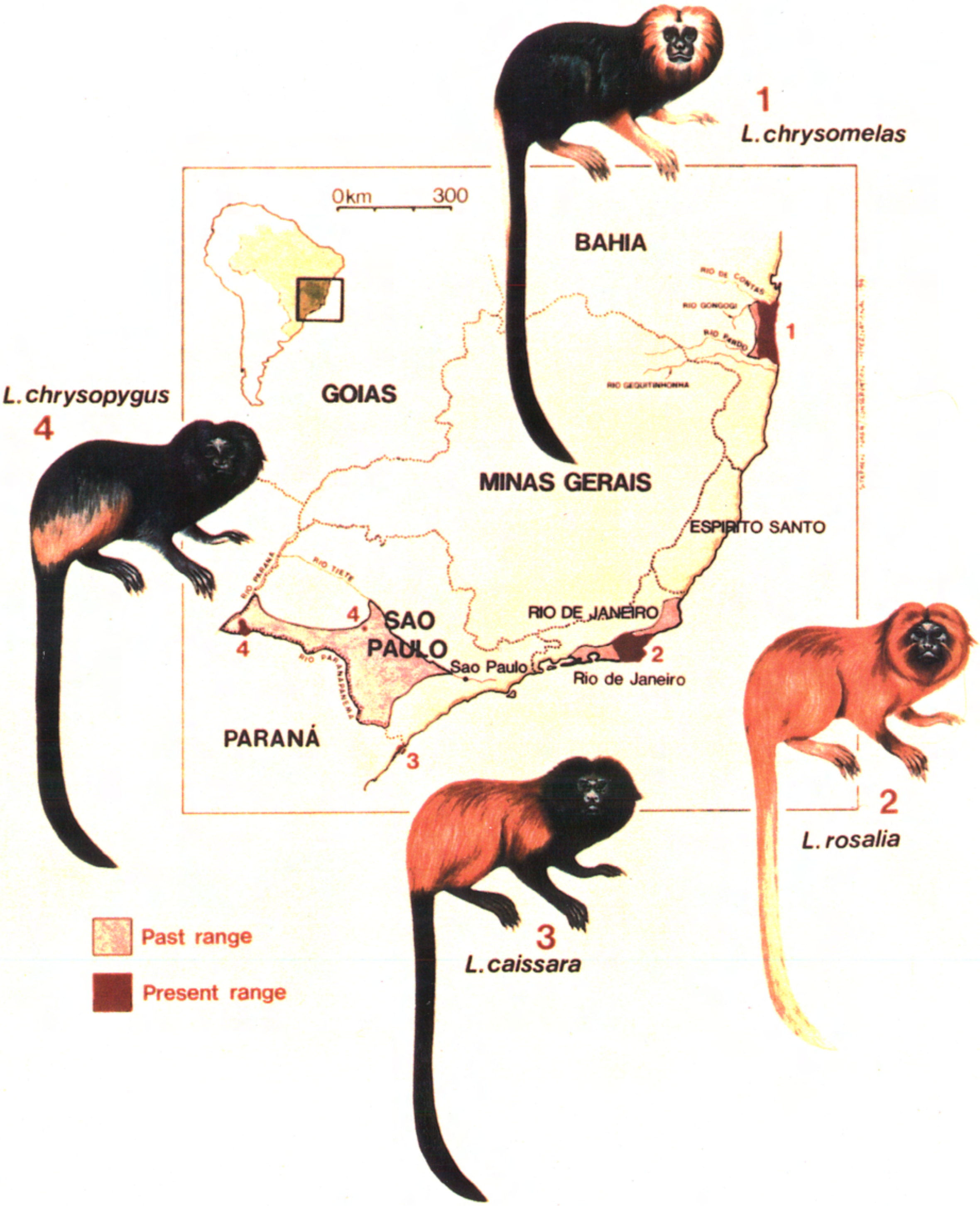
Leontopithecus:



Population Viability Workshop

LEONTOPITHECUS

POPULATION VIABILITY ANALYSIS

WORKSHOP REPORT

Belo Horizonte, Brazil
20-23 June 1990

Edited By:

U. S. Seal, J. D. Ballou, and C. V. Padua

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INTRODUCTION

The four species (*Leontopithecus rosalia, L. chrysomelas, L. chrysopygus* and the newly discovered *L. caissara*) of lion tamarins are threatened in the wild. Their historical habitat has been reduced to only 2% of its original area and is fragmented to such a degree that the most abundant species (*L. chrysomelas*) numbers less than 600 in the protected areas. Individual populations of all species are in immediate danger of being lost. Loss of these populations and genetic drift in the remaining populations will further reduce the viability of these species increasing their risk of extinction.

An endangered species is (by definition) at risk of extinction. The dominant objective in the recovery of such a species is to reduce its risk of extinction to some acceptable level - as close as possible to the background, "normal" extinction risk all species face. The concept of risk is used to define the targets for recovery, and is used to define recovery itself. Risk, not surprisingly, is a central issue in endangered species management. Unfortunately, there is ample reason to suppose that we (as humans) are not "naturally" good at risk assessment. Recovery will be more often successful if we could do this better. There is a strong need for tools that would help managers deal with risk. We need to improve estimation of risk, to rank order better the risk due to different potential management options, to improve objectivity in assessing risk, and to add quality control to the process (through internal consistency checks). Among the risks to be evaluated are those of extinction, and loss of genetic diversity.

The workshop was organized to combine available information on the biology and status of the species with analytical techniques that evaluate their conservation implications. The analytical procedures focused on estimating the probability of the species going extinct given various conditions and scenarios (Population Vulnerability Analysis - PVA). The broad sponsorship, the full participation by all present in the meeting and working groups, the presence of field workers, agency officials, support organizations and an array of scientists, and the strong local support made the meeting productive and an valuable experience.

The overall purpose of this workshop was to develop a Conservation Strategy that will assure, with high probability, the continued survival and adaptive evolution of each of the four species of *Leontopithecus*. The Conservation Strategy includes specific recommendations and priorities for research and management of both captive and wild populations. The Conservation Strategy was developed by detailed examination of each species natural history, biogeography, life-history characteristics, status in the wild and captivity and threats to their continued existence. Computer models were used to assist in evaluating the vulnerability of these populations to extinction.

Conservation of these species in the wild will require: (1) Immediate actions to secure and protect habitat; (2) Inventory and protection of the wild population; (3) Maintenance of scientifically managed captive populations; and; (4) Upon completion of the above, restocking of suitable habitat lacking tamarin populations.

This book is divided into two major sections, one in English the other in Portuguese. The Portuguese section is on a different color paper and follows the same arrangement as the English section.

Captive Breeding Specialist Group

Species Survival Commission
IUCN -- The World Conservation Union
U. S. Seal, CBSG Chairman

LEONTOPITHECUS CONSERVATION WORKSHOP

June 20-23, 1990

Belo Horizonte, Brazil

Workshop Goals:

The overall purpose of the workshop is to develop a Conservation Strategy that will assure, with high probability, the continued survival and adaptive evolution of each of the three species of Leontopithecus. The Conservation Strategy will include specific recommendations and priorities for research and management of both captive and wild populations. The Conservation Strategy will be developed by detailed examination of each species natural history, biogeography, life-history characteristics, status in the wild and captivity and threats to their continued existence. Computer models will be used to assist in evaluating the vulnerability of these populations to extinction.

The Conservation Strategy will be a document to be prepared in draft form during the workshop. It is a goal of the workshop that this document be reviewed and revised by all participants during the workshop as many times as necessary to achieve agreement on its content before departure.

Participants:

The list of participants include the Management Committees for each Leontopithecus, field and zoo biologists, managers and administrators for both the captive and wild populations, conservation educators, and population biologists.

Participants will be asked to prepare information for the workshop.

12101 Johnny Cake Ridge Road, Apple Valley, MN 55124, USA tel. 612-431-9325 fax 612-432-2757
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Briefing Book:

A briefing book (in English and Portuguese) will be distributed to all participants prior to the workshop. The book will contain summary information on: population biology concepts as they relate to developing Conservation Strategies; the natural and life-history of each species; the status of the wild and captive populations for each species; and preliminary results of computer models evaluating the extinction vulnerability of the species (to be revised and fine-tuned during the workshop). Some participants will be asked to prepare material for the Briefing Book in advance of the workshop.

Workshop Format:

The workshop will be organized in an effort to combine available information on the biology and status of the species with analytical techniques that evaluate their conservation implications. The analytical procedures will focus on estimating the probability of the species going extinct given various conditions and scenarios (Population Vulnerability Analysis - PVA).
The first part of the workshop will consist of an overview of the types of analyses and concepts used to develop conservation strategies for captive and wild populations. This will be followed by short presentations by workshop participants summarizing the state-of-the art knowledge on each species natural history, biogeography, taxonomy, etc, as they related to developing the Conservation Strategy. Discussions during and after these presentations will help identify areas of research and management concern that need to be addressed in the Conservation Strategy.

Once the basic data for each species are presented, analytical models will be prepared to simulate future population trends. These simulations will be conducted and refined throughout the rest of the workshop as the conservation goals and strategies evolve.

At the same time, working groups (to be identified during the workshop) will begin to draft the specific research and management recommendations for the Conservation Strategy. These drafts will be repeatedly presented to workshop participants for comments, refinements and revisions until a consensus is reached by all participants.

LEONTOPITHECUS

POPULATION VIABILITY ANALYSIS

WORKSHOP REPORT

CONSERVATION PLAN

LEONTOPITHECUS

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For

LEONTOPITHECUS

20-23 June 1990

OBJECTIVE

The objectives of the population viability analysis are to identify and evaluate the severity of threats that increase the probability of extinction for each species of *Leontopithecus* and to recommend actions and schedules needed to assure the long-term survival of each species as an evolving species in the wild, with greater than 98% probability of survival for 100 years.

CURRENT and POTENTIAL STATUS OF THE FOUR SPECIES

The four species (*Leontopithecus rosalia*, *L. chrysomelas*, *L. chrysopygus* and the newly discovered *L. caissara*) of lion tamarins are threatened in the wild. Their historical habitat has been reduced to only 2% of its original area and is fragmented to such a degree that the most abundant species (*L. chrysomelas*) numbers less than 600 in the protected areas. Individual populations of all species are in immediate danger of being lost. Loss of these populations and genetic drift in the remaining populations will further reduce the viability of these species increasing their risk of extinction. Conservation of these species in the wild will require:

(1) Immediate actions to secure and protect habitat;

(2) Inventory and protection of the wild population;

(3) Maintenance of scientifically managed captive populations; and;

(4) Upon completion of the above, restocking of suitable habitat lacking tamarin populations.

Based upon the detailed information received and condensed during the Population Viability Workshop, the following recommendations are made for the conservation of the *Leontopithecus* species:

RECOMMENDATIONS

All Species:

1. Establish each species in the wild with a total population size of at least 2000 by the year 2025.

2. Establish the population of each species in 3 or more separate subpopulations, each with at least 100 breeding-age adults, separated sufficiently to minimize (<5%) the probability that they will be affected by the same catastrophe in the same year. Smaller subpopulations will require more intensive monitoring and management.

3. Identify, secure, and protect sufficient habitat for each species to provide the carrying capacity for at least 2000 animals.

4. If the risk of extinction of a species in the wild is greater than 5% in 100 years establish a captive population of sufficient size to be demographically secure and to retain 90% of the genetic heterozygosity of the species for 100 years. Do not use this population for reintroduction until it is demographically and genetically secure.

5. Undertake inventories for tamarins in all areas that are suitable for protection and that might contain tamarins. If the areas contain *Leontopithecus*, a census and habitat evaluation should be conducted to provide the information for development of a management protocol.

6. Develop a population model and management plan for each of the subpopulations and protected areas as well as each captive population as a part of the conservation plan for each species of *Leontopithecus.*

7. Develop a metapopulation model and plan for each species of *Leontopithecus* which integrates the conservation strategies for all of the wild subpopulations and the captive populations.

8. In the event that captive animals are used to reinforce wild populations, prevent the introduction of infectious, metabolic or developmental conditions that may have adapted to or developed or carried by captive animals.

Individual Species

Leontopithecus rosalia:

Protected areas total 5500 ha of which 2900 ha is forested habitat, containing an estimated 290 golden lion tamarins (GLTs). Four additional relatively large blocks of habitat, probably containing *L. rosalia* and potentially available for protection total about 5150 ha. In addition, there are approximately 20 small areas (50-100 ha) that may be suitable for an average of 1.5 groups of 5 individuals each. Thus the total amount of forested area suitable for tamarins is about 10550 ha, with a potential carrying capacity of about 844 tamarins; the number of tamarins confirmed in the wild is 450. These figures exclude reintroduced, captive-born animals. The total habitat needed for 2000 animals is about 25000 ha.

Threats to the wild population include disease, fire, pesticides, train accidents, dam construction, and loss of potential habitat by deforestation. Studies of the wild population have provided life history and demographic data which have been used in the population models to evaluate risks of extinction and the effects of different conservation management strategies.

There are about 560 animals in the captive population, which is genetically and demographically managed according to principles of population biology.

RECOMMENDATIONS IN PRIORITY ORDER:

1. Identify and census new areas potentially capable of supporting golden lion tamarins.

2. Ensure the protection of areas currently holding GLTs as well as new areas potentially capable of supporting animals, principally large tracts of forests and areas near the Poço das Antas Reserve. This would include development of specific plans for the GLTs on the Base Naval and Fazenda Uniao.

3. Purchase land, where necessary, to assure protection of existing or potential GLT habitat.

4. Prevent catastrophic accidents, especially in the Poço das Antas Reserve. Specifically:

   a. Prevent transmission of diseases into the wild population

   b. Investigate methods to alter the water table in areas of peat (turfa) to prevent further fires and encourage rapid forest formation.

c. Prevent fire or toxic spills of products transported by rail through the reserve

5. Undertake reforestation and restoration of degraded habitat in protected areas, including a research program to develop rapid and cost-effective reforestation programs.

6. Increase the number of founders contributing to the captive population; for example rescue groups from threatened habitat islands and incorporate them into the captive breeding program.

7. Increase local, national and international environmental education program to contribute to the execution of all the above recommendations and assure the long-term continuation of environmental education programs through increasing IBAMA financial support.

8. Expand the reintroduction program.

9. Implement a program for the genetic and demographic management of the entire world population (captive and wild).

Table 1. The estimated costs (in US $1,000) to implement this program:

Recommendation	Total Year 1	Breakdown Personnel	Supplies	Equipment	Annual Cost Next 5 Years
Identify & Census New Areas	25	10	5	10	10
Protect New & Existing Areas	150	20	10	120	75
Land Acquisition	2570				
Fire Prevention	175	30	10	135	50
Disease Prevention	15	5	5	5	10
Prevent Train Disaster	500				

Table 1 continued. The estimated costs (in US $1,000) to implement this program:

Recommendation	Total Year 1	Breakdown Personnel	Supplies	Equipment	Annual Cost Next 5 Years
Restoration/ Reforestation					
Research	50	30	10	10	30
Implementation	100	40	60		80
Increase # Founders in Captive Pop.	10				10
Expand Environmental Education	50	20	5	25	35
Expand Reintroduction Program	45	15	5	25	30
Implement Global Management Program	45	20	20	5	25
TOTAL	3735				355

Current estimated costs for the *L. rosalia* conservation program are $200,000/year including education; community ecology; behavioral ecology research; reintroduction; restoration. These include costs of the coordinators outside of Brazil, but none of the costs of managing the captive population or Poço das Antas Reserve

Total estimated costs year 1 (including current program)= $3,920,000

Subsequent annual costs (for 5 years) = $545,000

Leontopithecus chrysomelas:

Protected areas of suitable forest total about 6200 ha. There are estimated to be 550-600 animals in this habitat with a potential maximum carrying capacity of about 1000 animals. Potential habitat of another 1000 ha is likely to be available at Una reserve and perhaps up to 9000 Ha in private ownership (and consequently more vulnerable to loss). Thus the total protected and potential habitat is between 7000 - 18000 ha, which might ultimately provide a capacity in the wild for between 850 and 3100 animals under optimal management. Threats include deforestation with habitat loss, fire, and illegal removal of animals. The captive population, now 285 animals, has adequate founders distributed among 22 institutions.

RECOMMENDATIONS:

1. Existing protected areas:
    a. Effective implementation of the Una reserve.

    b. Remove squatters from Una reserve.

    c. Urgently acquire 1000 Ha (at present being considered) to expand the corridor between two reserve blocks.

    d. Provide adequate infrastructure and protection for Una reserve.

    e. Survey the GHLT population and conduct further ecological research in Una, ESCAN and Lemos Maia reserves.

    f. Obtain secure commitment from CEPLAC regarding permanence of remaining forest at Lemos Maia.

    g. Secure transfer of ESCAN from CEPLAC to IBAMA; investigate possibilities of increasing ESCAN area.

    h. Study the degraded areas of the Una reserve, and the possibility for restoration.

2. Potential protected areas:

    a. Conduct vegetation survey of GHLT known range using satellite imagery and ground surveys.

b. Survey remaining populations throughout known range.

c. Identify new potential areas for protection, including extensive vegetation surveys and population estimation of GHLTs in the most important.

d. Conduct studies on forest regeneration from second growth and abandoned cocoa plantations.

e. Study deforestation rates and causes in the region.

3. Environmental Education:

a. Target landowners with proposals for the creation of private reserves.

b. Target local population to reduce illegal trade.

c. Involve Bahian students (Santa Cruz University) in conservation research in the region.

4. Captive breeding.

a. Expand network of captive breeding institutions

b. Allow more easy transfer of captive-bred animals between captive breeding institutions, both national and overseas.

c. Urgently transfer captive animals presently held at the Una reserve head-quarters to captive breeding facilities in Brazil or overseas.

d. Build a holding and screening facility in the region (not at the Una reserve) where confiscated animals, or animals being translocated (for example) could be held temporarily in transit or quarantine.

5. Re-introductions:

a. Identify potential areas for re-introduction programs.

Leontopithecus chrysopygus:

Protected areas total 36340 ha of which 29000 Ha are considered available habitat. There are about 450 animals known in the wild. If the protected and suitable habitat is managed at carrying capacity, the wild population can reach 1600 animals. This is not sufficient for a wild population of 2000 animals, which is the objective for this species. The captive population consists of 64 animals distributed in 2 institutions and was founded by 22 animals. The distribution and number of animals is not of sufficient size or distribution to assure survival. Threats to the wild population include fire, deforestation and hunting.

RECOMMENDATIONS:

1. Census animals in habitats outside the reserve ($50000)

2. Conduct a census of animals at Caitetus ($10000)

3. Increase funding for the Rio de Janeiro Primate Center ($100000/year)

4. Effectively control and prevent fire ($150000)

5. Develop a Masterplan for the scientific management of the captive population ($2000)

6. Intensify education program at Morro do Diabo (Year 1: $40000; Year 2: $40000) and initiate an environmental education at Caitetus (Year 1: $75000; Year 2 $40000)

7. Initiate programs of habitat restoration to increase the carrying capacity of both Morro do Diabo and Caitetus.

8. Increase funding for surveillance guards and park wardens.

9. Define the limits of the park

10. Develop a management plan for Morro do Diabo and Caitetus ($50000)

11. Create buffer zones around both protected areas

12. Continue field work on basic biology of BLT at Morro do Diabo ($30000/year)

13. Identify new habitat for restocking

Leontopithecus caissara:

The potential area (Superagui Island) is about 5000 ha. More suitable habitat may exist on the island and contiguous areas on the mainland.. The population size is unknown, but an educated guess indicates something between 125 and 625 animals, based on habitat requirements of the other lion tamarin species.
There is very little known about this recently discovered species. The primary immediate threat is illegal trade and development. There is no captive population. Information from the other *Leontopithecus* species will be used to guide the development of conservation recommendations for this species.

RECOMMENDATIONS:

1. Carry out basic research on the animals, their distribution and their habitat.

2. Include the species on the Brazilian List of Threatened Species and CITES.

3. Improve fiscalization and provide IBAMA with information to support the redefinition of the park limits.

4. Implement a vigorous environmental education program, focussing on local people.

5. As soon as basic research permits, initiate a captive breeding program.

6. Allocate funds according to the following Preliminary budget, over 3 years:

a. Research on distribution, population, and general ecology	$ 70,000
b. Research on ecology and behavior	$ 85,000
c. Habitat protection program	$ 50,000
d. Environmental education and public awareness	$ 50,000

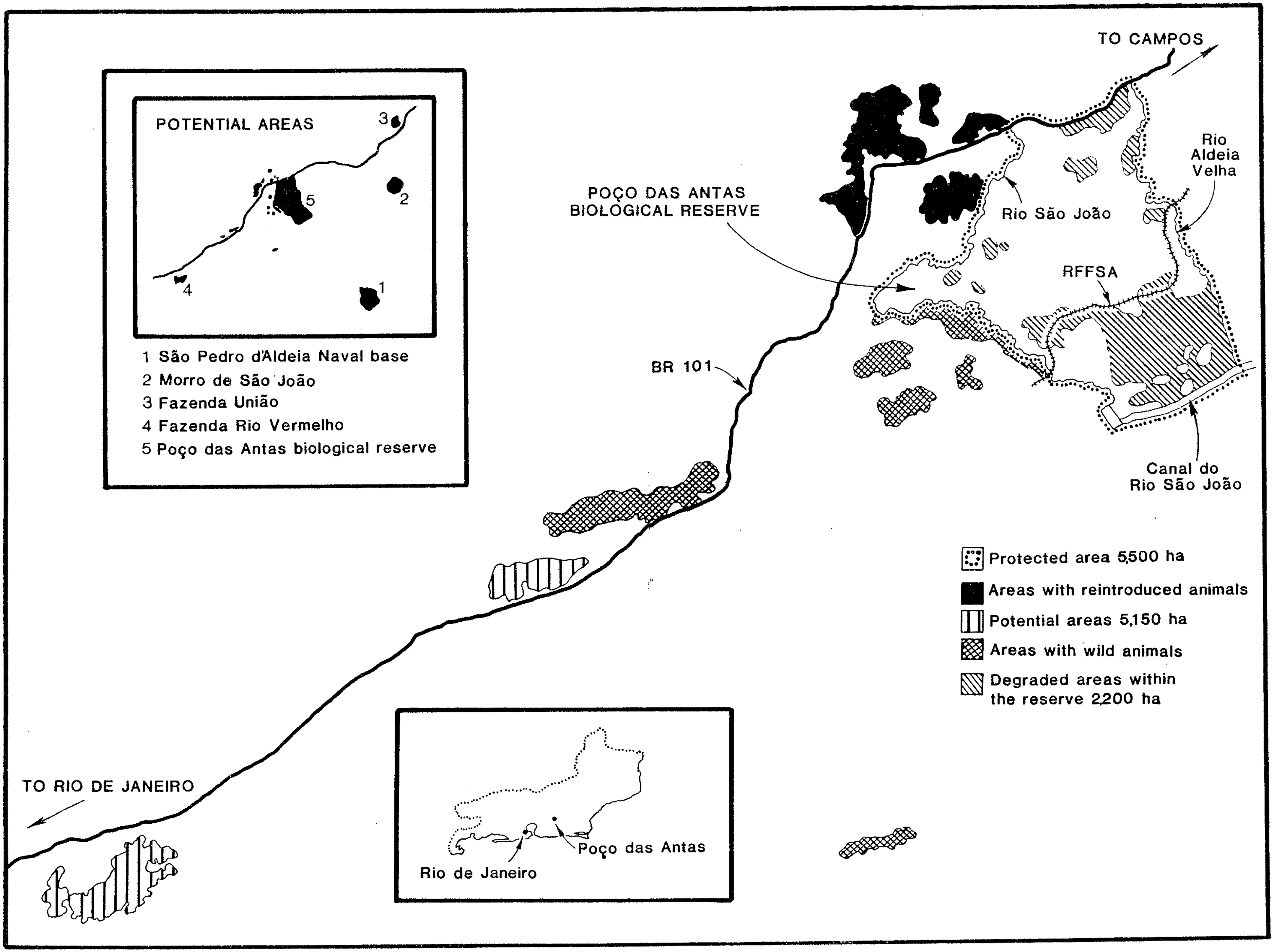
7. Create a special committee equivalent to the other 3 species, to deal with the conservation of the new lion-marmoset in the wild and eventually in captivity.

LEONTOPITHECUS

POPULATION VIABILITY ANALYSIS

WORKSHOP REPORT

CURRENT STATUS IN WILD



Distribution of golden lion tamarin.

GOLDEN LION TAMARIN WORKING GROUP SUMMARY

(D. Kleiman, J. Dietz, A. Baker, J. French, D. Rambaldi, L. Dietz, R. Montali)

I. Wild Population: Habitat Information

A. Identification of Protected Habitats

Location	Total Hectares	Hectares Forested	Owner
Poço das Antas	5,500	2900	IBAMA

B. Threats to the Protected Population

Source	Frequency	Severity
Disease	1 per 100 years	50% reduction in survival
Train	2 per 100 years	10% " " "
Pesticides	5 per 100 years	10% " " "
Fire	50 per 100 years	30% reduction in projected K

Rationale for estimates of frequency and severity.

