	96	120
1995	5	141	22	147	169
1996	6	147	24	176	200
1997	0	147	20	208	228
1998	0	147	14	265	279
1999	0	147	14	288	302
2000	6	153	18	341	359

administrative infrastructure. After release, the procedures and expenses for re-introduction and translocation are quite similar. Considering only the direct expenses in Brazil, a single re-introduced golden lion tamarin currently costs about US$7,000 to monitor and manage after release, compared with US$4,600 per translocated animal, including capture and post-release monitoring.

Lessons learned

Social disruption following translocation and re-introduction was not uncommon, especially when groups were released too close to one another. In some translocated family groups, breeding males in established groups were replaced by immigrant males. In the earliest re-introduction releases, groups had encounters that resulted in group fission and disappearances. Tamarin home ranges average 40 ha, thus releases are best sited 1 km from each other.

The most expensive stage of the translocation is the capture of a group in an isolated forest fragment. All traditional methods used to capture wild tamarins (e.g. traps baited with fruits) were unsuccessful, possibly because these isolated groups were harassed more by humans than the study populations within Poço das Antas Reserve.

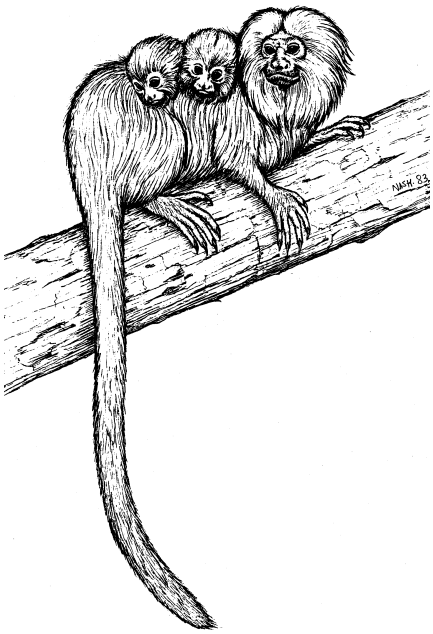
For the re-introduced population, the most expensive stage is post-release monitoring and management. Through intense behavioral monitoring and an analysis of post-release mortality and reproductive success, we determined that the key to success of the re-introduction, i.e. post-release survival and reproduction, was using a "soft" release. This including the following:

1. Intensive post-release monitoring to "rescue" the occasional sick or injured individuals and then re-release them, and
2. Provisioning of food and critical resources, such as nest boxes. Pre-release training has no discernible effect on post-release survival (Beck *et al.*, in press).

Infants born to re-introduced parents seem to be less affected by behavioral deficits than the original captive-born re-introduced individuals and thus survive better. The best re-introduction strategy for this species is therefore intensive support of the re-introduced captive-born animals to maximize their chances of survival and reproduction, with the aim of seeing wild-born offspring become truly independent.

The time necessary for a re-introduced group to become fully independent varies, but all groups were independent by five years after re-introduction. The translocated population was self-sustaining immediately after release, in that it was totally independent of provisioning or additional management. Neither re-introduction nor translocation would have been successful without the support of the local and federal staff of the Brazilian agency for the environment, IBAMA, or the local landowners who accepted family groups of tamarins onto their land; their support was facilitated through the golden lion tamarin conservation education program.

Conclusion



Golden lion tamarin (*Leontopithecus rosalia*) with young
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Although similar in their overall objective of establishing new populations of lion tamarins in otherwise unoccupied but appropriate habitats, we emphasize that the re-introduction and translocation programs in this case had different specific objectives. Re-introduction was used to increase the size and genetic diversity of the wild population, whereas translocation was used to rescue threatened wild sub-populations undoubtedly representing significant genetic diversity for the species. Both programs have been successful as measured by golden lion tamarin survival and reproduction after release. Both techniques have achieved growing populations.

Survival (especially in the early stages of the program) and reproduction of translocated golden lion tamarins were higher in comparison to the captive-born, re-introduced tamarins, and the population increased in size more rapidly. Population growth was achieved more quickly through translocation than through re-introduction.