Disease: There have been no signs of disease outbreaks, such as multiple deaths in the same group, on the Poço das Antas Biological Reserve since observations began in 1983. Therefore, we consider an epidemic unlikely. The predicted severity of an epidemic is based on an estimate of the worst case scenario by R. Montali.

Train: There have been two derailments on the Reserve since 1983, neither with consequences to the GLT population. However, spillage of fuel and a resulting fire, or spillage of a toxic chemical could result in elimination of nearby groups (estimated at 3) or habitat.

Pesticides: Pesticides are used on farms neighboring the Reserve. Errors could result in pesticide contamination of border areas. Elimination of insect populations or direct poisoning of tamarins could result in losses in groups in these areas.

C. Estimated Carrying Capacity

K= 290 ha with current forested area; total potential for Reserve if fully reforested= 508 ha.

We based this number on the observed density of about 1 animal/8 hectares for the Baker/Dietz study area (900 hectares), and a 33% lower density (1 animal/12 hectares) estimated for the rest of the currently suitable habitat on the Reserve (2000 hectares). We used the lower density both to arrive at a conservative estimate and because we think the habitat in the study area may be of higher quality than other areas of forest on the Reserve.

D. Potential habitat

Location	Forested Hectares	GLTs?	Ownership
Base Naval Sao Pedro	500	Yes	Military
Fazenda Uniao	1000	?	Fed. Gov't., Railroad
Rio Vermelho-P. Abreu	1650	?	Private, one owner
Morro de Sao Joao	2000	?	Private, many owners

	5150		

In addition, there are approximately 20 small areas, approximately 50-100 hectares in size each, that may be available as suitable habitat for an average of 1.5 groups of 5 individuals each (estimated total = 1500 hectares).

Threats to potential new areas:

BNSP:	Probablity of total deforestation by Year 2025	5%
FU:	" " " " "	10%
RV:	" " " " "	50%
MSJ:	" " " " "	50%
Small areas	" " " "	75%

E. Projections and Calculations Regarding Protected Areas in Year 2025.

The estimated total area of habitat suitable for golden lion tamarins by the year 2025, excluding small patches and if no other areas are identified, is 10,650 hectares. This projection requires (1) preservation in entirety of forest areas identified and (2) reforestation of all degraded habitat in Poço das Antas.

This potential area could support a total of 937 tamarins, 47% of the desired total wild population of 2000 individuals. If the small pockets of isolated forest are included, the total projected area available is 12,150 hectares. This potential area could support a total of 1062 animals, 53% of the desired wild population size. 63
Projections for the Year 2025:

Habitat for 2000 animals:	23,400 hectares required	(100%)
	- 5,500 hectares in Poço das Antas	(24%)
	- 5,150 hectares in unprotected areas	(22%)

	12,750 hectares needed by year 2025	(54%)

Thus, to reach the population goal of 2000 individuals would require identification or regeneration of an area larger than that identified to date. The analysis suggests that immediate priority must be the identification and protection of additional forest areas that together constitute more than two times the area in the Reserva Biologica Poço das Antas.

II. Wild Populations: Population Biology Information

A. Survival:

Infant--------------------------- 87% (N=60 infants)

Infancy to 2 years or--------- 90% (N=20 individuals)
dispersal (whichever first)

First year following------- dispersal	M	67% (N=15 individuals)
	F	50% (little data, but expected to be lower than for males, since fewer spaces available for female immigrants).
*Overall from birth to------ reproductive status	M	52% (.87 X .90 X .67)
	F	39% (.87 X .90 X .50)
*Adult survival (annual)----	M	86% (N=42.6 animal-years)
	F	85% (N=27.2 animal-years)

B. Age at first reproduction = 3 years

C. Number of offspring per female per year:

0	19%
1	6%
2	52%
3	6%
4	17%

Mean = 1.94 offsp/female/yr (N=31) 63

D. Proportion of adult males in breeding pool: 71% of adult males in territorial groups contribute to reproduction: about 40% of groups contain 2 adult males unrelated to the reproductive female, but only one male per group is likely to contribute genetically in any given year.

E. Effective population size = 94. We calculated this from an estimate of 45 groups on the Reserve, with one reproductive male in each group (total=45), one reproductive female in 90% of groups and two reproductive females in 10% of groups (total=49).

III. Status of Reintroduction Program (To 1 May, 1990)

A. Reintroduction of captive-born animals

# captive born animals reintroduced:	73	
# captive-born surviving:	28	(38%)

B. Reintroduction of wild-born animals

Wild-born reintroduced	6	
Wild-born surviving	3	(50%)

C. Reproductive Performance of Reintroduced Animals

# Born after reintroduction	34	
# infants surviving	21	(62%)

D. Total number of tamarins in wild from reintroduction:

Surviving adults + Offspring = 52

IV. Summary of important information on captive population

A. Demographic Summary (December 1989)

1. Number of living animals = 561
2. Number of Institutions = 113

B. Genetic Summary

1. Number of founders = 51
2. Founder equivalents = 12.4
3. Heterozygosity Lost = 2.4%

Analyses of the captive population indicates that new founders are required to reach the population's genetic and demographic objectives.

MAMMALIAN SPECIES No. 148, pp. 1–7, 4 figs.

Leontopithecus rosalia.

By Devra G. Kleiman

Published 8 May 1981 by The American Society of Mammalogists

Leontopithecus Lesson, 1840

Leontopithecus Lesson, 1840:184, 200. Type species designated by Pocock, 1917:255, as *Leontopithecus marikina* Lesson.

Marikina Gray (not Lesson), 1843:xviii, 15. Type species by tautonomy *Leontopithecus marikina* Lesson.

Leontocebus Elliot (part, not Wagner, 1840 = *Saguinus* Hoffmannsegg, 1807), 1913, 1:xxxv, 194. Type species designated as *Hapale chrysomelas* Wied (but Miller, 1912:380 had already designated *Midas leoninus* E. Geoffroy = *Saguinus fuscicollis fuscus* Lesson as type of *Leontocebus* Wagner).

Leontideus Cabrera, 1956:52. Renaming of *Leontocebus* Elliot. Type species *Simia rosalia* Linnaeus.

CONTEXT AND CONTENT. Order Primates, Suborder Haplorhini, Infraorder Platyrrhini, Family Callitrichidae. In addition to *Leontopithecus*, this family includes the extant genera *Saguinus*, *Callithrix*, and *Cebuella* (Hershkovitz, 1972, 1977). The genus *Leontopithecus* includes only one living species (Hershkovitz, 1972; Coimbra-Filho and Mittermeier, 1972).

Leontopithecus rosalia (Linnaeus, 1766)

Lion tamarin

[*Simia*] *Rosalia* Linnaeus, 1766:1, 41. Type locality Brazil, restricted to right bank, Rio São João, Rio de Janeiro, by Carvalho, 1965:22.

Midas chrysomelas Kuhl, 1820:51. Type locality Ribeirão das Minhocas, left bank upper Rio dos Ilhéus, Southern Bahia, Brazil.

Jacchus chrysopygus Mikan, 1823:fasc. 3, pl. 1. Type locality Ipanema (=Varnhagen or Bacaetava), São Paulo, Brazil.

[*Jacchus*] *Chrysurus* I. Geoffroy, 1827:520, attributed to Wied and cited as synonym of *chrysomelas*.

[*Jacchus Rosalia*] *Guyannensis* Fischer, 1829:65. Type locality French Guiana (but Eastern Brazilian individual probably transhipped from Cayenne to France—Hershkovitz, 1977).

[*Jacchus Rosalia*] *Brasiliensis* Fischer, 1829:65. Type locality not specified.

[*Midas*] *Leontopithecus marikina* Lesson, 1840:200. New name for *Simia rosalia* Linnaeus.

Midas [(*Leontopithecus*)] *ater* Lesson, 1840:203. Renaming of *Jacchus chrysopygus* Mikan.

L[*eontopithecus*] *aurora* Elliot, 1913, 1:182. Lapsus for *L. marikina* Lesson.

Leontocebus leoninus, Pocock (not Humboldt), 1914:898.

CONTEXT AND CONTENT. Context in generic account above. The three kinds of *Leontopithecus* are currently considered subspecies (Hershkovitz, 1972; Coimbra-Filho and Mittermeier, 1973). The taxonomy of *Leontopithecus* has been discussed by Hershkovitz (1977), Coimbra-Filho (1970*a*) and Coimbra-Filho and Mittermeier (1972). The following key to the subspecies is modified from Hershkovitz (1977):

1 Mane and trunk blackish, outer and inner side of thighs and rump contrastingly colored golden to reddish .... *L. r. chrysopygus*
  Mane, at least in front, mostly or entirely golden or reddish, trunk blackish, reddish, golden or buffy, thighs not contrastingly colored 2
2 Trunk blackish .... *L. r. chrysomelas*
  Trunk reddish, orange, golden, or buffy .... *L. r. rosalia*

The species includes three subspecies:

L. r. chrysopygus Mikan, 1823, see above (*ater* Lesson a synonym).

L. r. rosalia Linnaeus, 1766:1, 41, see above (*guyannensis* Fischer, *brasiliensis* Fischer, *marikina* Lesson, *aurora* Elliot, and *leoninus* Pocock are synonyms).

L. r. chrysomelas Kuhl, 1820:51, see above (*chrysurus* Geoffroy a synonym).

DIAGNOSIS. Lion tamarins are the largest of the callitrichids, with a long silky pelage. The face is almost bare and surrounded by a mane. The hands and digits are extremely long, with a web partially uniting the digits of the hand.

GENERAL CHARACTERS. Weights of captive adult males and females average 710 g (range 600 to 800 g) in *L. r. rosalia* (Hoage, 1978, pers. comm.). There is no sexual dimorphism, although females may average slightly heavier than males during pregnancy. Previously published weights are lower (Hershkovitz, 1977; Coimbra-Filho and Mittermeier, 1972; Napier and Napier, 1967), but some of these weights have combined juveniles and adults, as well as feral and captive-born animals (the latter are heavier). Length of head and body averages 261 mm (200 to 336) and length of tail averages 370 mm (315 to 400) (Hershkovitz, 1977; see also Coimbra-Filho, 1976; Coimbra-Filho and Mittermeier, 1972). The mane is derived from long hairs on the crown, cheeks, and throat and obscures the ears. Coloration of *L. r. rosalia* ranges from the pale golden to rich reddish-golden with occasional orange, brown, or black coloration on the tail and forefeet. *L. r. chrysomelas* and *L. r. chrysopygus* are predominantly black. *L. r. chrysomelas* has golden to reddish-orange on the front of the mane, the lower half of the forelimbs and the proximal half of the dorsal surface of the tail. *L. r. chrysopygus* has varying amounts of reddish-golden coloration on the rump, inner and outer thighs, and base of tail. The glans penis is acorn-shaped (Hershkovitz, 1977). For more complete discussion of diagnostic and general characters as well as color photographs of the three subspecies, see Hershkovitz (1977), Coimbra-Filho and Mittermeier (1973), and Coimbra-Filho (1976). A captive *L. r. rosalia* family at the National Zoological Park is shown in Fig. 1.

DISTRIBUTION. Lion tamarins historically occurred in the lowland forests of southeastern Brazil, in the states of Bahia, Espírito Santo, Rio de Janeiro, and São Paulo (Fig. 2). They are currently extinct in Espírito Santo (Hershkovitz, 1977; Coimbra-Filho and Mittermeier, 1973, 1977). *L. r. chrysopygus* was restricted to the tropical rain forests between the Rio Paranapanema and the Rio Tietê in the state of São Paulo. Since most of the forest has been destroyed, the current range of this form is restricted to the Morro do Diabo State Park (in the westernmost part of São Paulo), with a second remnant population near Gália, São Paulo (22°18'S, 49°34'W) (Hershkovitz, 1977; Coimbra-Filho, 1970*a*, 1970*b*, 1976).

L. r. chrysomelas has the most northerly range, and was originally found between the south bank of the Rio das Contas and the north bank of the Rio Belmonte along the Atlantic Coast (14° to 16°S). Currently there are small, scattered populations near Buerarema, Itabuna, Una, and possibly Ilhéus, in the state of Bahia (Hershkovitz, 1977; Coimbra-Filho and Mittermeier, 1973, 1977). Much of the original forest has been logged or has been replaced by cacao and rubber plantations, which are unsuitable for lion tamarins.

L. r. rosalia was historically found in the coastal forests of the states of Rio de Janeiro (formerly Guanabara) and Espírito Santo (23°S, 44°W to 20.5°S, 40.5°W) south of the Rio Doce. The range is now reduced to remnant forests in the Rio São João Basin in Rio de Janeiro, which are scattered and probably total considerably less than 900 km^2 in area (Coimbra-Filho and Mittermeier, 1977). It is not known how long the ranges of the three subspecies have been isolated. Both *L. r. chrysomelas* and *L. r. rosalia* live at altitudes of less than 300 m, while *L. r. chrysopygus* may range to 700 m. Distribution of *L. rosalia* is discussed further in Hershkovitz (1977), Coimbra-Filho (1970*a*, 1970*b*, 1976), and Coimbra-Filho and Mittermeier (1973, 1977).

There is no fossil record.

FIGURE 1. A captive golden lion tamarin family at The National Zoological Park (Photo courtesy of Smithsonian Institution).

FORM. Hershkovitz (1977) provided a complete summary of the morphology of *L. rosalia,* which forms the basis of this section unless otherwise specified. The remarkably different pattern of coloration of the three subspecies of *L. rosalia* has been attributed to a gradual evolutionary bleaching process (Hershkovitz, 1977). Individual differences in coloration and pattern in *L. r. rosalia*, and especially the tendency of captive golden lion tamarins to be nearly yellow-white in color, have often been attributed to diets which are deficient in carotenids and protein (Coimbra-Filho, 1965) or to excessive sunlight (Hershkovitz, 1977). However, captive *L. r. rosalia* acquire a rich, reddish-golden coloration from exposure to sunlight, which also causes a darkening of the facial skin (Kleiman, unpubl.). Coimbra-Filho and Cruz Rocha (1978) described a case of alopecia and depigmentation in a specimen of *L. r. chrysomelas*. Coimbra-Filho and Maia (1979*a*) described the molting patterns of captive *L. r. rosalia*. The face of *L. rosalia* is naked, with variation in the degree of pigmentation; facial coloration ranges from fleshy to purplish. Hair on the forehead is short and wedge-shaped, unlike the mane which arises from long hair on the crown, cheeks, and throat. The external ear of *L. rosalia* is rounded in form, and becomes concealed as the mane develops in the juvenile. There is a median laryngeal air sac present which is larger in males than females (Hershkovitz, 1977). A sternal apocrine scent gland is present (Epple and Lorenz, 1967).

The forelimbs are slender and elongate, and the long digits are designed for probing for grubs and insects. The fore and hindlimbs are more equal in length relative to other callitrichids. Limb proportions are as follows: length of humerus × 100/length of radius, 99 (98 to 103); length of femur × 100/length of tibia, 96 (94 to 101), length of humerus and radius × 100/length of femur and tibia, 88 (87 to 90). *L. rosalia* is less of a saltator than other callitrichids, with tendencies toward being a climber. The hand is shorter than the foot and the pollex is not opposable. The digits have sharp, recurved, laterally compressed claws. Relative lengths of digits, from longest to shortest, are: manus 3-4-2-5-1; pes 4-3-5-2-1. The palm is narrow, and the length of the middle finger is more than twice the width of the palm. The vertebral formula is C7, T12, L7, S3–4, Cd22–28 (Hershkovitz, 1977).

Two nipples are present and are axial in position. The milk of *L. r. rosalia* is similar to that of other New World monkeys (Buss, 1975). The penis is acorn-shaped and the penile stem is covered with papillae. The testes may be scrotal or inguinal, position being under some voluntary control. Measurements of testes of two males were 10 × 9 and 15.5 × 11 m. The somewhat pendulous scrotum is unpigmented; greatest scrotal diameter for

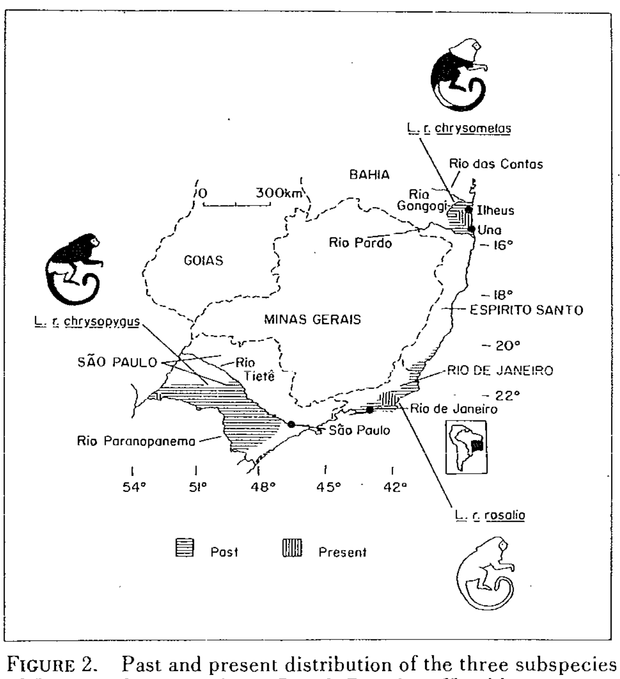


FIGURE 2. Past and present distribution of the three subspecies of *Leontopithecus rosalia* in Brazil. Based on Hershkovitz (1977) and Coimbra-Filho and Mittermeier (1977). Drawing by S. James.

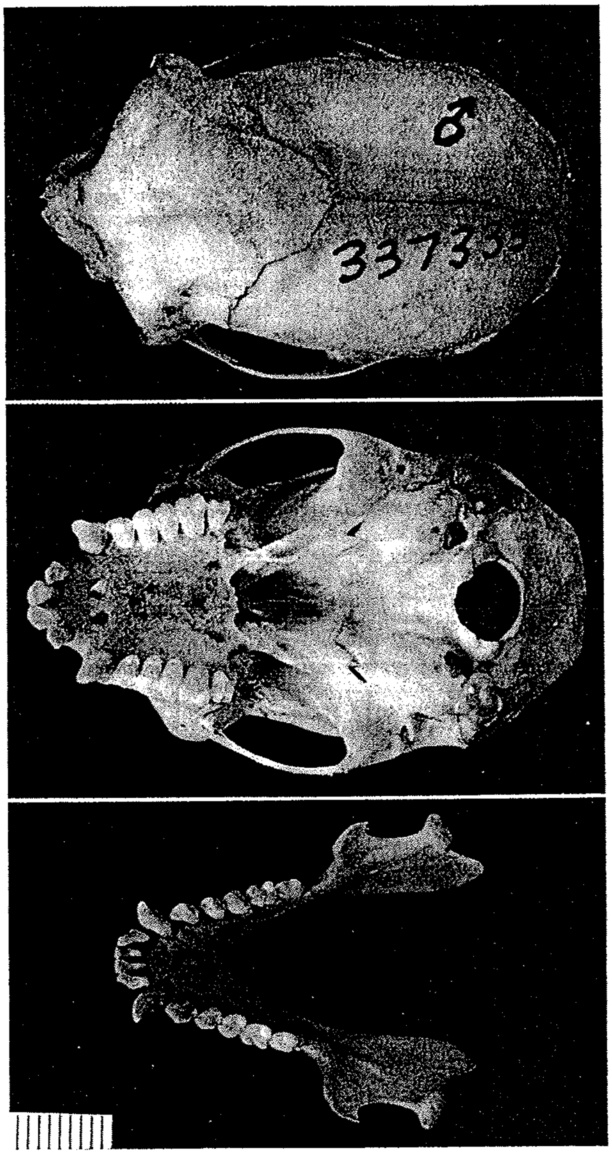


FIGURE 3. Photograph of skull of *L. r. rosalia* (courtesy of Smithsonian Institution). From top: dorsal and ventral views of cranium and ventral view of mandible. Scale is in mm.

a male was 18 mm. The baculum of *L. rosalia* is the most specialized of the callitrichids, with measurements of one individual being 3.0 mm long and 0.9 mm wide. Female external genitalia are unpigmented; the labia majora are more poorly differentiated than in other callitrichids. There are sebaceous and sudoriparous glands in the circumgenital area of both sexes (Hershkovitz, 1977).

The skull of *L. rosalia* (Figs. 3, 4) has been described by DuBrul (1965) and Hershkovitz (1977). The dental formula is i 2/2, c 1/1, p 3/3, m 2/2, total 32. The upper and lower incisors are comparatively short, and the canines are twice as long as adjacent teeth. The relationship between incisor and canine lengths has resulted in the use of the term "long-tusked" to describe *Leontopithecus* and *Saguinus* and "short-tusked" for *Callithrix* and *Cebuella*, in which the canines and long incisors are approximately the same length. Upper incisors have expanded crowns, with the outer incisor set in an oblique manner and posterior to the inner incisor (Figs. 3, 4). The lower incisors also have transversely expanded crowns, with the lateral incisor club-shaped and larger than the spatulate-shaped central incisor. The upper and lower canines are long and saberlike. Permanent upper and lower premolars are more molariform than in other callitrichids. All upper premolars are distinctly bicuspid with an incipient metacone often present in either or both P3 and P4. Lower premolars are also comparatively well molarized. Sample measurements (in

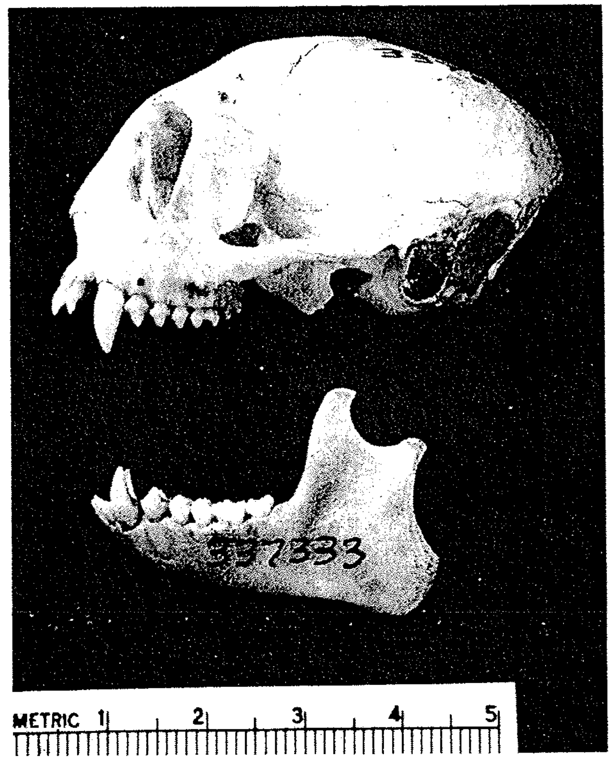


FIGURE 4. Lateral view of cranium and mandible of skull shown in Fig. 3.

mm) of an upper P2 and lower p2 respectively are: height of crown 3.0, 3.4; length 3.0, 2.9; width 3.3, 2.5. M1 is more than half again as large as the M2 and about a third larger than P4. The trigon basin of the M1 is deeply concave. Both upper molars have well-developed accessories. The lower molars are quadrate and simplified. The deciduous P4 is highly molarized which together with the molarization of the permanent premolars supports the suggestion that the center of mastication has shifted forward (Hershkovitz, 1977).

The greatest length of skull in adults is 50 to 62 mm. *L. rosalia* has four communicating sphenoidal cavitations opening behind in a pair of large sphenoidal fossae, which is unique among higher primates (Hershkovitz, 1977). The mandible outline is intermediate between the V-shape of *Callithrix* and the U-shape of *Saguinus*. The frontal contour is low and the nasal profile slightly concave. The orbits are somewhat square in outline with the interorbital area pneumatized. The auditory bullae are inflated; the dental arcade is between a U- and V-shape. The brain of *L. rosalia* is relatively larger but less complicated than in other callitrichids. Four major sulci have been found on each hemisphere (Hershkovitz, 1977). Some aspects of the muscular system and internal organs of *L. rosalia* are given in Hill (1957). Benirschke and Richart (1963) provide weights of some internal organs.

FUNCTION. Preliminary data on urinary chorionic gonadotropin levels in pregnant females were presented in Kleiman et al. (1978). Bush et al. (1977) provided information on physiologic measures (blood pH and gases, rectal temperature, respiration, and pulse rates) during physical restraint of *L. rosalia*.

ONTOGENY AND REPRODUCTION. As with other callitrichids, both fetuses share the same chorion (Benirschke and Layton, 1969). The placenta is discoidal with vascular anastomoses present, resulting in blood chimerism, a characteristic peculiar to callitrichids. Benirschke and Richart (1963) provided weights of fetuses and a placenta. Gestation was estimated as between 132 and 137 days, based on interbirth intervals (Hershkovitz, 1977; Rabb and Rowell, 1960; Ulmer, 1961); however, observed intervals between copulatory activity and birth suggest that gestation averages 129 days with a range of 125 to 132 days (Kleiman, 1977*a*; Wilson, 1977). Post-partum matings are most common approximately 3 to 10 days after birth (Snyder, 1974;

Wilson, 1977). Detection of pregnancy is difficult without palpation although the rise in urinary chorionic gonadotropins during weeks 4 to 9 of pregnancy suggests that the Non Human Primate Pregnancy test kit could be used to identify and chart the course of pregnancy (Kleiman et al., 1978). A behavioral estrus, with copulatory activity, is common during pregnancy shortly after the drop in chorionic gonadotropins (about 8 weeks pre-partum) (Kleiman and Mack, 1977). Otherwise, copulatory behavior is infrequent and appears to be confined to the period near ovulation.