Both techniques can be considered expensive, especially in the first year post-release. Re-introduction is more expensive on a per-animal basis because the lion tamarins need intensive post-release training and management. This re-introduction, however, benefited from its connection with the zoo community (not all re-introduction efforts are affiliated with zoos), resulting in substantial financial and technical contributions, and allowing for the zoo community's direct participation in *in situ* conservation, a benefit for both golden lion tamarins and zoos.

Models of metapopulation management are now being analyzed in order to evaluate the future use of re-introduction and translocation for this species, considering especially the demographic and genetic management of the species, and as a means of responding to catastrophes, such as fires or disease epidemics. Despite the positive growth rate of both the re-introduced and translocated populations, golden lion tamarins are still critically endangered because each of the existing fragmented populations is too small for long-term viability and only 1,000 individuals exist in the wild.

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Contributed by Maria Cecília M. Kierulff, Conservation International do Brasil /IESB, Ilheus, Bahia, Brazil, E-mail: cmartinsk@yahoo.com***; Benjamin B. Beck, Smithsonian National Zoological Park, Washington DC, USA 20008, E-mail:*** beckb@nzp.si.edu**; Devra G. Kleiman, Smithsonian National Zoological Park, Washington, DC, USA 20008, E-mail:*** Dgkleiman@aol.com ***& Paula Procópio, Associação Mico-Leão-Dourado, Casimiro de Abreu, Brazil, E-mail:*** ppobio@alternativa.com.br

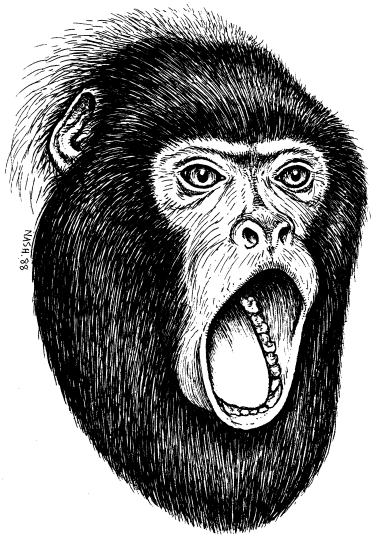
Translocation of black howler monkeys in Belize

Because translocations are controversial, difficult, costly, and often fail, they require careful evaluation and planning. While the value of primate translocations has been questioned by some, we believe their use as a management tool will be more important as forests are decimated and rates of hunting increase, leaving isolated primate populations in smaller forest fragments. While at least 10 species of primates have been translocated, there has been little long-term monitoring and evaluation, or reports on the management of such projects.

Planning

This project was part of a broader conservation effort for howler monkeys (Horwich *et al.*, 1993). The goal was to establish a viable population of black howlers (*Alouatta pigra*), listed as threatened under the U.S. Endangered Species Act, Appendix II of CITES, and insufficiently known by IUCN, in the Cockscomb Basin Wildlife Sanctuary (CBWS) where howlers had become locally extinct many years prior. The project involved translocating a founding population from the Community Baboon Sanctuary (CBS) of approximately 50 animals over a relatively short period of two years. Two potential problems influenced planning decisions:

1) how to maximize troop cohesion and limit dispersal, and
2) how howlers would respond to new foods.



Black howler monkey (*Alouatta pigra*)
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Also, as part of the project, we wanted to develop translocation methods as a tool for howler conservation. We found that careful planning for these potential problems was critical to the success of the project.

Seven aspects proved essential

1) Proven capture techniques:
As part of another ecology project, 47 black howlers were successfully captured by chemical immobilization without loss or major injury.

2) Howler survey and conservation assessment:
A feasibility study found translocation to be a viable conservation tool because the causes of the prior local extinction (yellow fever, hurricanes, and over-hunting) were no longer present in Cockscomb. Additionally, there had previously been an alarming rate of deforestation in the area (Koontz *et al.*, 1994), which was no longer occurring. Also, natural colonization in the Cockscomb Basin was deemed improbable because howlers had not been seen or heard in the area since 1978. Thus, because hunting was now controlled within the 100,000-acre park, and yellow-fever epidemics had not been reported for nearly 40 years in the immediate area, it seemed reasonable to attempt re-introduction of the species into the protected area.