The length of the ovarian cycle is unknown, and appears highly variable. However, 50% of observed intervals between peaks of sexual activity were from 14 to 21 days (Kleiman, 1977*a*), which is within the range of ovarian cycles reported for *Callithrix jacchus* by Hearn (1977). Litter size ranges from one to three, averaging two (Hershkovitz, 1977). In Brazil, births are concentrated in a 6-month period between September and February, after the start of the rainy season (Coimbra-Filho and Mittermeier, 1973; Coimbra-Filho and Maia, 1979*b*). In the Northern Hemisphere births occur mainly from February to August (Kleiman, 1977*a*; Hershkovitz, 1977). Both captive and wild individuals in Brazil are rarely reported to bear more than one litter per year, while both wild-caught and captive-born females in the North Temperate Zone may have two litters per year (Kleiman, 1977*b*).

Neonates are fully furred and with the eyes opened. The fur is usually pale golden and there may be a black band extending frontoparietally which is later obscured as the mane develops. Birth weights average 60.6 g (range 52.1 to 74.6 g); singletons are heaviest and triplets lightest (Hoage, 1978, pers. comm.). Neonatal length of head and body ranges from 100 to 114 mm and length of tail 117 to 143 mm (Hoage, 1978, pers. comm.). Growth rates may be found in Hoage (1978, pers. comm.), DuMond et al. (1979) and Rohrer (1979).

Young cling to the mother from birth, and are able to crawl from her dorsal to ventral surface for nursing. During the first 2 weeks, infants are often asleep or nursing and only gradually increase their visual exploration and manipulation of the environment. Manual and oral manipulation of objects increases rapidly from week 5. Infants first begin to leave carriers for brief periods during weeks 2 to 3 although well coordinated locomotion, such as jumping, leaping, and running is not common until week 8. Play activities become more common as locomotion and coordination improve. Young begin to eat solid food from the parents' hands during week 4, and start to acquire food independently during week 8; weaning occurs by week 12. Young juveniles acquire considerable food from parents and older siblings through food sharing and stealing. From week 10 they begin occasionally to share food with relatives; the major increase in food sharing behavior by older juveniles, however, occurs at ages 25 to 35 weeks, when recently-born younger siblings begin to eat solid food. By week 16, young are approximately one-half of adult weight (Hoage, 1977, 1978; Green, 1979). Signs of sexual maturity, that is, sternal scent marking and back arching, appear between weeks 32 to 40, and are more common in young males than females. Both sexes are sexually inhibited while still within the natal family group, and sibling or parent-offspring conflict may occasionally occur (Kleiman, 1979*a*). Most males and females are not sexually and socially mature until approximately 18 months of age (Kleiman and Jones, 1977). Other descriptions of development may be found in Ditmars (1933), Altmann-Schönberner, (1965), and Frantz (1963).

The longevity of captive animals has increased with improved care; captive individuals between 10 and 15 years of age often are still reproductively active (Kleiman, 1979*b*).

ECOLOGY. The sparse information available on the ecology of *L. rosalia* may be found in Coimbra-Filho (1970*a*, 1970*b*, 1976) and Coimbra-Filho and Mittermeier (1973, 1977). *L. rosalia* appears to be restricted to primary lowland forest, although little climax forest still exists within its range. Annual rainfall varies from 1100 to 2000 mm, with temperatures averaging 22°C. The wet season occurs from September to March within the range of *L. r. rosalia* and *L. r. chrysopygus*; in the range of *L. r. chrysomelas*, heaviest rains fall from March to June and in November and December. *L. rosalia* is usually found between 3 to 10 m above the ground, in dense vines and epiphytes, which may provide protection from aerial predators. Protection from predation may also be improved by the tendency for groups to sleep in tree holes abandoned by other species. Entrances to these shelters have been found as low as 1.5 m from the ground although most are 11 to 15 m above the ground. Hair deposits found in these shelters suggest extended usage (Coimbra-Filho, 1977). Coimbra-Filho (1977) captured *L. rosalia* by trapping groups in tree holes. Lion tamarins feed mainly on fruits, insects and occasionally small vertebrates. Insects of the orders Blattaria, Orthoptera, Homoptera, Lepidoptera, Hemiptera, and Coleoptera (especially larvae) are taken. Snails, lizards (*Anolis* spp.), and possibly bird eggs and hatchlings may also be eaten. Preferred fruits are soft, sweet and pulpy; species eaten include *Ficus* spp., *Inga* spp., *Tapirira guianensis*, *Cecropia* sp., *Posqueria latifolia*, and several forms of Myrtaceae including *Marlierea* sp., *Eugenia* sp., and *Campomanesia guabiroba*.

Group size varies from two to eight, with three to four being most common, although feeding aggregations of 15 to 16 have been reported. Groups are probably composed of a single reproductive pair, their offspring from one or two litters, and perhaps other relatives, thus forming a nuclear or extended family. There are no data on when juvenile dispersal occurs and the mechanisms of pair bond formation, although these phenomena have been examined in captivity (Kleiman 1978, 1979*a*). Home range size is not known. Lion tamarins are likely to be territorial, based on the high levels of intrasexual aggression observed in neighboring groups in captivity (Snyder, 1974). *L. r. chrysomelas* may form mixed-species associations with *Callithrix jacchus penicillata* (Coimbra-Filho, 1970*b*).

The three subspecies of *L. rosalia* are near extinction because of human activity within their range, the major factor being the near total destruction of the primary forest. Current estimates of the population sizes of the three subspecies are: golden lion tamarin (*L. r. rosalia*), about 100 to 200 animals; golden-headed lion tamarin (*L. r. chrysomelas*), about 200 animals; golden-rumped lion tamarin (*L. r. chrysopygus*), about 200 animals (Coimbra-Filho and Mittermeier, 1977). This species is in serious jeopardy, and may not survive. The export of specimens to zoos and as pets, especially *L. r. rosalia*, whose range is within one of the most densely populated areas of Brazil, may also have contributed to the species decline. Since the mid-1960's, conservation efforts have concentrated on three approaches: (1) the development of secure reserves, (2) the establishment of a captive breeding program in Brazil (the Tijuca Bank) to provide specimens for a reintroduction program, and (3) the implementation of an international cooperative breeding program to increase the captive population outside of Brazil. These topics are covered in several contributions in Bridgwater (1972) and in Hill (1970), Perry (1972), Magnanini (1977), Magnanini et al. (1975), Kleiman (1977*b*), Kleiman and Jones (1977), and Coimbra-Filho and Mittermeier (1977).

An *International Studbook* for *L. r. rosalia*, which documents changes in the captive population, is prepared annually by D. G. Kleiman. Of the three conservation programs, the poorest success has been achieved in the establishment and protection of secure reserves within Brazil. Although reserves now exist for all three subspecies (Coimbra-Filho and Mittermeier, 1977), only the Morro do Diabo State Park may be sufficiently large to maintain a viable population of *L. r. chrysopygus* without human interference. There are currently no firm estimates of population sizes within reserves for *L. rosalia*. However, Coimbra-Filho and Mittermeier (1978) do not recommend a reintroduction program in the near future. Captive breeding of the three subspecies at the Tijuca Biological Bank in Rio de Janeiro, directed by A. F. Coimbra-Filho, has been only partly successful, with many captive births but also with losses from unknown causes (Coimbra-Filho, pers. comm.). Outside Brazil, breeding success has improved the status of the captive population of *L. r. rosalia*. Based on the *International Studbook*, the numbers of captive golden lion tamarins increased from 69 in 1972, to 74 in 1975, and to 120 in 1978 (excluding an additional 18 specimens in South Africa in 1978) (Kleiman, 1979*b*) after a continuous annual decline in numbers of captive specimens between 1968 and 1972, when Brazil imposed a ban on the species export (Perry et al., 1975).

Care and maintenance techniques may be found in DuMond (1971, 1972) and Coimbra-Filho and Magnanini (1972). Hand-rearing and reintroduction techniques for hand-raised young may be found in DuMond et al. (1979) and Rohrer (1979). Captive specimens are susceptible to infection by *Herpes* viruses, rubeola, the bacteria *Pseudomonas*, *Klebsiella*, *Salmonella*, and to infestation with parasites such as *Prosthenorchis* and *Rictularia* (Hershkovitz, 1977). Due to its extreme rarity, *L. rosalia* has not been used in biomedical research.

BEHAVIOR. The following account is based mainly on observations of captive *L. r. rosalia*. *L. rosalia* is primarily arboreal. Individuals walk, run, and climb on branches using a quadrupedal gait. They frequently spring or leap from branch to branch and cling to and leap from vertical surfaces. In captivity, lion tamarins descend to the ground to explore and forage on the substrate. They apparently prefer to move in a horizontal plane (Coimbra-Filho and Magnanini, 1972). *L. rosalia* is diurnal, awaking near sunrise and retiring into nest boxes at dusk. A midday period of rest is common.

The basic social group appears to be a nuclear or extended family, and intrasexual aggression among unfamiliar adults is high, especially if an animal of the opposite sex is also present (Epple, 1967; Snyder, 1974). Females may be more aggressive than males (Snyder, 1974; Kleiman, 1979*a*). Within both artificially composed and natural family groups, only a single male and female reproduce (Snyder, 1974; Kleiman, 1978), even though all members of a group may interact socially. Dominance interactions are infrequent within established groups, and outbreaks of aggression are unpredictable, often occurring when the reproductive female approaches estrus (Kleiman, 1979*a*). One sign of tension is the arch back display whose function and contextual occurrence have been analyzed by Rathbun (1979). Groups of lion tamarins exhibit frequent tactile contact with allogrooming and huddling being two major social activities. Allogrooming movements are typically primate in form, with the hands being used to part the fur and both hands and mouth used to remove detritus. Males groom females more than the reverse (Kleiman, 1977*a*). Allosniffing is commonly seen, with the male sniffing the female more frequently, especially in the anogenital region, as she approaches estrus (Snyder, 1974; Kleiman, 1977*a*). Males also increase the frequency of other affiliative behaviors, such as grooming and huddling, as the female nears estrus. By contrast, females exhibit an increase in affiliative behaviors directed towards males approximately 2 to 4 days before the males' peak sexual interest (Kleiman, 1977*a*).

Copulatory behavior is primate in form with the male mounting and clasping the female in the mid-section anterior to the hindlimbs while keeping the hindfeet clasped on a branch or other surface. Shallow rapid thrusting movements precede intromission. Several intromissions may precede an ejaculation. Ejaculation is difficult to discern but may be recognized by (a) the female vocalizing and/or looking back to the male, (b) a prolonged thrust during intromission, (c) licking of the genitalia by the male and female after separation, and (d) a quiescent period without attempted mounts following separation (Snyder, 1974; Kleiman, 1977*a*). Copulatory activity, although infrequent, is more common in newly established pairs than in pairs with long-term bonds and with offspring (Kleiman, 1977*c*).

Both males and older juveniles participate in parental care activities (Hoage, 1977, 1978, pers. comm.; Frantz, 1963; Altmann-Schönberner, 1965; Snyder, 1974; Green, 1979). Immediately post-partum, the female carries the neonates exclusively and may be aggressive to family members who approach (Hoage, 1977; Snyder, 1974). Between 2 and 17 days post-partum, the young are first transferred to the male, with triplets usually being transferred earlier than twins or singletons (Hoage, 1977; Kleiman, 1977*c*). First transfers are accomplished by persistent interest by family members who approach, press the ventrum against the young, and manipulate young with the hands. Such transfers are facilitated by the mother's developing intolerance, expressed by scratching at the infants, and rubbing her back (young are carried dorsally) against surfaces. Hoage (1977, 1978) reports that: (1) mothers are the principal carriers of young through week 3, with fathers carrying more than mothers thereafter; (2) juvenile females begin carrying young earlier (week 2) than juvenile males (week 3), but juveniles of both sexes rarely carry younger siblings after week 8; (3) there is a tendency for parents (and possibly older juveniles) to preferentially carry infants of their own sex; and (4) primiparous parents with previous exposure to infants are most successful in rearing their own neonates, suggesting that experience with infants during the juvenile phase is important for successful reproduction.

Hoage (1978; pers. comm.) charted the social development of young lion tamarins, especially the ontogeny of food-sharing, an unusual behavior first reported by Wilson (1976) and further analyzed by Brown and Mack (1978) and Green (1979) with respect to the accompanying visual and vocal signals. Play consists mainly of chasing, grappling, and wrestling, and is observed primarily in juveniles (Snyder, 1974; Hoage, 1978, pers. comm.). Visual signals are not as complex as in Old World monkeys, but include agonistic patterns such as arched back displays (Rathbun, 1979), stares, open mouth threats, and piloerection. Tongue-flicking is a display seen mainly in the context of sexual behavior (Epple, 1967; Snyder, 1974). Vocalizations are complex; they consist of whines, trills, clucks, and non-tonal sounds, which can be combined to form more complex calls (McLanahan and Green, 1977; Green, 1979). There are few sex differences in the frequency or types of vocalizations. Of special interest is the Long Call, composed of trills, whines, and clucks, which bonded pairs produce as a duet. This call may function in spacing groups in the wild. Green (1979) and McLanahan and Green (1977) analyzed the contextual occurrence of the different vocalizations, and Green (1979) described vocal ontogeny.

Olfactory communication is mainly accomplished through scent marking with the sternal and circumgenital glands (Epple and Lorenz, 1967; Epple, 1972). Adult reproductive males and females scent mark at similar frequencies; young females rarely scent mark until paired, but young males begin scent marking while still in the natal family group. Adult reproductive males scent mark at relatively constant frequencies; breeding females, on the other hand, exhibit fluctuations, including low levels at estrus and after birth and higher levels during pregnancy (Mack and Kleiman, 1978; Kleiman and Mack, 1980).

GENETICS. The diploid number of chromosomes is 46. There are 4 metacentric, 28 submetacentric, and 12 acrocentric chromosomes. The X chromosome is submetacentric and the Y is metacentric (Hsu and Hampton, 1970). Five hybrids of *L. r. rosalia* and *L. r. chrysomelas* from three litters (none of which survived) were intermediate in color pattern between the parental types, although the color pattern of each hybrid differed (Coimbra-Filho and Mittermeier, 1976). Captive-born *L. rosalia* have been found with defects of the diaphragm, resulting in the migration of liver, stomach, and intestines into the chest region. The distribution of the defect in the captive population strongly suggests a genetic basis, but it is not the result of inbreeding of captive individuals (Bush et al., in press).

REMARKS. *L. r. rosalia* is often referred to as the golden marmoset. Other common names for the species are maned marmoset and silky marmoset. I am grateful to C. Handley and R. Thorington for assistance with the synonymies. S. James prepared the distribution map, and V. Garber and G. Hill typed the manuscript.

LITERATURE CITED

Altmann-Schönberner, D. 1965. Beobachtungen über Aufzucht und Entwicklung des Verhaltens beim Grossen Löwenaffchen, *Leontocebus rosalia*. Zool. Gart., 31:227–239.

Benirschke, K., and W. Layton. 1969. An early twin blastocyst of the golden lion marmoset, *Leontocebus rosalia* L. Folia Primat., 10:131–138.

Benirschke, K., and R. Richart. 1963. The establishment of a marmoset breeding colony and its four pregnancies. Lab. Anim. Care, 13:70–83.

Bridgwater, D. D. (ed.). 1972. Saving the lion marmoset. Wild Animal Propagation Trust, Wheeling, West Virginia, 223 pp.

Brown, K., and D. S. Mack. 1978. Food sharing among captive *Leontopithecus rosalia*. Folia Primat., 29:268–290.

Bush, R. M., R. Custer, J. Smeller, and L. M. Bush. 1977. Physiologic measures of nonhuman primates during physical restraint and chemical immobilization. J. Amer. Vet. Med. Assoc., 171:866–869.

Bush, R. M., et al. In press. Diagnosis and repair of familial diaphragmatic defects in golden lion tamarins. J. Amer. Vet. Med. Assoc.

Buss, D. H. 1975. Composition of milk from a golden lion marmoset. Lab. Primate News, 14:17–18.

Cabrera, A. 1956. Sobre la identificación de *Simia leonina* Humboldt (Mammalia, Primates). Neotropica, 2:49–53.

Carvalho, C. T. de. 1965. Comentários sôbre os mamiferos descritos e figurados por Alexandre Rodrigues Ferreira em 1790. Arq. Zool., São Paulo, 12:7–70.

Coimbra-Filho, A. F. 1965. Breeding lion marmosets at Rio de Janeiro Zoo. Internat. Zoo Yearb., 5:109–110.

— 1970*a*. Acêrca da redescoberta de *Leontideus chrysopygus* (Mikan, 1823) e apontamentos sôbre sua ecologia (Callithricidae, Primates). Rev. Brasil. Biol., 30:609–615.

— 1970*b*. Considerações gerais e situação atual dos micosleões escuros, *Leontideus chrysomelas* (Kuhl, 1820) e *Leontideus chrysopygus* (Mikan, 1823) (Callithricidae, Primates). Rev. Brasil. Biol., 30:249–268.

— 1976. *Leontopithecus rosalia chrysopygus* (Mikan, 1823), o mico-leão do Estado de São Paulo (Callitrichidae, Primates). Silvic. São Paulo, 10:1–36.

— 1977. Natural shelters of *Leontopithecus rosalia* and some ecological implications (Callitrichidae: Primates). Pp. 79–89, *in* The biology and conservation of the Callitrichidae (D. G.

Kleiman, ed.). Smithsonian Inst. Press, Washington, D.C., 354 pp.

Coimbra-Filho, A. F., and N. da Cruz Rocha. 1978. Acêrca de disfunção pigmentar em *Leontopithecus rosalia chrysomelas* (Kuhl, 1820), seu tratamento e recuperação (Callitrichidae, Primates). Rev. Brasil. Biol., 38:165–170.

Coimbra-Filho, A. F., and A. Magnanini. 1972. On the present status of *Leontopithecus* and some data about new behavioural aspects and management of *L. rosalia rosalia*. Pp. 59–69, *in* Saving the lion marmoset (D. D. Bridgwater, ed.). Wild Anim. Propagation Trust, Wheeling, West Virginia, 223 pp.

Coimbra-Filho, A. F., and A. de A. Maia. 1979*a*. O processo da muda dos pêlos em *Leontopithecus r. rosalia* (Linnaeus, 1766) (Callitrichidae, Primates). Rev. Brasil. Biol., 39:83–93.

— 1979*b*. A sazonalidade do processo reprodutivo em *Leontopithecus rosalia* (Linnaeus, 1766) (Callitrichidae, Primates). Rev. Brasil. Biol., 39:643–651.

Coimbra-Filho, A. F., and R. A. Mittermeier. 1972. Taxonomy of the genus *Leontopithecus* Lesson, 1840. Pp. 7–22, *in* Saving the lion marmoset (D. D. Bridgwater, ed.). Wild Anim. Propagation Trust, Wheeling, West Virginia, 223 pp.

— 1973. Distribution and ecology of the genus *Leontopithecus* Lesson, 1840 in Brazil. Primates, 14:47–66.

— 1976. Hybridization in the genus *Leontopithecus*, *L. r. rosalia* (Linnaeus, 1766) × *L. r. chrysomelas* (Kuhl, 1820) (Callitrichidae, Primates). Rev. Brasil. Biol., 36:129–137.

— 1977. Conservation of the Brazilian lion tamarins (*Leontopithecus rosalia*). Pp. 59–94, *in* Primate conservation (Prince Rainier and G. H. Bourne, eds.). Academic Press, New York, 658 pp.

— 1978. Reintroduction and translocation of lion tamarins: A realistic appraisal. Pp. 41–48, *in* Biology and behaviour of marmosets (H. Rothe, H. J. Wolters, and J. P. Hearn, eds.). Eigenverlag H. Rothe, Gottingen, 301 pp.

Ditmars, R. L. 1933. Development of the silky marmoset. Bull. New York Zool. Soc., 36:175–176.

DuBrul, E. L. 1965. The skull of the lion marmoset, *Leontideus rosalia* Linnaeus. Amer. J. Phys. Anthrop., 23:261–276.

DuMond, F. 1971. Comments on minimum requirements in the husbandry of the golden marmoset (*Leontideus rosalia*). Lab. Primate Newsl., 10:30–37.

— 1972. Recommendations for a basic husbandry program for lion marmosets. Pp. 120–136, *in* Saving the lion marmoset (D. D. Bridgwater, ed.). Wild Anim. Propagation Trust, Wheeling, West Virginia, 223 pp.

DuMond, F. V., B. L. Hoover, and M. A. Norconk. 1979. Handfeeding parent-reared golden lion tamarins, *Leontopithecus r. rosalia*, at Monkey Jungle. Internat. Zoo Yearb., 19:155–158.

Elliot, D. G. 1913. A review of the primates. Amer. Mus. Nat. Hist., New York, 1:1–316.

Epple, G. 1967. Vergleichende Untersuchungen über Sexual- und Sozialverhalten der Krallenaffen (Hapalidae). Folia Primat., 7:37–65.

— 1972. Social communication by olfactory signals in marmosets. Internat. Zoo Yearb., 12:36–42.

Epple, G., and R. Lorenz. 1967. Vorkommen, Morphologie und Funktion der Sternaldrüse bei den Platyrrhini. Folia Primat., 7:98–126.

Fischer, J. B. 1829. Synopsis mammalium. J. G. Cottae, Stuttgart, 752 pp. (not seen)

Frantz, J. 1963. Beobachtungen bei einer Löwenaffchen—Aufzucht. Zool. Gart., 28:115–120.

Geoffroy, I. 1827. Ouistiti-Jacchus. Dict. Classique. Hist. Nat., 12:512–520.

Gray, J. E. 1843. List of the specimens of Mammalia in the collection of the British Museum. British Mus. Nat. Hist., London, 216 pp.

Green, K. M. 1979. Vocalizations, behavior, and ontogeny of the golden lion tamarin, *Leontopithecus rosalia rosalia*. Unpub. D.Sc. dissert. Johns Hopkins University, Baltimore, Maryland.

Hearn, J. P. 1977. The endocrinology of reproduction in the common marmoset, *Callithrix jacchus*. Pp. 163–171, *in* The biology and conservation of the Callitrichidae (D. G. Kleiman, ed.). Smithsonian Inst. Press, Washington, D.C., 354 pp.

Hershkovitz, P. 1972. Notes on New World monkeys. Internat. Zoo Yearb., 12:3–12.

— 1977. Living New World monkeys (Platyrrhini) with an introduction to primates. Univ. of Chicago Press, Chicago, 1:1–1117.

Hill, C. A. 1970. The last of the golden marmosets. Zoonooz, 43:12–17.

Hill, W. C. O. 1957. Primates. Comparative anatomy and taxonomy, III. Pithecoidea: Platyrrhini (families Hapalidae and Callimiconidae). Edinburgh Univ. Press, Edinburgh, 354 pp.

Hoage, R. J. 1977. Parental care in *Leontopithecus rosalia rosalia*: Sex and age differences in carrying behavior and the role of prior experience. Pp. 293–305, *in* The biology and conservation of the Callitrichidae (D. G. Kleiman, ed.). Smithsonian Inst. Press, Washington, D.C., 354 pp.

— 1978. Biosocial development in the golden lion tamarin, *Leontopithecus rosalia rosalia* (Primates: Callitrichidae). Unpubl. Ph.D. dissert., Univ. of Pittsburgh, Pittsburgh, Pennsylvania.

Hoffmannsegg, G. von. 1807. Beschreibung vier Affenartiger Thiere aus Brasilian. Mag. Gesellsch. Naturf. Fr., Berlin, 1:83–104.

Hsu, T. C., and S. H. Hampton. 1970. Chromosomes of Callithricidae with special reference to an XX/'XO' sex chromosome system in Goeldi's marmosets (*Callimico goeldii*, Thomas, 1904). Folia Primat., 13:183–195.

Kleiman, D. G. 1977*a*. Characteristics of reproduction and sociosexual interactions in pairs of lion tamarins (*Leontopithecus rosalia*) during the reproductive cycle. Pp. 181–190, *in* The biology and conservation of the Callitrichidae (D. G. Kleiman, ed.). Smithsonian Inst. Press, Washington, D.C., 354 pp.

— 1977*b*. Progress and problems in lion tamarin, *Leontopithecus rosalia rosalia*, reproduction. Internat. Zoo Yearb., 17:92–97.

— 1977*c*. Monogamy in mammals. Quart. Rev. Biol., 52:39–69.

— 1978. The development of pair preferences in the lion tamarin (*Leontopithecus rosalia*): Male competition or female choice? Pp. 203–208, *in* Biology and behaviour of marmosets (H. Rothe, H. J. Wolters, and J. P. Hearn, eds.). Eigenverlag H. Rothe, Göttingen, 301 pp.

— 1979*a*. Parent-offspring conflict and sibling competition in a monogamous primate. Amer. Nat., 114:753–760.

— 1979*b*. 1978 International Studbook: Golden lion tamarin, *Leontopithecus rosalia*. Nat. Zool. Park, Washington, D.C.

Kleiman, D. G., D. W. Gracey, and G. D. Hodgen. 1978. Urinary chorionic gonadotropin levels in pregnant golden lion tamarins: Preliminary observations. J. Med. Primatol., 7:333–338.

Kleiman, D. G., and M. Jones. 1977. The current status of *Leontopithecus rosalia* in captivity with comments on breeding success at the National Zoological Park. Pp. 215–218, *in* The biology and conservation of the Callitrichidae (D. G. Kleiman, ed.). Smithsonian Inst. Press, Washington, D.C., 354 pp.

Kleiman, D. G., and D. S. Mack. 1977. A peak in sexual activity during mid-pregnancy in the golden lion tamarin, *Leontopithecus rosalia* (Primates: Callitrichidae). J. Mamm., 58:657–660.

— 1980. The effects of age, sex, and reproductive status on scent marking frequencies in the golden lion tamarin (*Leontopithecus rosalia*). Folia Primat., 33:1–14.

Kuhl, H. 1820. Beiträge zur Zoologie und vergleichenden Anatomie. Hermann, Frankfurt am Main. 152 pp.

Lesson, R.-P. 1840. Species des mammifères: Bimanes et quadrumanes; suivi d'un mémoire sur les Oryctéropes. J. B. Bailliere, Paris, 291 pp. (not seen)

Linnaeus, C. 1766. Systema Naturae. 12th ed. L. Salvii, Uppsala, 1:1–532.

Mack, D. S., and D. G. Kleiman. 1978. Distribution of scent marks in different contexts in captive lion tamarins, *Leontopithecus rosalia* (Primates). Pp. 181–188, *in* Biology and behaviour of marmosets (H. Rothe, H. J. Wolters, and J. P. Hearn, eds.). Eigenverlag H. Rothe, Göttingen, 301 pp.

Magnanini, A. 1977. Progress in the development of Poços das Antas Biological Reserve for *Leontopithecus rosalia rosalia* in Brazil. Pp. 131–136, *in* The biology and conservation of the Callitrichidae (D. G. Kleiman, ed.). Smithsonian Inst. Press, Washington, D.C., 354 pp.

McLanahan, E. B., and K. M. Green. 1977. The vocal repertoire and an analysis of the contexts of vocalization in *Leontopithecus rosalia*. Pp. 251–269, *in* The biology and conservation of the Callitrichidae (D. G. Kleiman, ed.). Smithsonian Inst. Press, Washington, D.C., 354 pp.

Magnanini, A., et al. 1975. The Tijuca bank of lion marmosets, *Leontopithecus rosalia*: A progress report. Internat. Zoo Yearb., 15:284–287.

Mikan, J. C. 1823. Delectus florae et faunae Brasiliensis. A. Strauss, Vienna, 54 pp. (not seen)
Miller, G. S.; Jr. 1912. List of North American land mammals. Bull. U.S. Natl. Mus., 79:1–455.
Napier, J. R., and P. H. Napier. 1967. A handbook of living primates. Academic Press, New York, 456 pp.
Perry J. 1972. In danger—golden lion marmosets. Smithsonian Mag., 3(9):49–53.
Perry, J., D. D. Bridgwater, and D. L. Horseman. 1975. Captive propagation—a progress report. Pp. 361–372, *in* Breeding endangered species in captivity (R. D. Martin, ed.). Academic Press, New York, 420 pp.
Pocock, R. I. 1914. On the facial vibrissae of mammals. Proc. Zool. Soc. Lond., pp. 889–912. (not seen)
— 1917. The genera of Hapalidae (marmosets). Ann. Mag. Nat. Hist., ser. 8, 20:247–258.
Rabb, G. B., and J. E. Rowell. 1960. Notes on reproduction in captive marmosets. J. Mamm., 41:401.
Rathbun, C. D. 1979. Description and analysis of the arch display in the golden lion tamarin, *Leontopithecus rosalia rosalia*. Folia Primat., 32:125–148.
Rohrer, M. A. 1979. Hand-rearing golden lion marmosets, *Leontopithecus rosalia*, at the Oklahoma City Zoo. Anim. Keeper's Forum, 6:33–39.
Snyder, P. A. 1974. Behavior of *Leontopithecus rosalia* (golden lion marmoset) and related species: A review. J. Human Evol., 3:109–122.
Ulmer, F. A. 1961. Gestation period of the lion marmoset. J. Mamm., 42:253–254.
Wagner, J. A. 1840. Die Säugthiere in Abbildungen nach des Natur, mit Beschreibungen von Dr. Johann Christian Daniel von Schreber. Forgesetzt von Dr. Johann Andreas Wagner. Supp. 1–4, 1:1–551. T. O. Weigel, Leipzig. (not seen)
Wilson, C. G. 1976. Food sharing behavior in primates: Another species added. Ark. Acad. Sci. Proc., 30:95–96.
— 1977. Gestation and reproduction in golden lion tamarins. Pp. 191–192, *in* The biology and conservation of the Callitrichidae (D. G. Kleiman, ed.). Smithsonian Inst. Press, Washington, D.C., 354 pp.

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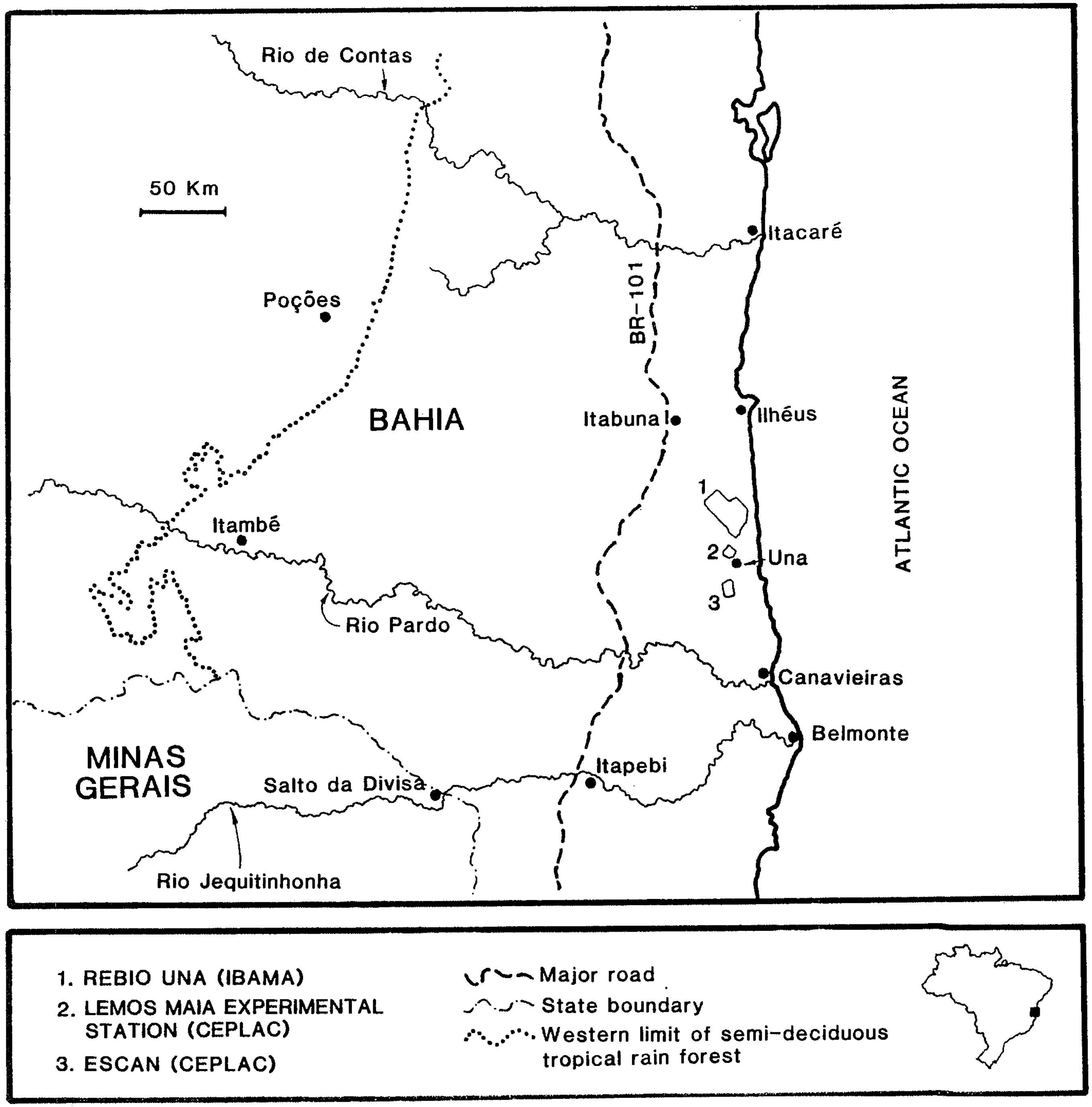
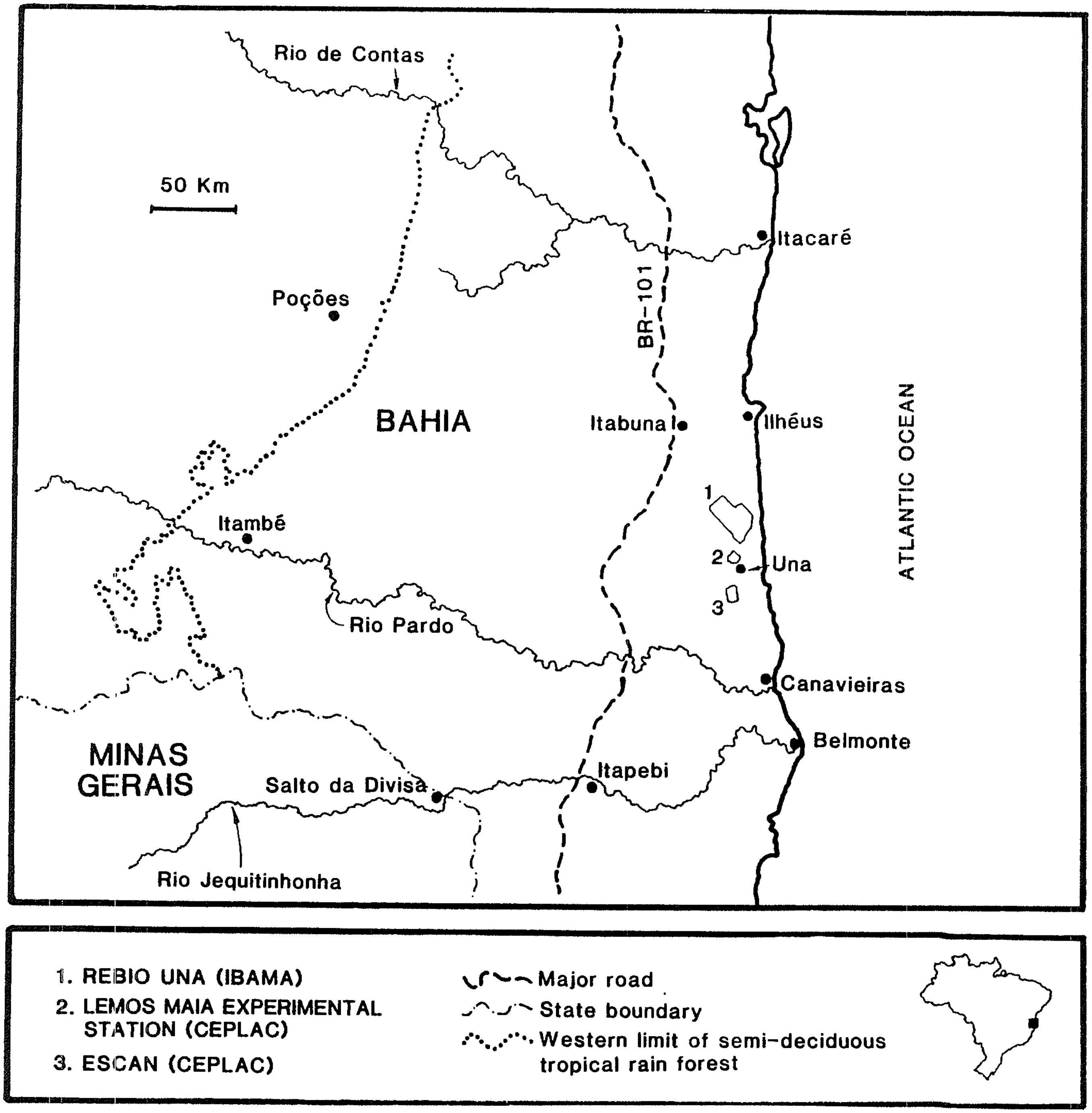


Current locations of protected golden-headed lion tamarin habitat.



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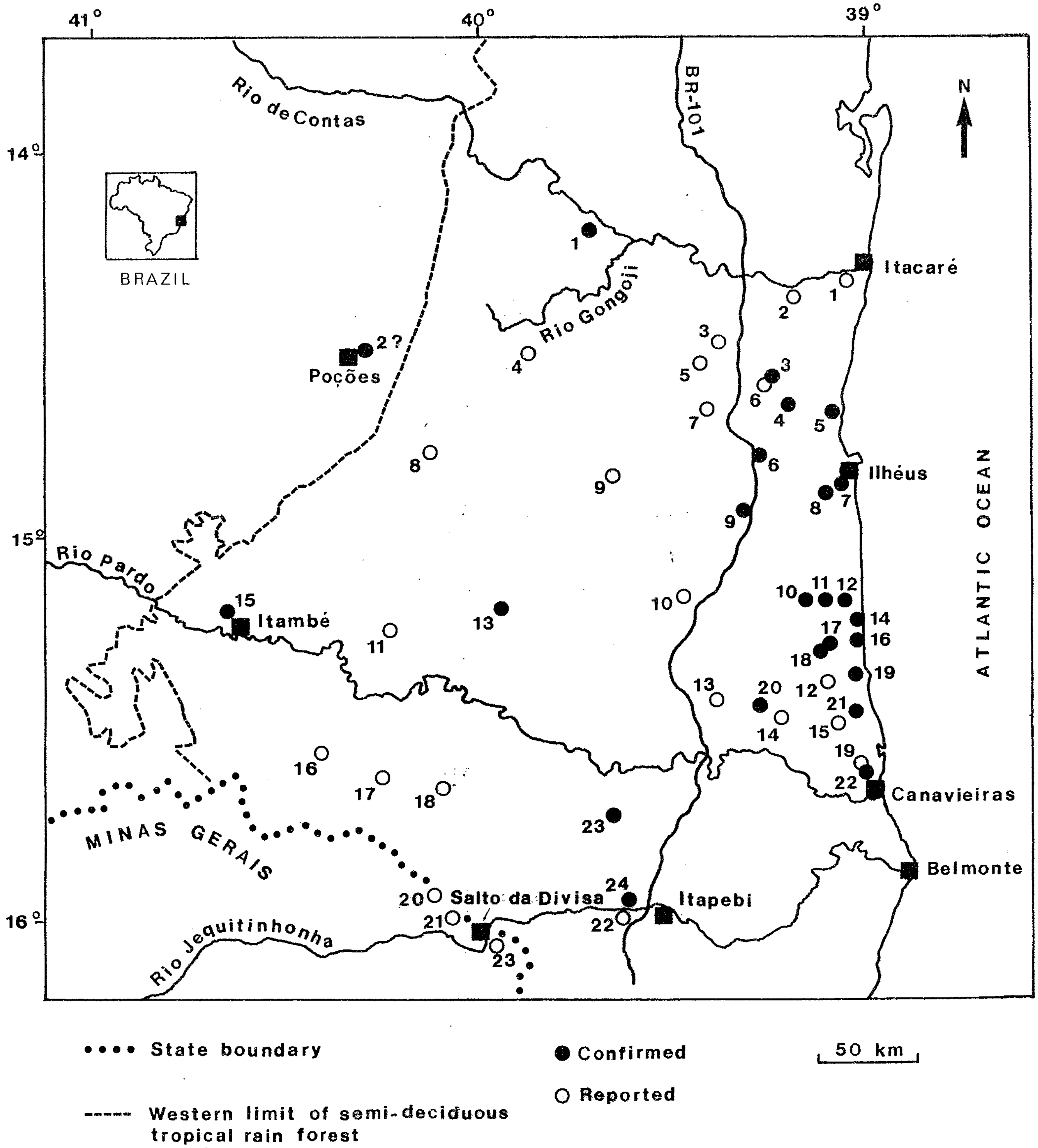
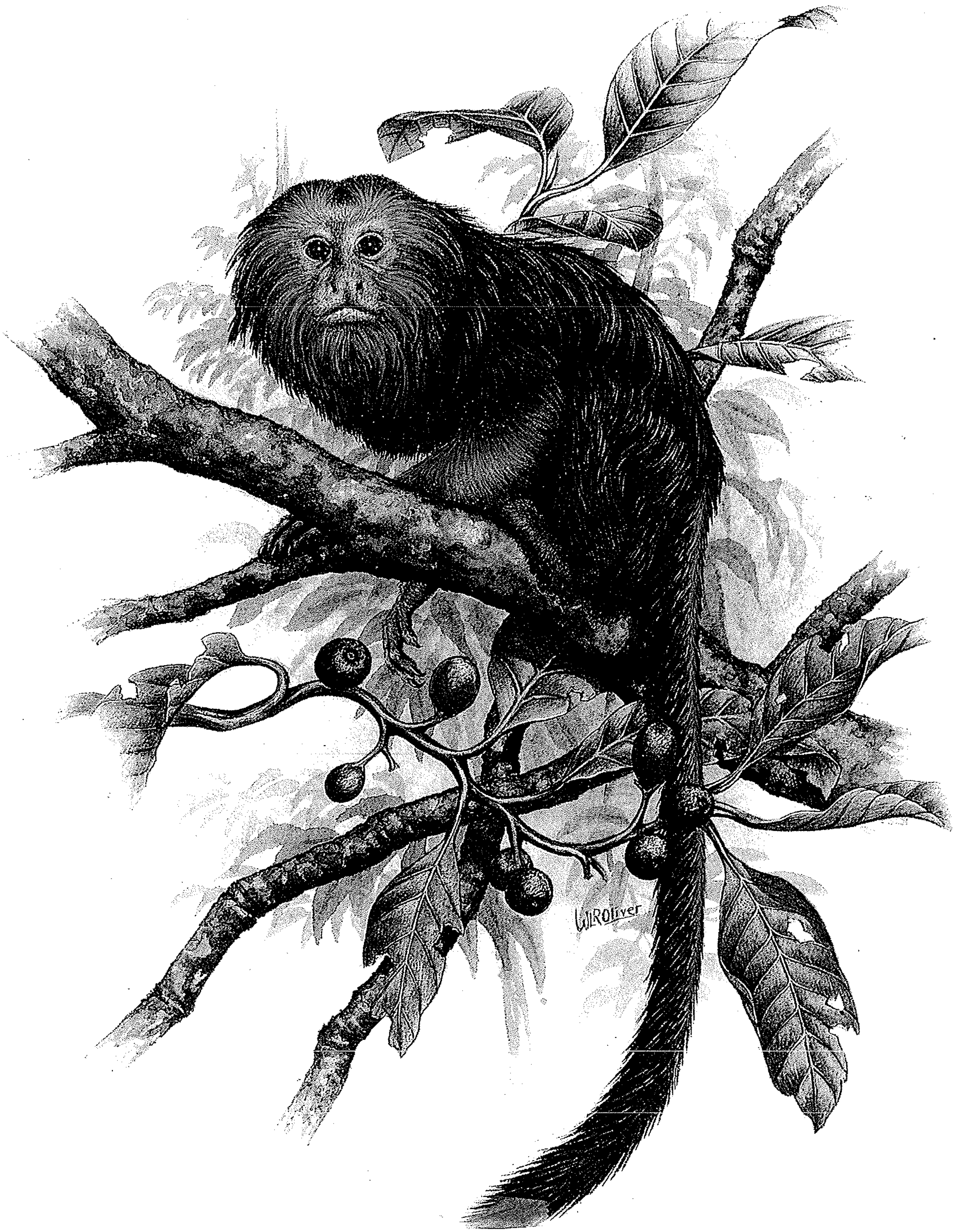


Confirmed (museum specimens and sightings) and reported localities for *Leontopithecus chrysomelas* in southern Bahia, Brazil. From A. B. Rylands, I. B. Santos, and R. A. Mittermeier (in press). In: Kleiman, D. G. (ed.), A Case Study in Conservation Biology: the Golden Lion Tamarin.



Golden-Headed Lion Tamarin (*Leontopithecus chrysomelas*)

Illustration: W. Oliver

GOLDEN-HEADED LION TAMARIN WORKING GROUP REPORT

(Anthony Rylands (Chairperson), Jeremy Mallinson, Adelmar Coimbra Filho, Cristina Alves, Max de Menezes, Saturnino de Souza, Ilmar Santos, Iolita Bampi, Jo Gipps).

I. Wild Population

A. Areas Protected at Present: (map attached)

Three areas identified within known range (between Rio de Contas and Rio Jequitinhonha)

1. Biological Reserve of Una (IBAMA) (REBIO Una)
   - Decreed December 1980D, with 11400 ha
   - Only 5342 ha acquired by IBDF (now IBAMA) in two blocks:
   Zona da Piedade (2607 ha) with 80 squatter families, now reduced to 30 and Zona de Maruim (2735 ha), with no squatter families.
   - 659 ha bought 1989/90 to widen corridor between two zones.
   - Total area now owned by IBAMA = 6001 ha

2. Estacao Experimental de Lemos Maia (CEPLAC)
   - Approximately area 495 ha, of which approx 100 = forest
   - Three km South of REBIO Una

3. Estacao Experimental de Canavieiras (ESCAN) (CEPLAC)
   - Approximately area 500 ha,
   - Approximately 40 km south of REBIO Una
   - Almost completely covered with good forest
   - Being considered for transfer from CEPLAC to IBAMA

B. Potential for Future Protected Habitat

1. Una:
   - More land (1000 ha) is being purchased, to make it more rounded (reduced perimeter); this process can continue, bringing in land already part of the government decree
   - This will bring total reserve size to 6585 ha (high probability)
   - A further 1000 ha might be included in the future (low probability)

2. Lemos Maia:
- A suggestion has been made to purchase corridor between Una and Lemos Maia (an area of the order of 600 ha - high probability)

3. ESCAN:
- There is a low probability that more land can be bought (not more than 350 ha). There is a high probability that ownership of ESCAN be transferred from CEPLAC to IBAMA. There is a low probability that neighbouring land (say 500 ha) be transferred to IBAMA from Instituto Nacional de Colonizacao e Reforma Agraria (INCRA).

4. Ranches with GHLT in the Una region, which have good GHLT habitat, which may become available as protected areas (low probability)
- Dendévea Farm (2,500 ha: the best forest area in UBR region)
- Piedade Farm (1,100 ha of forest, most secondary in abandoned cocoa and rubber plantation, but with some good forest)
- Pindorama Farm (Two blocks: one of about 1,000 ha of good forest and another of 300 ha).

5. There are further ranches in the area, some of which may be available as protected forest habitat (low probability). A pure guess would be 10 farms each of 150 ha, giving 1500 ha.

6. There are a further 13 registered localities where GHLTs have been recorded recently (observations or skin specimens), and 36 localities reported by local people (unconfirmed; total area of suitable habitat not determined, but say 49 patches of an average size of 50 ha, giving a possible total of 2450 ha).

C. Summary of existing and potential protected habitat. (Numbers in ha)

	Existing (a)	High prob (b)	Total (a+b)
a. Una	5585	1000	6585
b. Lemos Maia	100	600	700
c. ESCAN	500	-	500
d. Listed ranches	-	-	-
e. Other ranches	-	-	-
f. Sightings etc	-	-	-
TOTAL	6185	1600	7785

	Low prob (c)	Total (a+b+c)
a. Una	1000	7585
b. Lemos Maia	-	700
c. ESCAN	850	1350
d. Listed ranches	4900	4900
e. Other ranches	1500	1500
f. Sightings etc	2450	2450
TOTAL	10700	18485

Thus, in summary:
* there are 6185 ha of protected habitat.
* there is a high probability of this increasing to 7785 ha.
* there is a further (very) low probability of this increasing to 18485 ha.

D. Number of Animals Protected at Present

These estimations are based on the use of the following methods and assumptions:

Method 1: . Average group size = 6.6 and group home-range size (no overlap) = 42 ha

Method 2: . Range of densities estimated by transect survey at Lemos Maia, 1980. Low: 0.046 ind/ha; High: 0.167 ind/ha

1. Una:
   - if whole reserve consisted of ideal habitat, population would be:
     Method 1 972 individuals
     Note: the figure of 466 (50%) is used in the following calculations as being more realistic.
     Method 2 257 - 933 individuals

2. Lemos Maia:
   Method 1 20 individuals
   Method 2 5 - 17 individuals
   Observed: 3 groups seen, 20 individuals

3. ESCAN:
   Method 1 79 individuals
   Method 2 23 - 84 individuals
   Observed: 2 groups seen; not more than ten groups

Existing protected areas and animals summary

	Area (Ha)	Pop, method 1	Pop, method 2
Una	5585	466	257 - 933
Lemos Maia	100	20	5 - 17
ESCAN	500	78	23 - 84
Total	6185	564	285 - 1033

E. Numbers of Animals That Could be Protected, (should extra land be obtained).

	A	B	C	D	E
Method 1	564	251	815	1680	2495
Method 2 (low)	285	74	358	492	850
Method 2 (high)	1033	267	1300	1787	3087

A = Total number of animals in existing areas
B = Total number of animals in high probability areas
C = A + B
D = Total number of animals in low probability areas
E = C + D

F. Threats to the Wild Population

1. Deforestation is very rapid over the whole area. For example, in 1980, there were seven sawmills in the town of Una; in 1989, there were 23. Agrarian reform is resulting in local landowners destroying forest patches, because of fears of its appropriation for settlement schemes.
   Annual rate of deforestation is between 1 and 5 %

2. A worsening of the recent localized outbreaks of witch's broom disease (an important incurable disease of cocoa) might result in cocoa plantations being substituted by African Palm oil or coconut palms or, perhaps the worst alternative for GHLTs, to cattle pasture. Cocoa plantations (especially 'cabruca', involving planting in thinned-out forest) can increase GHLT carrying capacity of remaining forest patches, and act as corridors for dispersal. Possible annual loss of marginal GHLT habitat could be 1%/year; possibility of catastrophic outbreak: 1%, resulting in 50% loss of marginal GHLT habitat.

3. International trade in live GHLTs was very bad in the 1980's, but has been reduced by the activities of the GHLT IRMC. However, internal trade is still widespread. Potential annual loss (harvest) of 50 - 100 animals.

4. Fires are infrequent (compared to Poço das Antas, since the climate is much less seasonal, and generally wetter), but in certain regions (especially around Canavieiras) burning cattle pastures, and the spread of fire into surrounding forest, is a distinct possibility.
   Frequency: 5% Severity: 1% <u>or</u> Frequency: 1% Severity: 5%

G. Re-introductions and Translocations

1. There is limited potential for re-introductions at the present time. Although the captive population will soon be in surplus, there is insufficient knowledge of habitat availability and protection status (see Overview document analysis by Devra Kleiman, with which we agree, however, the situation should be kept under close review, as data on protected habitat availability in the region accumulates, and local awareness of GHLT conservation issues increases.

2. There is a recommendation in the GHLT Overview document (4d) that a holding/screening centre be established in the region (not at Una Reserve - see B below), to hold confiscated animals awaiting final placement, and perhaps for holding animals being translocated from doomed habitat to vacant, secure habitat. The same considerations with regard to feasibility apply as in 6a. above.

H. Demographic Information

There is little published information on life-history or demographic characteristics of this species in the wild; it will almost certainly be necessary to use GLT information for modelling, where GHLT information is lacking.

Breeding: three groups at Lemos Maia (1980) bred only once in the year (August, 1 group; September, 2 groups)

Density: 0.9 - 3.0 groups/sq km
4.6 - 16.7 individuals/sq km

Group structure: there can be more than one adult male and female in each group; only one female breeds

Litter size: 2

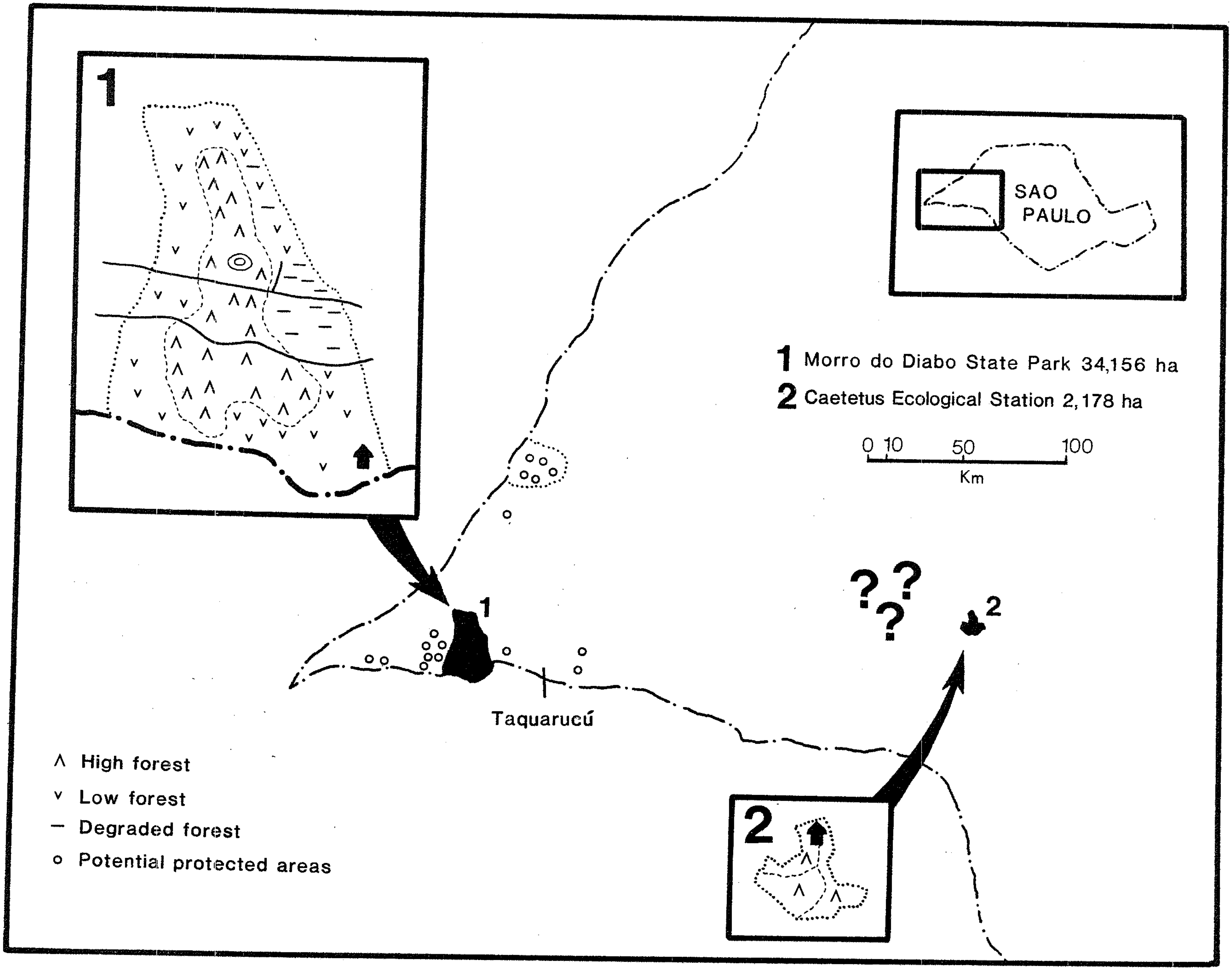
II. POPULATION IN CAPTIVITY

The population at 31 August 1989 consisted of 285 individuals (130.116.39) held in 22 collections. The population has 83 founders of which 75 are alive. Therefore, from a demographic point of view, the captive population is secure.

Based on the number of founders currently represented in this population, the genetic diversity of the wild population is adequately protected. However, founder representation is markedly unequal, with 21 living founders with no living offspring; everything should be done, therefore, to maximise the retention of allelic diversity.

Due to the current success of the captive breeding programme, the captive population will, in the near future, be in a position to provide animals for re-introduction to the wild. However, at the present time, re-introduction is not considered to be a viable option, due to the paucity of information on the status of the wild population; it is therefore important for census work to be carried out at the earliest opportunity.

With regard to the 21 captive individuals presently held in cages at the Una reserve, the Management Committee has advised on the importance of removing these from the reserve to avoid transmission of disease or social disruption with the native population. The management committee has identified a further 20-23 different locations able to accomodate 37-40 pairs to take individuals outside Brazil. These zoos have already signed the IRMC Management Agreements Memorandum of Understanding and all have previous experience of the maintenance and breeding of Callitrichids. However, due to the success of the overall captive breeding programme workldwide, it may be found difficult to absorb further animals from Una into the captive population at the present time.



Distribution of black lion tamarin.

Black Lion Tamarin (Leontopithecus chrysopygus)

Photo: WWF US/Russ Mittermeier

BLACK LION TAMARIN WORKING GROUP REPORT

Claudio Padua, Faical Simon, Suzana Padua, Alexine Keuroghlian, Helder Faria, Jose Max, Francisco Serio).

I. Protected Wild Habitat

A. Identification of Protected Habitats

1. Morro do Diabo State Park	34,156 ha
2. Caetetus Ecological Station	2,178 ha
Total	36,334 ha

Total habitat protected = 29,503 ha

The Morro do Diabo State Park and the Caetetus Ecological Station are under the administration of the Forestry Institute of Sâo Paulo - Environment Secretary (State Government).

B. Threats to the Habitat

1. Morro do Diabo: fire, invasion and "Ramal de Dourados" Railroad
2. Caetetus Ecological Station:
   - fire
   - presence of hunting (not a major threat to the species itself, for hunters are usually interested in other animals). There is an urgent need for a larger number of wardens.
   - water - quality and quantity (since the watersheds are outside of the area).

C. Threats to the Population

	Frequency	Reduction
1. Fire	1-20 years	50%
2. Disease	1-100 years	50% 100% in Caetetus
3. Hunting	---	100% In Caetetus

D. Other Possible Habitats

Private properties:
- around 2,500 ha
- an appropriate survey will be started in August 1990
- status of these areas - private properties

Threats to the populations:
- deforestation
- fire
- hunting
- frequency and intensity not estimated
- % of survivorship ??
- % of reproduction ??

Interactions among populations: impossible

II. Biology of Populations

A. Carrying Capacity

Number of individuals:

	Min	Max
Morro do Diabo	80	450
Caetetus	8	30

Home Range = 200 ha

The members of the group agreed to use data of GLT or GHLT whenever specific data is not available.

B. Environmental variation

The species show a certain degree of habitat tolerance, since they are found in areas apparently of low habitat quality. The region of Morro do Diabo contains much habitat variation. Fires may occur with a frequency of 1 per 20 years and result in about a 50% reduction in the tamarin population.

C. Wild Population Information

Fertility
1. Age of 1st Reprouction: Minimum = 24 Mos.
2. Number of offspring/female/year = 2
3. Do all males contribute to reproduction = No; % = ?
4. Number of animals contributing to breeding pool: Minimum = 25%, 20 individuals

III. Other Considerations

A. Wild populations

1. Necessity of survey

2. Necessity for continuous monitoring

3. More effective protection for Caetetus Station

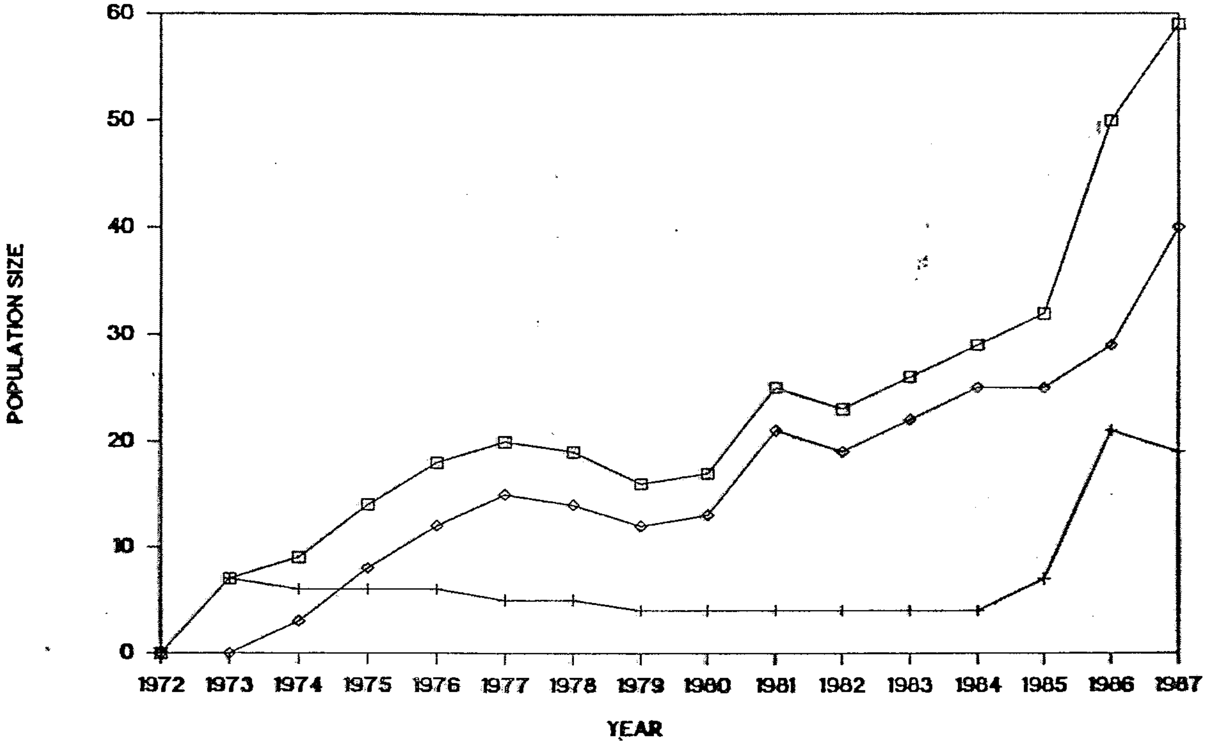
4. Restoration of degraded areas at Morro do Diabo

B. Captive populations:

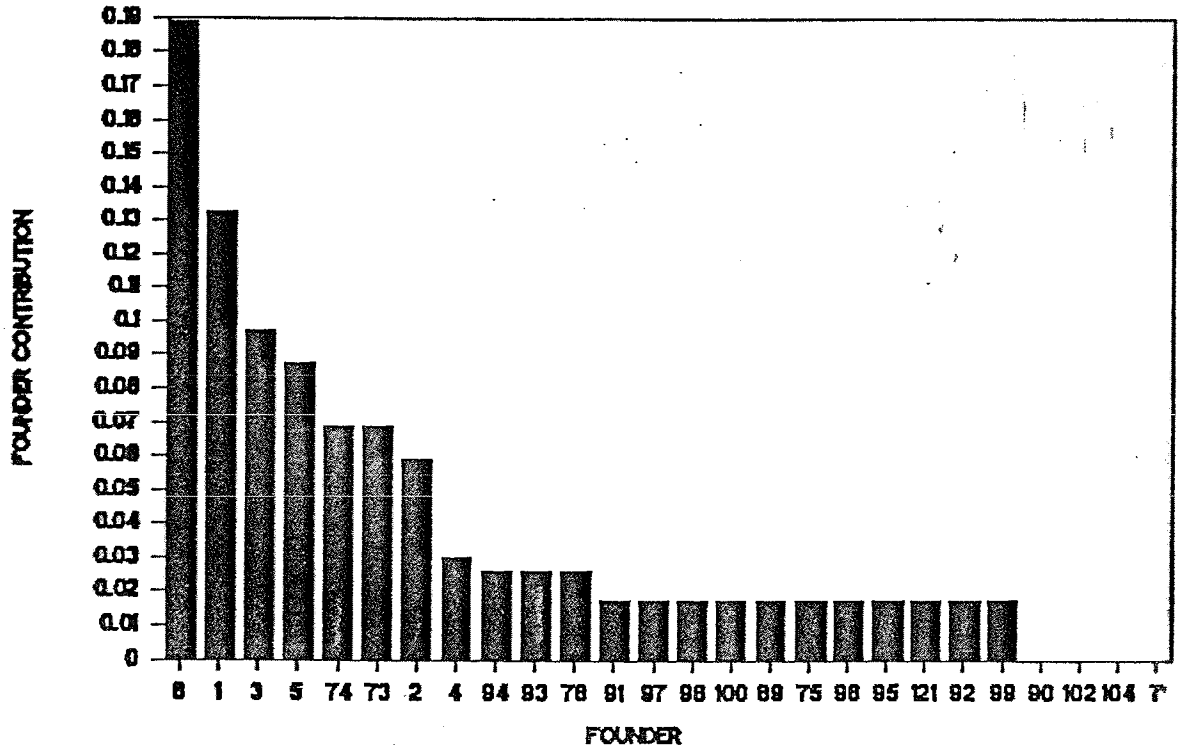
(# of live specimens, June 1990) = 64

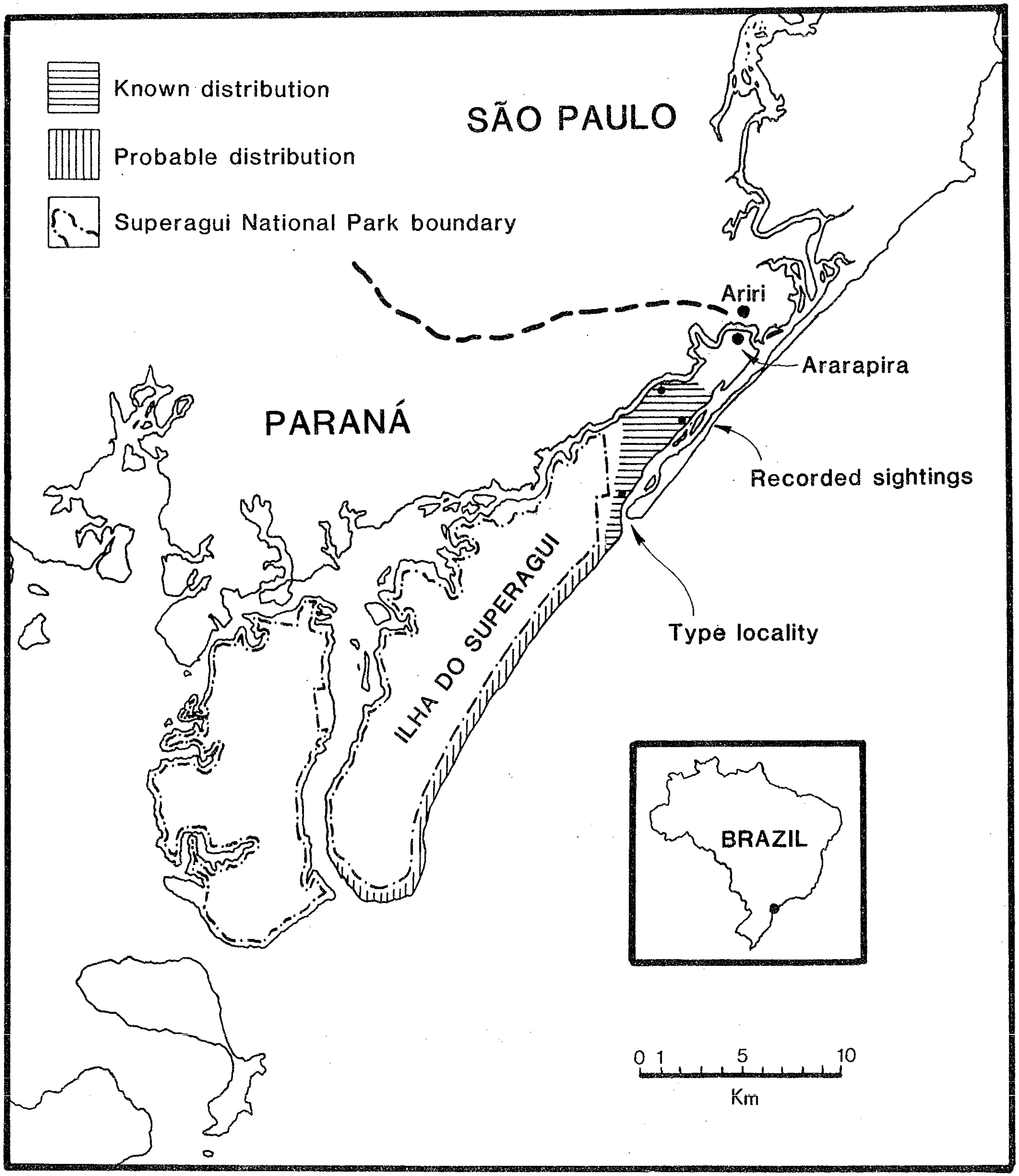
Considering the small size of the population, the existing colonies seem to be doing well. It is clear that there is a necessity of dividing the population among a larger number of colonies.

BLT POPULATION GROWTH



BLT FOUNDER CONTRIBUTION





Distribution of black-faced lion tamarin.

BLACK-FACED LION TAMARIN WORKING GROUP REPORT

(Ibsen Camara, Maria Lorini, Vanessa Persson)

I. WILD POPULATIONS

A. Habitat Information

1. Protected areas: Unknown. The species was recorded in 3 localities of Superagui Island.

2. Area with appropriate habitat: Unknown. An educated guess indicates something around 5.000 ha in Superagui Island.

3. Status: Privately owned.

4. Threats to the habitat: Cattle raising (buffalos) and urban projects in the future. Fishermen population in the area, estimated at 200-300 people.

5. Threats to the population: Illegal trade.

6. Other potential habitat: Unknown. Depends on research.

B) Population Information

1. Population tendencies: No information. Depends on survey.

2. Habitat potential: No information. Depends on survey.

3. Threats to the population: Illegal trade in view of publicity arising from its discovery. This threat is immediate and serious.

4. Interactions between populations: No information.

C) Biological Information

Very little is known. The population size is unknown, but an educated guess indicates something between 125 and 625 specimens, based on habitat requirements of the other lion-tamarin species. There is no information regarding survival, fertility, etc.

II. CAPTIVE POPULATIONS None.

CONSERVATION ACTION PLAN FOR

THE BLACK-FACED LION TAMARIN, *Leontopithecus caissara*

A New Species from the Southern Brazilian Atlantic Forest

1) A Survey of the Range of the Black-faced Lion Tamarin.

Described only in 1990, the Black-faced Lion Tamarin, *Leontopithecus caissara,* is known only from a small portion of the island of Superagui, municipality of Guaraquecaba, in the coastal region of northern Parana, southern Brazil (25 18'S, 48 11'W). However, it is not impossible that the new species also occurs in other parts of Superagui, and also on other islands and adjacent portions of the mainland as well. A preliminary survey in the region should be carried out as soon as possible, to determine the full range of the species, and evaluate its population, with special emphasis on the region included in the Superagui National Park. Since the Black-faced Lion Tamarin is almost certainly the rarest and most endangered of all Neotropical primates, this project should be considered a very high priority.

Estimated over three years ..... US 75,000

2) Ecology and Behaviour of the Black-faced Lion Tamarin.

Another priority is to learn more of the biology of this new species, both to determine the needs of the Black-faced Lion Tamarin in order to construct a plan for its survival and also because of its intrinsic scientific interest, regarding the existing zoological discussions on the genus *Leontopithecus*. Two excellent models for such a field study already exist: the research program on the Golden Lion Tamarin, *Leontopithecus rosalia* in the Poço de Antas Biological Reserve, Rio de Janeiro, and the Black Lion Tamarin, *Leontopithecus chrysopygus,* on Morro do Diabo Reserve in Sao Paulo. Needed for such a research program would be lodging for researches and some equipment, including traps, radio-telemetry equipment and other material.

Estimated cost over three years ..... US 75,000

3) Habitat Protection of the Black-faced Lion Tamarin.

All of the area in which the new species occurs falls within the Guaraquecaba Environmental Protection Area (APA), and it is possible that populations will be found in the borders of the Superagui National Park as well. In any case, there will be a need to increase vigilance in the area and perhaps to extend the boundaries of the existing park to include the range of the species. A great part of the adopted strategy will depend on the results so the scientific survey, but additional protection (new guards and logistic) will probably be needed as well. This can perhaps be arranged with IBAMA, and it is highly recommended that local people (the "caicaras", after whom the species is named) should be involved for this purpose. This will increase local enthusiasm for conservation measures and will ensure that people which know the area of the Black-faced Lion Tamarin intimately are involved in its protection.

Estimated cost over three years US 75,000

4) Conservation Education and Public Awareness: The Black-faced Lion Tamarin as a "flagship" species for the coastal Atlantic Forest of the state of Parana.

A critical component of the program for the Black-faced Lion Tamarin will be a local education and public awareness program in the region. Very successful models for this already exist for the Golden Lion Tamarin, *L. rosalia*, and the Black Lion Tamarin, *L. chrysopygus*, and can be followed for this species as well, although on smaller scale as the human population in the range of the Black-faced Lion Tamarin is much smaller. Among the measures needed would be a preliminary survey to determine local attitudes, production of educational material (e.g. posters, shirts, etc.), and eventually a mobile education unit if this proves practical or convenient.

Estimated cost over three years US 25,000

5) Captive Breeding Program.

Techniques for breeding in captivity are well-developed, and have proven quite successful for the three other species. Once the preliminary survey has been conducted it would be advisable to initiate a captive breeding program for the species as well. The Rio de Janeiro Primate Center would be the obvious starting point for such a program, and other Brazilian and international institutions involved with the genus *Leontopithecus* should also be involved.

Estimated costs over three years US 50,000

TOTAL COSTS OVER THREE YEARS US 300,000

LEONTOPITHECUS

POPULATION VIABILITY ANALYSIS

WORKSHOP REPORT

SMALL POPULATION OVERVIEW

INTRODUCTION

An endangered species is (by definition) at risk of extinction. The dominant objective in the recovery of such a species is to reduce its risk of extinction to some acceptable level - as close as possible to the background, "normal" extinction risk all species face.

The concept of risk is used to define the targets for recovery, and is used to define recovery itself. Risk, not surprisingly, is a central issue in endangered species management. Unfortunately, there is ample reason to suppose that we (as humans) are not "naturally" good at risk assessment. Recovery will be more often successful if we could do this better. There is a strong need for tools that would help managers deal with risk. We need to improve estimation of risk, to rank order better the risk due to different potential management options, to improve objectivity in assessing risk, and to add quality control to the process (through internal consistency checks). Among the risks to be evaluated are those of extinction, and loss of genetic diversity.

In the last several years such tools have been developing. The applied science of Conservation Biology has grown into some of the space between Wildlife Management and Population Biology. A set of approaches, loosely known as "Population Viability Analysis" has appeared.

These techniques are already powerful enough to improve recognition of risk, rank relative risks, and evaluate options. They have the further benefit of changing part of the decision making process from unchallengeable internal intuition to explicit (and hence challengeable) quantitative rationales.

In the following sections, Jon Ballou and Tom Foose each describe aspects of Population Viability Analysis (PVA). The text, adapted from that used in other PVAs (Ballou et al. 1989, Lacy et al. 1989), provides an overview of some of the population biology concepts that form the foundation of Population Viability Assessment. Each contributor approaches the subject from their own expertise and experience, so the contributions differ somewhat in perspective and content. There is some overlap, which may help the newcomer by occasionally repeating a point in different language. After these general reviews, information on the captive and wild populations of *Leontopithecus* to provide a basis for a detailed PVA is presented, and recommendations for improving the probability of recovery of these taxa.

SMALL POPULATION OVERVIEW

J. Ballou

The primary objective of single-species conservation programs is to reduce the risk of population extinction. A first step in doing this is to identify those factors that can potentially cause extinction in the population. The most fundamental threat is, of course, declining population size. If a population is declining in numbers, and no action is taken to reverse the trend, then extinction is imminent. However, even if a small population is not declining or even if it is increasing, its fate is uncertain. Small populations are challenged by a number of factors that increase the likelihood of the population going extinct simply because the population is small.

Challenges to Small Populations

Challenges to small populations can be categorized as intrinsic (random variation of genetic and demographic events within the population occurring without reference to environmental events) or extrinsic (environmental events acting on the genetics and demography of a population). At the most basic level, the level of the individual, an intrinsic challenge to the population Demographic Variation. Demographic variation is the normal variation in the population's birth and death rates and sex ratio caused by random differences among individuals in the population. The population can experience fluctuations in size simply by these random differences in individual reproduction or survival. These randomly caused fluctuations can be severe enough to cause the population to go extinct. For example, one concern in extremely

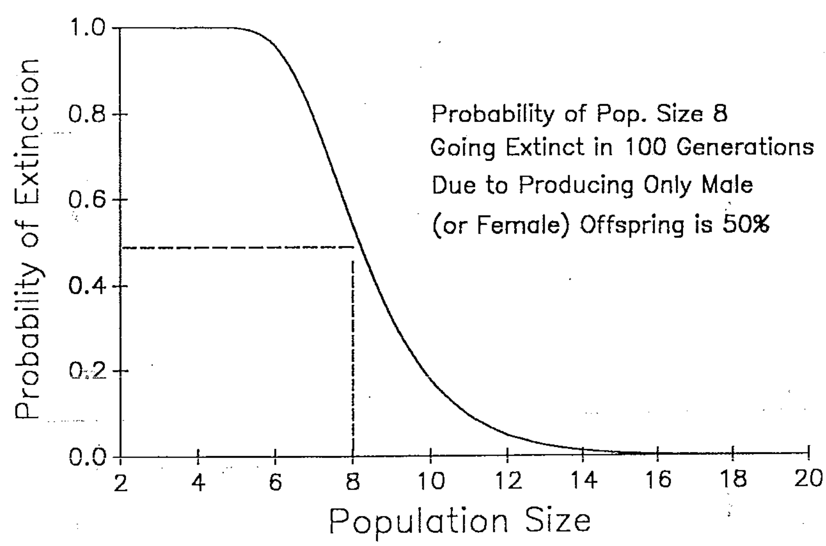


Figure 1. Example of demographic variation: Probability of extinction by 100 generations due solely to producing only one sex of offspring during a generation.

small populations is the possibility that all individuals born into the population during one generation are of one sex, resulting in the population going extinct. Figure 1 illustrates the probability of this occurring over a 100 generation period in populations of different size. There is a 50% chance of extinction due to biased sex ratio in a population of size 8 sometime during this time period.

Similar consequences could result from the coincidental effects of high death rates or low birth rates. However, these risks are practically negligible in large populations. In general, the effect of any one individual on the overall population's trend is significantly less in large populations than small populations. As a result, demographic variation is a relatively minor challenge in all but very small populations (less than 20 animals).

A more significant extrinsic threat to small populations is Environmental Variation. Variation in environmental conditions clearly impact the ability of a population to reproduce and survive. Populations susceptible to environmental variation fluctuate in size more than less susceptible populations, increasing the danger of extinction. For example, reproductive success of the endangered Florida snail kite (*Rostrhamus sociabilis*) is directly affected by water levels, which determine prey (snail) densities: nesting success rates decrease by 80% during years of low water levels. Snail kite populations, as a result, are extremely unstable (Bessinger 1986).

Another level of threat to small populations are Catastrophes such as Disease Epidemics. Catastrophes are similar to other forms of environmental variation in that they are external to the population. However, they are listed separately because of the magnitude of their effects and the difficulty of predicting their occurrence. They can be thought of as relatively rare events that can have devastating consequences for a large proportion of the population. Disease epidemics can have a direct or indirect effect on a population. For example, in 1985 the sylvatic plague had a severe indirect effect on the last, remaining black-footed ferret population by reducing the ferrets prey base, the prairie dog. Later that same year, the direct effect of distemper killed most of the wild population and all of the 6 ferrets that had been brought into captivity (Thorne and Belitsky 1989).

Catastrophes are rare disasters capable of decimating a population. Catastrophic events can include natural events (floods, fires, hurricanes) or human-induced events (deforestation or other habitat destruction). Both large and small populations are susceptible to catastrophic events. Tropical deforestation is the single most devastating 'catastrophe' affecting present rates of species extinction. Estimates of tropical species' extinction rates vary between 20 and 50% by the turn of the century (Lugo 1988).

Small populations are also susceptible to genetic challenges. The primary genetic consideration is the loss of Genetic Variation. Every generation the genes that get passed on to offspring are a random sample of the genes of the parents. In small populations, each random sample of genes is a small sample and represents only a fraction of the genes of the parental generation. Some of the genetic variation present in the parents, may not, just by chance, get passed on to the offspring. This genetic variation is then lost to the population. This process is called genetic drift because the genetic characteristics of the population can drift or vary over time. In small populations, genetic drift can cause rapid loss of genetic variation - the smaller the population, the more rapid the loss of variation.

Conservation programs include the maintenance of genetic diversity as a primary goal for several reasons. If species are to survive over the long-term, they must retain the ability to adapt to changing environments (i.e. evolve). Since the process of natural selection requires the presence of genetic variation, conservation strategies must include the preservation of genetic diversity for long-term survival of species. In addition to long-term evolutionary considerations, the presence of genetic diversity has been shown to be important for maintaining the fitness of the population. A growing number of studies show a general, but not universal, correlation between genetic diversity and various traits related to reproduction, survival and disease resistance (Allendorf and Leary 1986). Individuals with lower levels of genetic variation often have higher mortality rates and lower reproductive rates than individuals with more diversity.

Inbreeding (matings between relatives) also causes populations to lose genetic diversity. All the animals in small populations quickly become related. An offspring produced from related parents are inbred and can get the same alleles from its mother and father. Inbred individuals

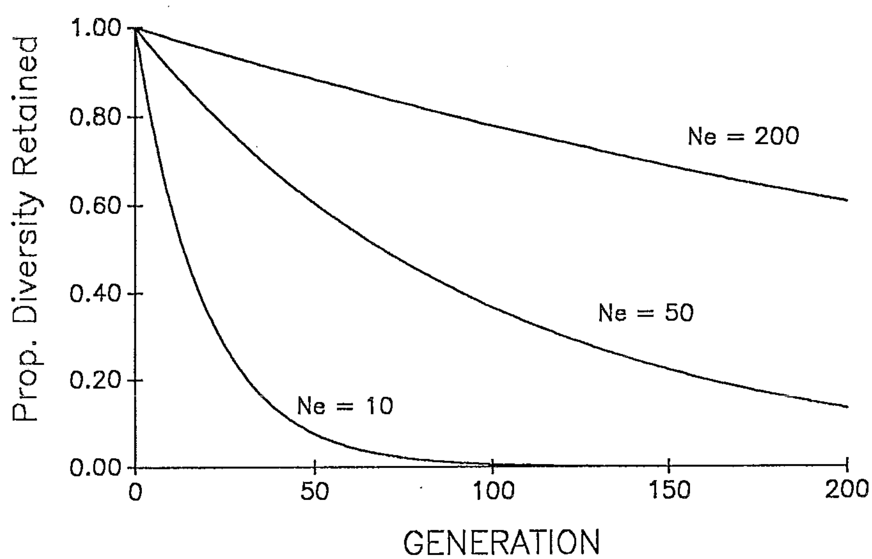


Figure 2. Loss of genetic diversity over 200 generation in populations with different effective sizes (Ne).

are therefore more homozygous than non-inbred individuals and they have lower levels of genetic diversity than animals born to unrelated parents.

The loss of genetic variation in populations of different size is shown in Figure 2. The rate of loss is a function of the effective size of the population (Ne; the percent of diversity lost each generation is 1/2Ne). Technically, a population's effective size is the size of an ideal population that loses genetic diversity at the same rate as the real population. There is extensive literature on how to estimate a population's effective size (Lande and Barrowclough 1987); however, the number of animals contributing to the breeding pool each generation can be used as a very rough estimate of the effective size. The effective size of the population is therefore much less than the actual number of animals; estimates suggest that Ne is often only 10 to 30% of the total population. Seemingly large populations will lose significant levels of genetic diversity if their effective sizes are small.

Data on the effects of inbreeding in exotic species also show the importance of maintaining genetic diversity. Numerous studies have shown that inbreeding can significantly reduce reproduction and survival in a wide variety of wildlife (Ralls and Ballou 1983; Wildt et al, 1987; Figure 3). Inbreeding depression results from two effects: 1) the increase in homozygosity allows deleterious recessive alleles in the genome to be expressed (whereas they are not in non-inbred, more heterozygous individuals); and 2) in cases where heterozygotes are more fit than homozygotes simply because they have two alleles, the reduced heterozygosity

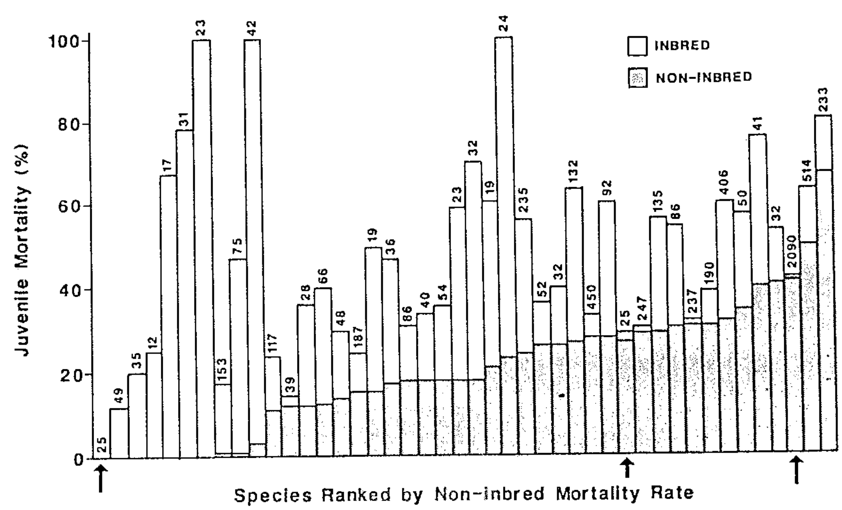


Figure 3. Effects of inbreeding on juvenile mortality in 45 captive mammal populations (From Ralls and Ballou, 1987).3

caused by inbreeding reduces the fitness of the inbred individuals (over dominance). In both cases, the loss of genetic variation due to inbreeding has detrimental effects on population survival.

Small, isolated populations, with no migration from other populations, lose genetic diversity and become increasingly inbred over time. Their long-term survival potential is doubly jeopardized since they gradually lose the genetic diversity necessary for them to evolve and their short-term survival is jeopardized by the likely deleterious effects of inbreeding on survival and reproduction.

The genetic and demographic challenges discussed above clearly do not act independently in small populations. As a small population becomes more inbred, reduced survival and reproduction are likely: the population decreases. Inbreeding rates increase and because the population is smaller and more inbred, it is more susceptible to demographic variation as well as disease and severe environmental variation. Each challenge exacerbates the others resulting in a negative feedback effect termed the "Extinction Vortex" (Gilpin and Soule, 1986). Over time the population becomes increasing smaller and more susceptible to extinction (Figure 4).

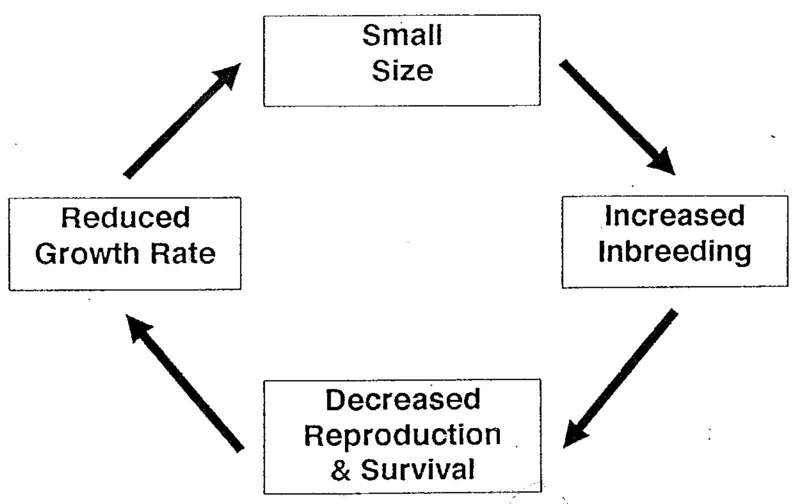


Figure 4. "Extinction Vortex" caused by negative feedback effects of inbreeding in small populations.

Population Viability Analyses

Many of the challenges facing small populations are stochastic and result from random unpredictable events. Many can generally be assumed to decrease the likelihood of long-term survival of the population. However, because of their stochastic nature, their exact effects on population extinction and retention of genetic diversity can not be predicted with total accuracy. For example although inbreeding depression is a general phenomenon, its effects vary widely between species (Figure 3) and it is not possible to precisely predict how any one population will respond to inbreeding.

Nevertheless, conservation strategies that address these unpredictable issues of extinction and loss of genetic diversity must be developed and implemented. The process that has been developed over recent years to assess extinction probabilities and loss of genetic diversity is called Population Viability Analysis (PVA; Soule 1987). PVA is defined as a systematic evaluation of the relative importance of factors that place populations at risk. It is an attempt to identify those factors that are important for the survival of the population. In some cases, this may be easy - habitat destruction is often a critical factor for most endangered species. But at other times, the effects of single factors, and the interaction between factors, are more difficult to predict.

To try to gain a more quantitative understanding of the effect of these factors, computer models have been developed that apply a combination of analytical and simulation techniques to model the populations over time and estimate the likelihood of a population going extinct and the loss of its genetic variation. The model is first provided with information describing the life-history characteristics of the population. Depending on the model used, this includes data on age of first reproduction, litter size distribution, survival rates, mating structure and age distribution as well as estimates of the variation associated with each of these variables. A number of different external factors may also be considered. This may include levels of environmental variation, change in carrying capacity and severity of inbreeding depression. Models also allow consideration of threats facing the population: probability of catastrophes and their severity, habitat loss and disease epidemics (Figure 5). The models use the life-history variables, the external factors and the potential threats to project the population into the future,

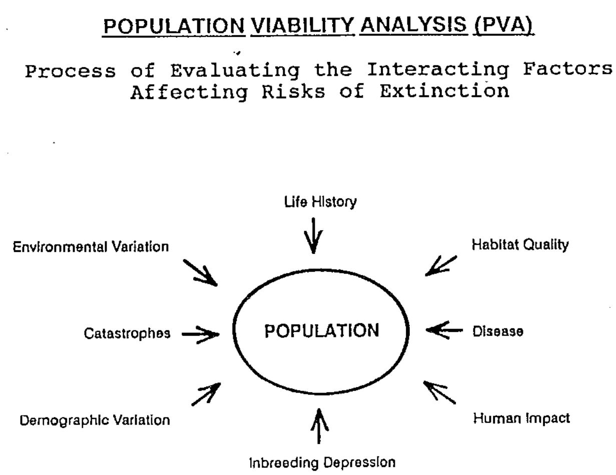


Figure 5. Population Viability Analyses (PVA) model the effects of different life-history, environmental and threat factors on the extinction and retention of genetic diversity in single populations.

measuring the level of genetic variation that is retained over time and recording if and when the population goes extinct (population size goes to zero). The simulations are repeated, often thousands of times, to provide estimates of the statistical variation associated with the results. The probability of extinction at any given time is measured as the number of simulations that the population had gone extinct by that time divided by the total number of simulations run (Figure 6). The levels of genetic variation are recorded as the percent of the original heterozygosity and number of original alleles retained in the population at any particular point.

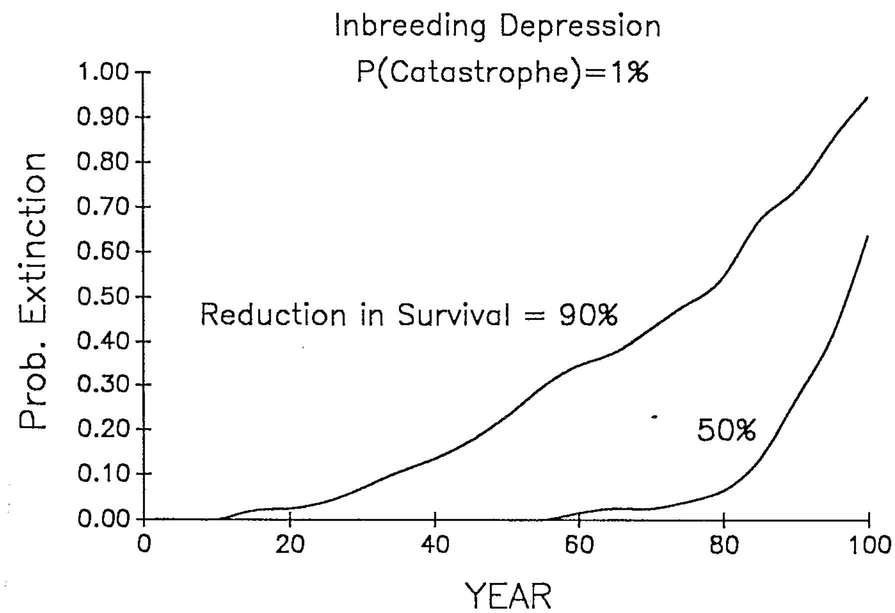


Figure 6. Hypothetical example of population extinction results from the VORTEX PVA model. The model includes negative effects of inbreeding and a catastrophe probability of 1%. The probability of extinction is shown over time for two different levels of catastrophe severity: a 90% reduction in survival vs 50% reduction in survival.

A number of population viability models have been developed. The model used by the Captive Breeding Specialist Group of the IUCN is VORTEX, written by Robert Lacy (Chicago Zoological Society). This model has been used extensively to develop conservation strategies for a number of species including the Black-footed ferret, Florida panther, Puerto Rican Parrot, Javan rhino and the four species of lion tamarins.

The true value of the model is not in trying to examine the effects of all variables simultaneously in the population. The interactions between these many factors is too complex to attempt to interpret the results of population projections based on more than just of few of these considerations. We can gain far more insight into the dynamics of the population by examining only one or two factors at a time - and picking those factors that we believe have an impact on the population and ignoring those that don't.

The primary use of the model in developing conservation strategies is its use in conducting "what if" analyses. For example 'what if' survival were decreased in the wild population as a result of a disease outbreak? How would that effect the extinction of the population and retention of genetic diversity? These 'what if' analyses can also be used to evaluate management recommendations. For example, how would the probability of population extinction change if the carrying capacity of the reserve holding the animals were increased by 10%?

Because the models don't examine all factors potentially contributing to extinction, the model results usually underestimate a population's probability of extinction. However, it is important to stress that the purpose of the PVA is not to estimate exact extinction probabilities but to identify the relative importance of the various factors being considered and to evaluate the effect of a range of management recommendations on the survival of the population.

Implications of PVA on Management Goals

The concepts of population extinction and loss of genetic diversity are based on probabilities rather than certainties. The results from the PVA models provide us with information on the probability of extinction given certain assumptions about the biology and status of the population. As a result, we can not predict or guarantee what will happen to these populations with any absolute certainty.

This has some fairly strong implications when we are trying to develop conservation strategies to reduce the risks of extinction in the populations. We must be able to recognize that we will not be able to formulate and implement recommendations that will guarantee the survival of any population. We can only formulate and implement recommendations that will decrease the likelihood of extinction in populations over a given time period.

A common approach is to develop management strategies that assure a 95% chance of the population surviving for 100 years and maintaining 90% of its genetic variation over the same time period (Shaffer 1987; Soule et al, 1986). This would assure a high probability of survival and retain a large proportion of the population's ability to genetically adapt and evolve to changing environments. This approach defines the Minimum Viable Population (MVP) size to achieve these management objectives. Management strategies can only be fully evaluated if both degree of certainty and time frame for management are specified.

Metapopulations

The discussion to this point has focused on the extinction and genetic dynamics of a single population. However, often managers are faced with a species distributed over several interacting populations. When this is the case and animal movement (migration) between populations is high enough that the dynamics (extinction or genetic) of any single population is affected by dynamics of other nearby populations, the group of interacting populations is called a Metapopulation (Figure 7). The understanding of metapopulation dynamics has become increasingly important for the development of conservation strategies.

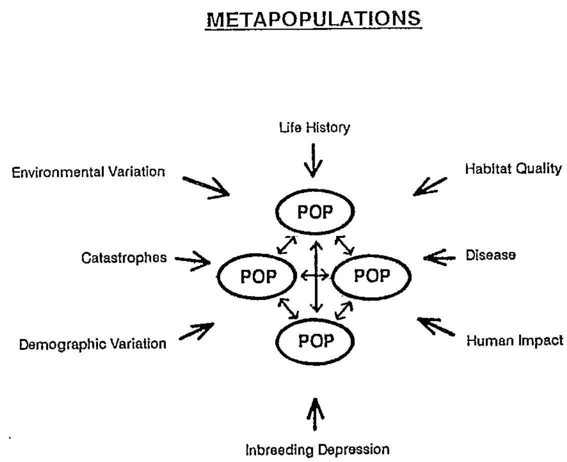


Figure 7. The interaction between population 'patches' results in a Metapopulation structure. Conservation strategies must consider the spatial distribution of the patches and its effect on correlated extinctions and recolonization between patches.

Metapopulation management focuses on the spatial distribution of the populations and how that influences both the genetic and demographic dynamics of the system. The metapopulation system can be thought of as a grouping of populations ('patches') of different sizes and distances from each other, with some patches periodically going extinct and being recolonized by migrants from other patches. The most important conservation considerations are rates of extinction for the individual patches and the re-colonization rates between patches (Gilpin 1987).

As we have discussed above, the extinction dynamics of any single patch is affected by any number of factors including size of population, rate of population recovery following a population decline, etc. From a metapopulation perspective, the simplest level is when patch extinction rates are not correlated with each other: the probability of extinction of any one patch is independent of any other patch. Environmental variation and catastrophes increase the extinction correlation between patches and this increases the likelihood of the entire metapopulation going extinct. So considerations of the spatial distribution between patches, and what that means in terms of how similarly they react to environmental variation and catastrophes is an important part of developing management strategies.

On the other side of the coin is the effect of spatial distribution on recolonization rates between patches. The closer patches are to each other, the higher the probability of a patch being recolonized following an extinction by migrants from a neighboring patch. Thus, distances between patches is positively correlated with recolonization and long-term survival of the metapopulation.

Patch extinction and recolonization also effect the retention of genetic diversity in the metapopulation. Small, fragmented and isolated populations rapidly lose genetic diversity. However, with migration between patches, gene flow among patches can be increased and the effective size of the total metapopulation is significantly increased. However, if recolonization following extinction repeatedly involves a very limited number of individuals (one pair or a pregnant female), then individual patches can be genetically invariant as a result of the recurrent founder effects.

The interaction between the positive aspects of recolonization and the negative effects of correlated patch extinction complicate the understanding of metapopulation dynamics, both at the genetic and demographic level. Unfortunately, computer models that combine aspects of single-population extinction and genetic considerations discussed above with considerations of metapopulation theory are not yet available for developing conservation management strategies.

Nevertheless, managers should be cognizant of the complexities of metapopulation systems. In general, populations distributed over several populations are more secure over the long-term than one population located at a single site. This is particularly true if there is gene flow between patches (either natural or through management intervention) and the patches are not susceptible to the same catastrophic threats. In many cases, a captive population can serve as a secure patch that can be used as a source to recolonize other patches through reintroduction efforts and as a reservoir for genetic diversity.

References

Allendorf, F.W. & R.F. Leary. 1986. Heterozygosity and fitness in natural populations of animals. Pp. 57-76. In: M.E. Soule (ed): Conservation Biology: The Science of Scarcity and Diversity. Sinauer Assoc.: Sunderland, Mass.

Beissinger, S.R. 1986. Demography, environmental uncertainty, and the evolution of mate desertion in the snail kite. Ecology 67:1445-1459.

Gilpin, M.E. 1987. Spatial structure and population vulnerability. Pp. 125-139. In: M.E. Soule (ed): Viable Populations for Conservation. Univ. Cambridge Press: Cambridge, MA.

Gilpin, M.E. & M.E. Soule. 1986. Minimum viable populations: processes of species extinction. Pp. 19-34. In: M.E. Soule (ed): Conservation Biology: The Science of Scarcity and Diversity. Sinauer Assoc.: Sunderland, Mass.

Lande, R. & G. Barrowclough. 1987. Effective population size, genetic variation, and their use in population management. Pp. 87-124. In: M.E. Soule (ed): Viable Populations for Conservation. Cambridge Univ. Press: Cambridge.

Lugo, A.E. 1988. Estimating reductions in the diversity of tropical forest species. Pp. 58-70. In: E.O. Wilson & F.M. Peter (eds): Biodiversity. National Academy Press: Washington,D.C.

Ralls, K. & J.D. Ballou. 1983. Extinction: lessons from zoos. Pp. 164-184. In: C.M. Schonewald-Cox, S.M. Chambers, B. MacBryde, & L. Thomas (eds): Genetics and Conservation. Benjamin/Cummings: Menlo Park, CA.

Ralls, K. & J.D. Ballou. 1986. Captive breeding programs for populations with a small number of founders. Trends in Ecology and Evolution 1:19-22.

Shaffer, M.L. 1987. Minimum viable populations: coping with uncertainty. Pp. 69-86. In: M.E. Soule (ed): Viable Populations for Conservation. Cambridge Univ. Press: Cambridge, MA.

Soule, M., Gilpin, M., Conway, W. & T. Foose. 1986. The Millennium Ark: how long a voyage, how many staterooms, how many passengers?. Pp. 101-113. In: K. Ralls & J.D. Ballou (eds): Proceedings of the workshop on Genetic Management of Captive Populations. Zoo Biology (5):.

Soule, M.E. 1987. Viable Populations for Conservation. Cambridge Univ. Press: Cambridge.

Thorne, E.T. and D.W. Belitsky. 1989. The black-footed ferret captive propagation effort in Wyoming. In: Seal, U. S., E.T. Thorne, M.A. Bogan, and S.H. Anderson (eds): Conservation Biology and the Black-Footed Ferret. New Haven: Yale Univ. Press.

Wildt, D.E., Bush, M., Goodrowe, K.L., Packer, C., Pusey, A.E., Brown, J.L., Joslin, P. & S.J. O'Brien. 1987. Reproductive and genetic consequences of founding isolated lion populations. Nature 329:328- 331.

INTERACTIVE MANAGEMENT OF SMALL WILD AND CAPTIVE POPULATIONS

T. J. Foose

Introduction

Conservation strategies for endangered species must be based on viable populations. While it is necessary, it is no longer sufficient merely to protect endangered species *in situ*. They must also be managed.

The reason management will be necessary is that the populations that can be maintained of many species under the pressures of habitat degradation and unsustainable exploitation will be small, i.e. a few tens to a few hundreds (in some cases, even a few thousands) depending on the species. As such, these populations are endangered by a number of environmental, demographic, and genetic problems that are stochastic in nature and that can cause extinction.

Small populations can be devastated by catastrophe (weather disasters, epidemics, exploitation) as exemplified by the case of the black footed-ferret and the Puerto Rican parrot, or be decimated by less drastic fluctuations in the environment. Demographically, small populations can be disrupted by random fluctuations in survivorship and fertility. Genetically, small populations lose diversity needed for fitness and adaptability.

Minimum Viable Populations

For all of these problems, it is the case that the smaller the population is and the longer the period of time it remains so, the greater these risks will be and the more likely extinction is to occur. As a consequence, conservation strategies for species which are reduced in number, and which most probably will remain that way for a long time, must be based on maintaining certain minimum viable populations (MVP's), i.e. populations large enough to permit long-term persistence despite the genetic, demographic and environmental problems.

There is no single magic number that constitutes an MVP for all species, or for any one species all the time. Rather, an MVP depends on both the genetic and demographic objectives for the program and the biological characteristics of the taxon or population of concern. A further complication is that currently genetic and demographic factors must be considered separately in determining MVP's, although there certainly are interactions between the genetic and demographic factors. Moreover, the scientific models for assessing risks in relation to population size are still in rapid development. Nevertheless, by considering both the genetic and demographic objectives of the program and the biological characteristics pertaining to the population, scientific analyses can suggest ranges of population sizes that will provide calculated protection against the stochastic problems.

Genetic and demographic objectives of importance for MVP

Probability of survival (e.g., 50% or 95%) desired for the population;

Percentage of the genetic diversity to be preserved (90%, 95%, etc.);

Period of time over which the demographic security and genetic diversity are to be sustained (e.g., 50 years, 200 years).

In terms of demographic and environmental problems, for example, the desire may be for 95% probability of survival for 200 years. Models are emerging to predict persistence times for populations of various sizes under these threats. Or in terms of genetic problems, the desire may be to preserve 95% of average heterozygosity for 200 years. Again models are available. However, it is essential to realize that such terms as viability, recovery, self-sustainment, and persistence can be defined only when quantitative genetic and demographic objectives have been established, including the period of time for which the program (and population) is expected to continue.

Biological characteristics of importance for MVP

Generation time: Genetic diversity is lost generation by generation, not year by year. Hence, species with longer generation times will have fewer opportunities to lose genetic diversity within the given period of time selected for the program. As a consequence, to achieve the same genetic objectives, MVP's can be smaller for species with longer generation times. Generation time is qualitatively the average age at which animals produce their offspring; quantitatively, it is a function of the age-specific survivorships and fertilities of the population which will vary naturally and which can be modified by management, e.g. to extend generation time.

The number of founders. A founder is defined as an animal from a source population (the wild for example) that establishes a derivative population (in captivity, for translocation to a new site, or at the inception of a program of intensive management). To be effective, a founder must reproduce and be represented by descendants in the existing population. Technically, to constitute a full founder, an animal should also be unrelated to any other representative of the source population and non-inbred.

Basically, the more founders, the better, i.e. the more representative the sample of the source gene pool and the smaller the MVP required for genetic objectives. There is also a demographic founder effect; the larger the number of founders, the less likely is extinction due to demographic stochasticity. However, for larger vertebrates, there is a point of diminishing returns (Figure 1), at least in genetic terms. Hence a common objective is to obtain 20-30 effective founders to establish a population. If this objective cannot be achieved, then the program must do the best with what is available. If a pregnant female woolly mammoth were discovered wandering the tundra of Alaska, it would certainly be worth trying to develop a recovery plan for the species even though the probability of success would be low. By aspiring to the optima, a program is really improving the probability of success.

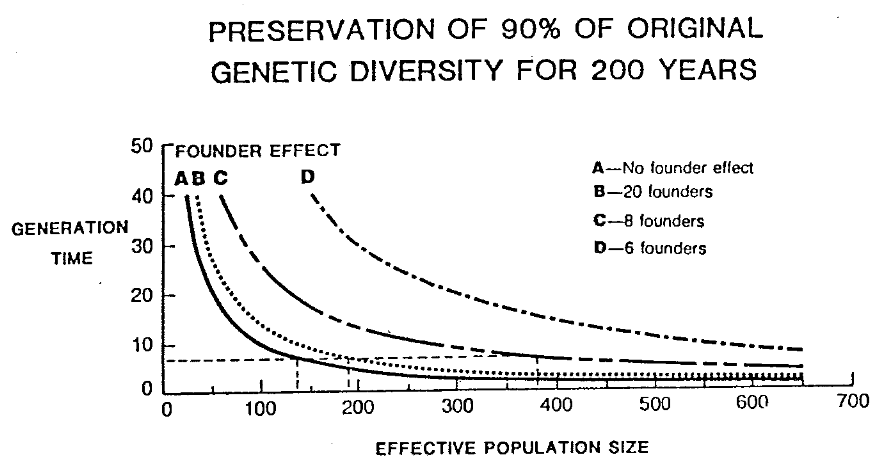


Figure 1. Interaction of number of founders, generation time of the species, and effective population size required for preserving 90% of the starting genetic diversity for 200 years.

Effective Population Size. Another very important consideration is the effective size of the population, designated N_e. N_e is not the same as the census size, N. Rather, N_e is a measure of the way the members of the population are reproducing with one another to transmit genes to the next generation. N_e is usually much less than N. For example in the grizzly bear, N_e/N ratios of about .25 have been estimated (Harris and Allendorf 1989). As a consequence, if the genetic models prescribe an N_e of 500 to achieve some set of genetic objectives, the MVP might have to be 2000.

Growth Rate. The higher the growth rate, the faster a population can recover from small size, thereby outgrowing much of the demographic risk and limiting the amount of genetic diversity lost during the so-called "bottleneck". It is important to distinguish MVP's from bottleneck sizes.

Population viability analysis

The process of deriving MVP's by considering various factors, i.e. sets of objectives and characteristics, is known as Population Viability (sometimes Vulnerability) Analysis (PVA). Deriving applicable results in PVA requires an interactive process between population biologists, managers, and researchers. PVA has been applied to a number of species (e.g., Parker and Smith 1988, Seal et al. 1989, Ballou et al. 1989, Lacy et al. 1989, Lacy and Clark, in press).

As mentioned earlier, PVA modelling often is performed separately with respect to genetic and demographic events. Genetic models indicate it will be necessary to maintain populations of hundreds or thousands to preserve a high percentage of the gene pool for several centuries. Recent models allow simultaneous consideration of demography, environmental uncertainty, and genetic uncertainty.

MVP's to contend with demographic and environmental stochasticity may be even higher than to preserve genetic diversity especially if a high probability of survival for an appreciable period of time is desired. For example, a 95% probability of survival may entail actually maintaining a much larger population whose persistence time is 20 times greater than required for 50% (i.e., average) probability of survival; 90%, 10 times greater. From another perspective, it can be expected that more than 50% of actual populations will become extinct before the calculated mean persistence time elapses.

Species of larger vertebrates will almost certainly need population sizes of several hundreds or perhaps thousands to be viable. In terms of the stochastic problems, more is always better.

Metapopulations and Minimum Areas

MVP's imply minimum critical areas of natural habitat, that may be difficult or impossible to maintain single, contiguous populations of the thousands required for viability.

However, it is possible for smaller populations and sanctuaries to be viable if they are managed as a single larger population (a metapopulation) whose collective size is equivalent to the MVP (Figure 2). Actually, distributing animals over multiple "subpopulations" will increase the effective size of the total number maintained in terms of the capacity to tolerate the stochastic problems. Any one subpopulation may become extinct or nearly so due to these causes; but through recolonization or reinforcement from other subpopulations, the metapopulation will survive. Metapopulations are evidently frequent in nature with much local extinction and re-colonization of constituent subpopulations occurring.

Unfortunately, as wild populations become fragmented, natural migration for re-colonization may become impossible. Hence, metapopulation management will entail moving animals around to correct genetic and demographic problems (Figure 3). For migration to be effective, the migrants must reproduce in the new area. Hence, in case of managed migration it will be important to monitor the genetic and demographic performance of migrants

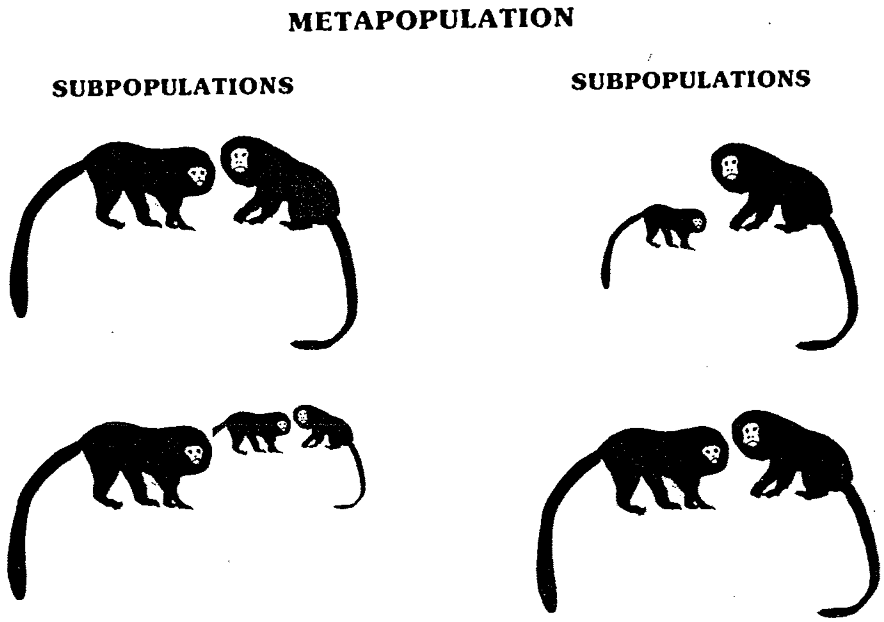


Figure 2. Multiple subpopulations as a basis for management of a metapopulation for survival of a species in the wild.

Managed migration is merely one example of the kinds of intensive management and protection that will be desirable and necessary for viability of populations in the wild. MVP's strictly imply benign neglect. It is possible to reduce the MVP required for some set of objectives, or considered from an alternative perspective, extend the persistence time for a given size population, through management intervention to correct genetic and demographic problems as they are detected. In essence, many of these measures will increase the N_e of the actual number of animals maintained.

The tamarins are already subject to intervention: animals are disturbed by people, movements are obstructed, the populations are fragmented by development, fires are controlled, and captive bred tamarins are being released into the wild. Such interventions are manifestations of the fact that as natural sanctuaries and their resident populations become smaller, they are in effect transforming into megazoos that will require much the same kind of intensive genetic and demographic management as species in captivity.

MANAGED MIGRATION AMONG WILD POPULATIONS

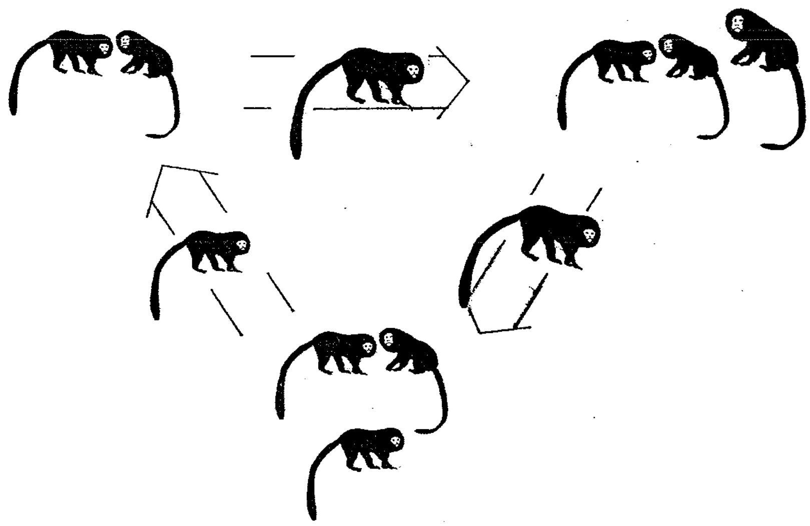


Figure 3. Managed migration among subpopulations to sustain gene flow in a metapopulation.

Captive Propagation

Another way to enhance viability is to reinforce wild populations with captive propagation. More specifically, there are a number of advantages to captive propagation: protection from unsustainable exploitation, e.g. poaching; moderation of environmental vicissitudes for at least part of the population; more genetic management and hence enhance preservation of the gene pool; accelerated expansion of the population to move toward the desired MVP and to provide animals more rapidly for introduction into new areas; and increase in the total number of animals maintained.

It must be emphasized that the purpose of captive propagation is to reinforce, not replace, wild populations. Captive colonies and zoos must serve as reservoirs of genetic and demographic material that can periodically be transfused into natural habitats to re-establish species that have been extirpated or to revitalize populations that have been debilitated by genetic and demographic problems.

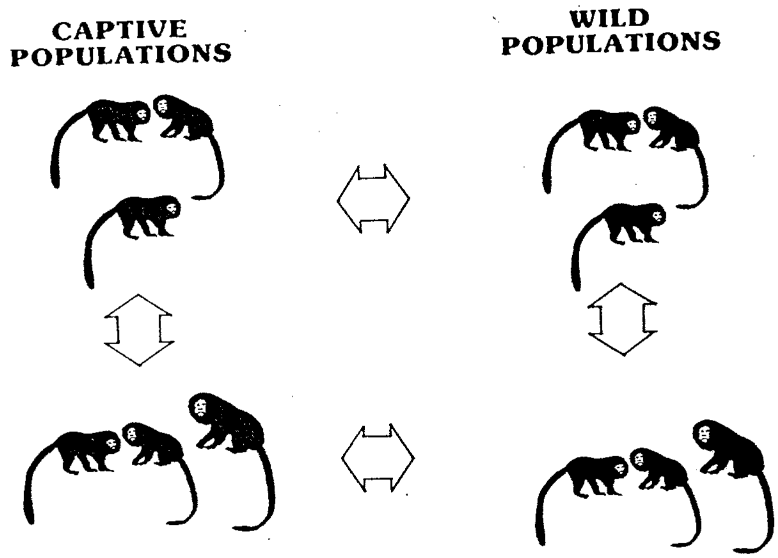


Figure 4. The use of captive populations as part of a metapopulation to expand and protect the gene pool of a species.

The survival of a great and growing number of endangered species will depend on assistance from captive propagation. Indeed, what appears optimal and inevitable are conservation strategies for the species incorporating both captive and wild populations interactively managed for mutual support and survival (Figure 4). The captive population can serve as a vital reservoir of genetic and demographic material; the wild population, if large enough, can continue to subject the species to natural selection. This general strategy has been adopted by the IUCN (the world umbrella conservation organization) which now recommends that captive propagation be invoked anytime a taxon's wild population declines below 1000 (IUCN 1988).

Species Survival Plans

Zoos in many regions of the world are organizing scientifically managed and highly coordinated programs for captive propagation to reinforce natural populations. In North America, these efforts are being developed under the auspices of the AAZPA, in coordination with the IUCN SSC Captive Breeding Specialist Group (CBSG), and are known as the Species Survival Plan (SSP).

Captive propagation can help, but only if the captive populations themselves are based on concepts of viable populations. This will require obtaining as many founders as possible, rapidly expanding the population normally to several hundreds of animals, and managing the population closely genetically and demographically. This is the purpose of SSP Masterplans. Captive programs can also conduct research to facilitate management in the wild as well as in captivity, and for interactions between the two.

A prime examples of such a captive/wild strategy is the combined USFWS Recovery Plan/SSP Masterplan for the red wolf. Much of the captive propagation of red wolves has occurred at a special facility in Washington state, but there is also a growing number of zoos providing captive habitat, especially institutions within the historical range of the red wolf.

Another eminent example of a conservation and recovery strategy incorporating both captive and wild populations is the black-footed ferret. This species now evidently survives only in captivity. Because the decision to establish a captive population was delayed, the situation became so critical that moving all the animals into captivity seemed the only option, circumstances that also applied to the California condor. Another option may have been available if action to establish a captive population had occurred earlier as was done with the Puerto Rican parrot and plain pigeon. Consideration of the survivorship pattern, which exhibited high juvenile mortality for ferrets, as it does for many mammals and birds, suggested that young animals destined to die in the wild might be removed with little or no impact on the population. The AAZPA and CBSG/SSC/IUCN are involved in these kinds of strategies and programs worldwide.

REFERENCES

Allendorf, F.W. 1986. Genetic drift and the loss of alleles versus heterozygosity. Zoo Biology 5:181-190.

Ballou, J.D., T.J. Foose, R.C. Lacy, and U.S. Seal. 1989. Florida panther population viability analysis. Report to the U.S. Fish and Wildlife Service. Captive Breeding Specialist Group, Species Survival Commission, IUCN, Apple Valley, Minnesota.

Beissinger, S. R. 1986. Demography, environmental uncertainty, and the evolution of mate desertion in the snail kite. Ecology 67:1445-1459.

Crow, J.F. and M. Kimura. 1970. Introduction to Population Genetics Theory. Harper and Row, New York.

Falconer, D.S. 1981. Introduction to Quantitative Genetics. 2nd Ed. Longman, New York.

Foose, T.J., R. Lande, N.R. Flesness, G. Rabb, and B. Read. 1986. Propagation plans. Zoo Biology 5:139-146.

Franklin, I. R. 1980. Evolutionary change in small populations. In: Soule, M.E. and B.A. Wilcox (eds.). Conservation Biology. Sunderland, MA: Sinauer. Pp. 135-150.

Fuerst, P.A. and T. Maruyama. 1986. Considerations on the conservation of alleles and of genic heterozygosity in small managed populations. Zoo Biology 5:171-180.

Gilpin, M. E. 1987. Spatial structure and population vulnerability. In: Soule, M. E. (ed). Viable Populations for Conservation. Cambridge, MA: Univ. Cambridge Press. Pp. 125-139.

Gilpin, M. E. and Soule, M. E. 1986. Minimum viable populations: processes of species extinction. In: Soule, M. E. (ed). Conservation Biology: The Science of Scarcity and Diversity. Sunderland, Mass.: Sinauer Assoc. Pp. 19-34.

Goodman, D. 1987. The demography of chance extinction. In: Soule, M. E. (ed). Viable Populations for Conservation. Cambridge, MA: Cambridge Univ. Press. Pp. 11-34.

Grier, J.W. 1980a. Ecology: A simulation model for small populations of animals. Creative Computing 6:116-121.

Grier, J. 1980b. Modeling approaches to bald eagle population dynamics. Wildlife Society Bulletin 8:316-322.

Grier, J.W. and J.H.Barclay 1988. Dynamics of founder populations established by reintroduction. In: T.J. Cade, J.H. Enderson, C.G. Thelander, and C.M. White (eds.). Peregrine Falcon Populations. Boise, Idaho: The Peregrine Fund. Pp. 698-700.

Harris, R. and F. Allendorf. 1989. Genetically Effective Population Sizes of Large Mammals: Assessment of Estimators. Conservation Biology. In press.

IUCN. The IUCN Policy Statement on Captive Breeding. 1988. IUCN. Gland.

Lacy, R.C. 1987a. Loss of genetic diversity from managed populations: Interacting effects of drift, mutation, immigration, selection, and population subdivision. Conservation Biology 1:143-158.

Lacy, R.C. 1987b. Further genetic and demographic analyses of small rhino populations. Pachyderm 9:16-19.

Lacy, R.C. 1988. Genetic variability in captive stocks: Assessing past loss, present status, and future outlook. AAZPA 1988 Annual Proceedings 113-121.

Lacy, R.C. 1989. Analysis of founder representation in pedigrees: Founder equivalents and founder genome equivalents. Zoo Biology 8:111-124.

Lacy, R.C., N.R. Flesness, and U.S. Seal. 1989. Puerto Rican Parrot (Amazona vittata) population viability analysis and recommendations. Report to the U.S. Fish and Wildlife Service. Captive Breeding Specialist Group, Species Survival Commission, IUCN, Apple Valley, Minnesota.

Lacy, R.C. and T.W. Clark. Population Viability Analysis of the Eastern Barred Bandicoot (Perameles gunni). In T.W. Clark, ed. The Management and Conservation of Small Populations. Chicago: Chicago Zoological Society. (In press.)

Lande, R. and G.F. Barrowclough. 1987. Effective population size, genetic variation, and their use in population management. In M.E. Soule, ed. Viable Populations for Conservation. Cambridge, Cambridge University Press. Pp. 187-223.

Lugo, A. E. 1988. Estimating reductions in the diversity of tropical forest species. In: Wilson, E. O. and Peter. F. M. (eds): Biodiversity. Washington,D.C.: National Academy Press. Pp. 58-70.

Nei, M. 1987. Molecular Evolutionary Genetics. New York: Columbia University Press.

O'Brien, S. J. and Evermann, J. F. 1988. Interactive influence of infectious diseases and genetic diversity in natural populations. Trends in Ecology and Evolution 3:254-259.

Parker, W. and Smith R. 1988. Draft USFWS Recovery Plan/Species Survival Plan (SSP) Masterplan for Red Wolf.

Ralls, K. and J. Ballou. 1983. Extinction: lessons from zoos. Pages 164-184 in C.M. Schonewald-Cox, S.M. Chambers, B. MacBryde, L. Thomas, eds. Genetics and Conservation. Menlo Park, CA: Benjamin/Cummings.

Ralls, K., Ballou. J. D., and Templeton. A. R. 1988. Estimates of lethal equivalents and the cost of inbreeding in mammals. Conservation Biology 2:185-193.

Ralls, K., K. Brugger, and J. Ballou. 1979. Inbreeding and juvenile mortality in small populations of ungulates. Science 206:1101-1103.

Seal, U.S., E.T. Thorne, M.A. Bogan, and S.H Anderson. (eds). 1989. Conservation Biology and the Black-Footed Ferret. Yale University Press: New Haven.

Shaffer, M. L. 1981. Minimum population sizes for species conservation. Bioscience 31:131-134.

Shaffer, M.L. 1987. Minimum viable populations: coping with uncertainty. In: Soule, M.E. (ed): Viable Populations for Conservation. Cambridge, MA: Cambridge Univ. Press. pp. 69-86.

Soule, M.E., ed. 1987. Viable Populations for Conservation. Cambridge: Cambridge Univ. Press.

Soule, M., M. Gilpin, W. Conway, and T. Foose. 1986. The millennium ark: How long a voyage, how many staterooms, how many passengers? Zoo Biology 5:101-114.

Thompson, E. The probability of passing the entire genome to k offspring. In: Ballou, J., T.J. Foose, and M. Gilpin (eds.) Analytical Methods for Population Viability Analysis and Management. (In preparation.)

Thorne, E.T. and D.W. Belitsky. 1989. The black-footed ferret captive propagation effort in Wyoming. In: Seal, U. S., E.T. Thorne, M.A. Bogan, and S.H. Anderson (eds): Conservation Biology and the Black-Footed Ferret. New Haven: Yale Univ. Press.

Wildt, D.E., M. Bush, K.L. Goodrowe, C. Packer, A.E. Pusey, J.L. Brown, P. Joslin, and S.J. O'Brien. 1987. Reproductive and genetic consequences of founding isolated lion populations. Nature 329:328-331.

LEONTOPITHECUS

POPULATION VIABILITY ANALYSIS

WORKSHOP REPORT

POPULATION EXTINCTION MODEL

POPULATION EXTINCTION MODEL OF LION TAMARINS IN CURRENTLY PROTECTED AREAS

Jonathan D. Ballou and Claudio Valladares-Padua

INTRODUCTION

Computer models that evaluate the probability of extinction and loss of genetic variation in populations are an important part of population viability analysis. They provide a quantitative summary of the conservation status of the populations and permit evaluation of the effects of different management recommendations on the long-term survival of the populations (See Small Population Overview).

The VORTEX model by Robert Lacy (Chicago Zoological Society) was used to model the current conservation status of the known lion tamarin populations in currently protected areas (see appendix). For the golden lion tamarin (GLT) this was limited to the population of approximately 290 individuals in Poço das Antas Biological Reserve. Golden-headed lion tamarins (GHLT) were modelled in the Una Biological Reserve (est. minimum 466 animals), the Ecological Station at Canaviriras (ESCAN; est. 79 animals) and at the Experimental Station at Lemos Maia (est 20 animals). The black lion tamarins (BLT) were modelled at both Morro do Diabo (est minimum 80 animals) and the Ecological Station at Caitetus (est. minimum 8 animals). The recently discovered population of black-faced lion tamarins (BFT) at Superagui National Park were modeled, although very little is known about this population. Each of these populations was considered an isolated population and was modeled for 100 years. Each 100 year simulation was repeated between 200 and 1000 times (depending on the model results and on the computer run-time required). Both probability of extinction and expected heterozygosity were tracked over time. When the population size dropped to zero, it was counted as an extinction event during that year; the probability of extinction was then based on the average extinction rates over all simulations. Expected heterozygosity was calculated by monitoring allele frequencies over time in the population.

In order to evaluate the sensitivity of the results to the basic assumptions made when developing the models and explore the effects of potential management options on the survival of the population, each population was run several times using different starting parameters.

The potential contribution of a population to the long-term preservation of a species is evaluated on the basis of its probability of extinction and its ability to retain a significant proportion of its original genetic diversity over some specified time period. An accepted conservation objective is that the population be of sufficient size and security to have lower than 2% probability of going extinct and be able to retain 90% of its heterozygosity over 100 years.

The purpose of this modelling is to evaluate the current conservation status of each of the lion tamarin populations using these criteria and evaluate the sensitivity of its status to various potential changes in the biology, ecology, environment and management of these populations.

DATA SOURCES

The PVA models were based on data presented at the PVA workshop and summarized in the species overviews in this volume. Data from the Dietz and Baker ecological studies on golden lion tamarins in the Poço das Antas provided the most complete lion tamarin data set and unless otherwise specified, life-history parameters used in the models for the other species were based on the GLT data. Data are completely lacking for the black-faced lion tamarin (*L. caissara*).

SURVIVAL

		MALES	FEMALES
GLT:	Age 0-1	13%+.14	13%+.14
	Age 1-2	10%+.12	10%+.12
	Age 3-2	33%+.21	50%+.21
	Adult*	19%+.11	19%+.11

* Data from the wild population show a 15% adult annual mortality rate. However, the population extinction model assumes constant adult mortality and does not allow for truncation at the age of maximum longevity (15 years). If a constant mortality rate of 15% (without truncation) is applied to the population, than more than 5% of the population unrealistically survives longer than 15 years of age and the generation length is almost 9 years, much higher than expected for GLTs. To correct for this effect, we calculated what annual adult mortality rate would be required to match the net reproductive rate observed for the wild population (1.95). The results show that if adult mortality were 19%, then the net reproductive rate obtained from the model matched that of the population. Therefore, 19% annual adult mortality was used in the model runs.

BLT, BFT & GHLT: ALL MEANS SAME AS GLT; VARIATION 2/3 THAT OF GLT
(See Environmental Variation Below)

REPRODUCTION

GLT: Females can produce up to two litters per year.
Data from the Dietz and Baker field studies from 1986 through 1989 show that:

19% of females produce 0 offspring/year		
6%	"	produce 1 offspring/year
52%	"	produce 2 offspring/year
6%	"	produce 3 offspring/year
17%	"	produce 4 offspring/year

The standard deviation of the percent of females breeding each year was calculated as 0.23 (see Environmental Variation below).

% of Males Breeding = 71%

BLT: Data from Padua's field studies in Morro do Diabo Biological Research suggest that females produce fewer litters per year than GLTs. From data on 2 years of observations on 4 groups:

25% produced 0 young per year
25% produced 1 young per year
50% produced 2 young per year

All other values associated with reproduction were assumed to be similar to the GLT.

GHLT: Since very little is known about reproduction, all values were assumed to be similar to the GLT.

BFT: Assumed to be similar to the GLT.

CURRENT CARRYING CAPACITY

All populations were assumed to be at the carrying capacity:

GLT: Poço das Antas = 290

BLT: Morro do Diabo = minimum of 80 to maximum of 350 Caitetus = minimum of 8 to maximum of 30

GHLT: Una = minimum of 466 to maximum of 972
Lemos Maia = 20
ESCAN = 79

BFT: Superagui = minimum of 125 to maximum of 625

Except where noted, the minimum estimated population sizes were used in the model to provide conservative PVA estimates for these populations.

AGE DISTRIBUTION

GLTs:

Age in Months	Percent Males	Percent Females
< 9	16	19
9-18	18	21
18-30	18	19
> 30	48	41

BLT, GHLT and BFT: No data available. Assumed same as GLT.

ENVIRONMENTAL VARIATION

GLT: Effect of environmental variation on mortality and reproduction has been observed to be low in the Reserve. Even during relatively dry years, reproductive and survival rates have remained high. At this time, direct estimates of the effects of environmental variation on the population are lacking.

However, environmental variation plays a critical role in varying reproductive and mortality rates in natural populations. The VORTEX model incorporates the intrinsic demographic variation (binomial variation) associated with survival and reproduction. Conceptually, this is the inherent "demographic" variation in the population. One way to incorporate environmental variation in the model is to increase the demographic variation by some constant multiple. The variance of reproductive and survival rates are then higher than expected under the binomial process alone.

During the study period (5 years), there was one very wet year during the dry season and reproduction increased by 15% (Dietz and Baker, pers comm). These data were used to impose environmental variation on the population by assuming that there is a 80% chance (4 out of 5 years) that reproduction is equal to or less than 15% higher than the mean each year. These data can be used to define a probability distribution for environmental variation. This distribution gives a standard error about 3 to 4 times that expected from the binomial distribution alone for the percent of females breeding at this carrying capacity.

Using this as rough guide for environmental variance, and realizing that this is likely to be an underestimate of total environmental variation, we assumed the multiplicative effect of environmental variation to be 5 times that of demographic variation. This was termed the NORMAL environmental variation. To explore the ramifications of this parameter on the model, additional models were run assuming this multiplicative effect to be 10 times the demographic variation. This was termed HIGH environmental variation. The standard deviations shown under reproduction are based on the NORMAL estimate.

Data on the effects of environmental variation on mortality are also unavailable but were believed to be less than on reproduction. Therefore the multiplicative effect of environmental variation on mortality was 50% that of reproduction. The standard deviations shown under Survival above are based on this estimate.

BLT, BFT & GHLT: Environmental variation in areas containing both the and BLT were thought to be less than Poço das Antas. For both of these species, the multiplicative effects of environmental variation was estimated to be 2/3 that of GLT.

CATASTROPHES

GLT: Source, probability and severity of catastrophes:

Disease: 1% chance/year; 50% reduction in survival. Train Disaster: 2%/year; 10% reduction in survival. Pesticide Disaster: 5%/year; 10% survival reduction.

Since the VORTEX model allows only two independent catastrophes to act on the population, one catastrophe was defined as having a 1% chance of occurring/year resulting in a 50% reduction in survival and the second catastrophe was defined as having a 7% chance of occurring/year resulting in a 10% reduction in survival (i.e. train and pesticide disasters were combined).

BLT: Independent catastrophes having a 5% chance of occurring/year with a 50% reduction in survival (fire) and a 1% chance of occurring/year with a 50% reduction in survival (disease) were used for the Morro do Diabo population. In Caitetus, a disease epidemic is likely to totally decimate the population: its effect was modelled as having a 100% reduction in survival.

GHLT: Disease was identified as the primary threat.
Probability and severity were not estimated: the values used in the model were the same used for disease in the GLT: 1% chance of occurring/year with a 50% reduction in survival.

BFT: No data: catastrophes and severities same as GLT.

INBREEDING DEPRESSION

GLT: Reduced survival and reproduction due to inbreeding is a common phenomenon in mammal species. In the captive population of golden lion tamarins, inbred animals suffer significantly higher mortality rates than non-inbred animals and have reduced litter sizes. The population extinction model can take into consideration the effects of inbreeding depression on survival by stochastically modelling the effects of lethal genes in the population. In captivity, the average GLT has been measured to have 4.3 lethal equivalents (genes that are lethal in the homozygous state). The same level of genetic load was imposed on the wild population. This load was reduced by 50% in some model runs to explore the effects of this parameter on the results.

BLT, BFT, GHLT:
Captive populations not large enough or non-existent to estimate levels of genetic load. Inbreeding depression assumed to be the same as GLT.

MODEL LIMITATIONS

The VORTEX model simulates the survival and reproductive events of each individual in the population. As a result, large populations require significantly more computer time than small populations, particularly when inbreeding depression is included as a consideration (modeling the effects of inbreeding requires additional computer memory to track individual alleles in the population). While most model scenarios were run with 1000 simulations, the number of simulations for some model scenarios was limited for this reason.

DETERMINISTIC RESULTS

The model calculated estimates of deterministic population growth rates and generation lengths without considering stochastic demographic or environmental effects or inbreeding effects (i.e. using simple life-table calculations). The results are shown in Table 1 below:

Table 1. Deterministic model results.

SPECIES:	AREA	Potential Annual Growth Rate	Generation Length (Yrs)
GLT	Poço das Antas	1.12	6.72
GHLT	All Areas	1.12	6.85
BLT	All Areas	1.02	6.26
BFT	Superagui	1.12	6.72

All populations showed robust population growth rates except for the black-lion tamarin, which had a lower reproductive rate than the other species modeled.

RESULTS: 1) GOLDEN LION TAMARINS

Table 2 shows the probability of extinction at 100 years with NORMAL and HIGH environmental variation (EV) for the various model runs on the golden lion tamarin population at Poço das Antas biological Reserve. The various aspects of the different runs are explained below.

TABLE 2.

RUN	MODEL DESCRIPTION	Probability of Extinction within 100 years EV*=NORMAL	EV*=HIGH
1	K=290; Genetic Load = 4.3;	15%	17%
2	Reduce Inbreeding Depression	< 1%	3%
3	No Inbreeding Depression	< 1%	< 1%
4	Increase K to 508	1%	2%
5	Reduce Catastrophes	5%	7%
6	Reintroduction program	13%	19%

RUN	MODEL DESCRIPTION	% Heterozygosity Retained EV*=NORMAL	EV*=HIGH
1	K=290; Genetic Load = 4.3	87%	86%
2	Reduce Inbreeding Depression	91%	91%
3	No Inbreeding Depression	92%	92%
4	Increase K to 508	93%	93%
5	Reduce Catastrophes	89%	88%
6	Reintroduction program	87%	87%

EV* = Environmental variation multiplicative factor 5 for NORMAL, 10 for HIGH.

Status Quo: Run (1) shows the outcome for the current Poço das Antas population with no changes over the 100 year time period under the assumption that the genetic load is comparable to that seen in the captive population. The carrying capacity (K) is constant at 290 animal. As the population now stands, it does not meet the conservation criteria of lower than 2% probability of extinction and 90% retention of genetic diversity. Doubling the effect of environmental variation has little effect on these results.

Reduced Inbreeding: Runs (2) and (3) show the results of assuming less inbreeding effect (50%) than is observed in the captive population and no inbreeding effect, respectively. In both cases, the extinction probabilities and levels of variation retained are significantly improved. Clearly, assumptions about levels of load in the populations have significant affects the model results.

Management Manipulations: Runs (4), (5) and (6) show the effects of applying various population management manipulations to the basic model in run (1). These results are shown in Figure 1.

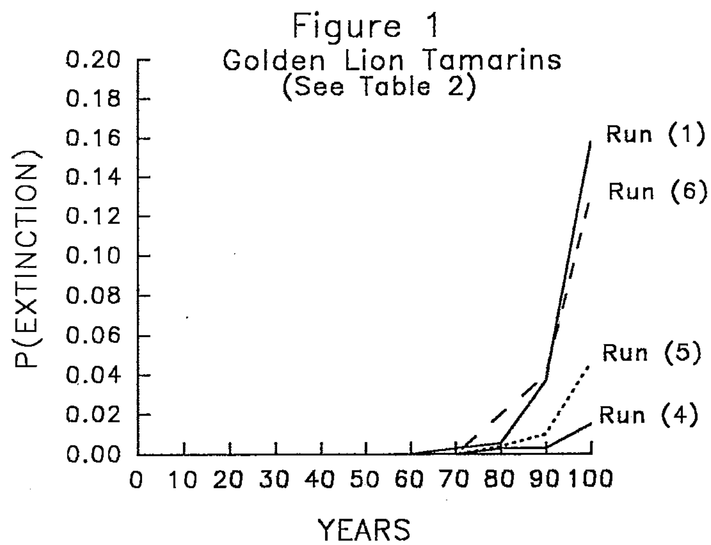
Run (4): Only about 53% of the Poço das Antas Biological reserve is forested. Fires keep much of the unforested land from developing into tamarin habitat. If fires were controlled, researches estimate that the carrying capacity of the reserve can increase from 290 to 508 in 35 years (by the year 2025). This requires an increase in carrying capacity of 1.6%/year. This rate of carrying capacity change was incorporated into the model for Run (4). The results suggest that such a change could significantly improve the long-term survival of the population and its ability to retain genetic diversity.

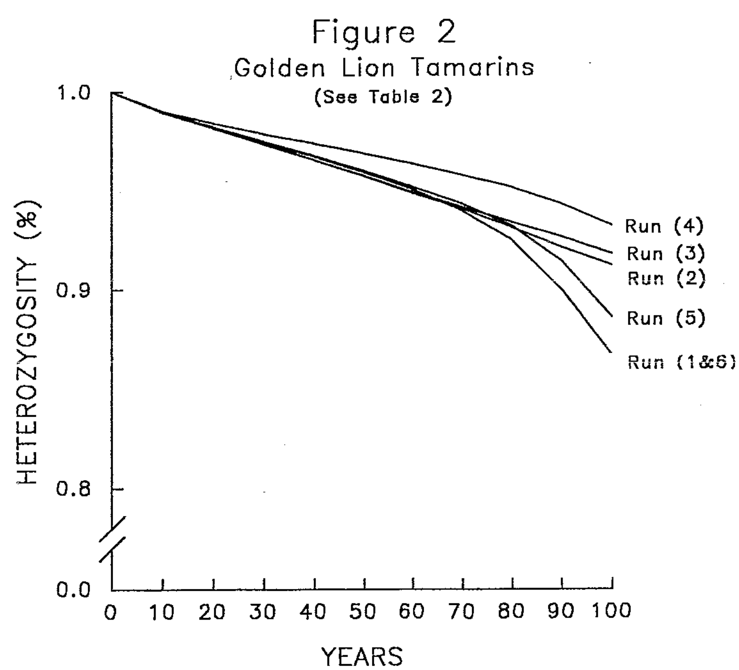
Run (5): Three types of catastrophes were identified: disease outbreaks, derailments of trains carrying harmful substances and pesticide contamination from outside the reserve. The likelihood of catastrophes in the reserve can most likely be reduced by a) closing the train tracks through the reserve and b) instituting additional disease-prevention procedures while handling animals in the reserve. Run (5) shows the results if the threat of train derailments were totally removed and the likelihood of disease epidemics was reduced by 50%. Although these actions would reduce the risk of population extinction by about 50%, they alone are not sufficient to secure the demographic and genetic fate of the population.

Run (6): A reintroduction program that brings unrelated animals into the population can potentially improve both the demographic and genetic status of small populations. However, in the Poço das Antas Reserve, the wild population is at carrying capacity and the population's natural growth rate (depending on the level of inbreeding depression experienced) is likely to be sufficient to produce individual to replace vacancies as they arise. Therefore, reintroduction of additional animals will not likely affect the overall extinction rates of the population but should affect the retention of heterozygosity. Run (6) models the effects of reintroducing 6 unrelated animals (two adults, two juveniles and two sub-adults) into the reserve every year for ten years. The probability of extinction was reduced by 2%

(but still not statistically different from run [1]), while the level of retained heterozygosity remained unchanged. Additional models need to be run to explore how the duration and intensity of a reintroduction program effects long-term population survival and genetic goals.

Figure 1 and 2 show the extinction probability and heterozygosity retained over time with these changing scenarios in the Poço das Antas population.





RESULTS: GOLDEN-HEADED LION TAMARINS

Table 3 shows the extinction probabilities and retained heterozygosities for the models of the three GHLT populations (Una, Lemos and ESCAN).

TABLE 3.

RUN	MODEL DESCRIPTION	Probability of Extinction within 100 years	
		EV*=NORMAL	EV*=HIGH
1	Una: K=466; Genetic Load = 4.3	< 1%	< 1%
2	Una: Reduce Inbreeding Depression	< 1%	< 1%
3	Lemos: K=20; Genetic Load = 4.3	> 99%	> 99%
4	Lemos: Reduce Inbreeding Depression	> 99%	> 99%
5	ESCAN: K=79; Genetic Load = 4.3	> 99%	> 99%
6	ESCAN: Reduce Inbreeding Depression	> 99%	> 99%

RUN	MODEL DESCRIPTION	% Heterozygosity Retained	
		EV*=NORMAL	EV*=HIGH
1	Una: K=466; Genetic Load = 4.3	95%	95%
2	Una: Reduce Inbreeding Depression	95%	95%
3	Lemos: K=20; Genetic Load = 4.3	----*	----*
4	Lemos: Reduce Inbreeding Depression	----*	----*
5	ESCAN: K=79; Genetic Load = 4.3	----*	----*
6	ESCAN: Reduce Inbreeding Depression	----*	----*

----* = All populations extinct by this time.

The results marked '>99%' were cases in which extinction occurred in all simulations (100% extinction rate). However, because of statistical error associated with the number of simulations run, there remains a slight chance of population survival. These results were recorded as > 99% rather than 100% probability of extinction.

Una, with a conservative estimate of 466 animals, is the only population capable of retaining genetic diversity and surviving to 100 years with a high probability (Run 1). Both of the other populations have less than a 1% chance of surviving over that time period (Runs 3 and 5). The extinction probabilities and heterozygosity loss for Una is lower than that of the GLTs in Poço das Antas (under the assumption of a potential carrying capacity of 508) because environmental variation is assumed to be less at Una and the Poço das Antas population must grow from the current 290 animals to 508. During that growth phase it is more susceptible to loss of genetic variation and risks of extinction than the GHLT population at Una.

Table 3 also shows the results if inbreeding depression is not as deleterious as is observed in the captive GLT population (Runs 2, 4 and 6) and for NORMAL vs. HIGH levels of environmental variation. These assumption have little bearing on the overall results.

Management options were not modeled for the GHLT populations because the populations in the smaller areas are assumed to be at carrying capacity, which has little or no chance of increasing over time in these small reserves. The population size of 466 at Una represents a 50% occupancy rate of the total reserve. Modeling a larger population size would only further reduce extinction probabilities and loss of diversity.

RESULTS: BLACK LION TAMARINS

Table 4 shows the model results from the black lion tamarin (BLT) in both Morro do Diabo and Caitetus.

TABLE 4.

RUN	MODEL DESCRIPTION	Probability of Extinction within 100 years: EV*=NORMAL	EV*=HIGH
1	Morro do Diabo: K=80	> 99%	> 99%
2	Morro do Diabo: K=350	> 99%	> 99%
3	Morro do Diabo: Increasing K	> 99%	> 99%
4	Morro do Diabo: Reduced Inbreeding Depression	97%	97%
5	Caitetus: K=8	> 99%	> 99%
6	Caitetus: K=30	> 99%	> 99%

RUN	MODEL DESCRIPTION	% Heterozygosity Retained EV*=NORMAL	EV*=HIGH
1	Morro do Diabo: K=80	----*	----*
2	Morro do Diabo: K=350	72%	79%
3	Morro do Diabo: Increasing K	----*	----*
4	Morro do Diabo: Reduced Inbreeding Depression	79%	80%
5	Caitetus: K=8	----*	----*
6	Caitetus: K=30	----*	----*

Population size estimates for Morro do Diabo ranged from a minimum of 80 animals to a maximum of 350. This range was modelled and the results show that even with 350 animals, the population has a greater than 99% chance of going extinct within 100 years (Run 2). In Caitetus, estimates of population size range from 8 to 30 (Runs 5 and 6). Extinction probabilities are also above 99%. These results differ from those of the GHLT and GLT because of the assumed lower fecundity rate of the BLTs (only one rather than two litters per year).

The effect of reducing the assumed level of inbreeding depression by 50% on the survival of the Morro do Diabo population at K=350 was examined. Although this reduces the extinction probability slightly, it is not enough to bring the population out of high extinction risk.

One management option that can be considered is to increase the carrying capacity of the reserve. Currently, 30% of Morro do Diabo is not forested. Management intervention could allow the restoration of degraded habitat in the reserve, thereby increasing the carrying capacity by 30% from 80 to 104 animals. This 30% increase was modeled as occurring over a 35 year period. The results of the model indicate that this would have little impact on the long-term survival of the population.

Extinction probabilities over time for Morro do Diabo and Caitetus are shown in Figures 3 and 4 respectively. The loss of heterozygosity over time for Morro do Diabo is shown in Figure 5.

Figure 3
Black Lion Tamarins: Morro do Diabo
(See Table 4)

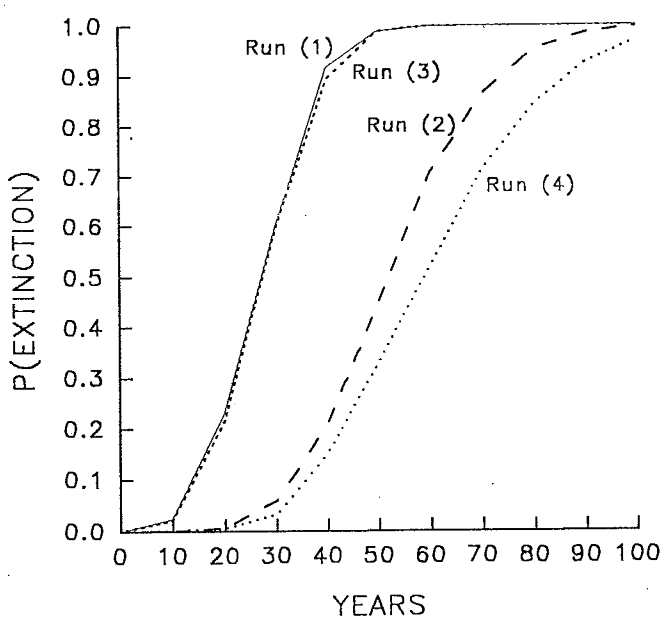


Figure 4
Black Lion Tamarins: Caitetus
(See Table 4)

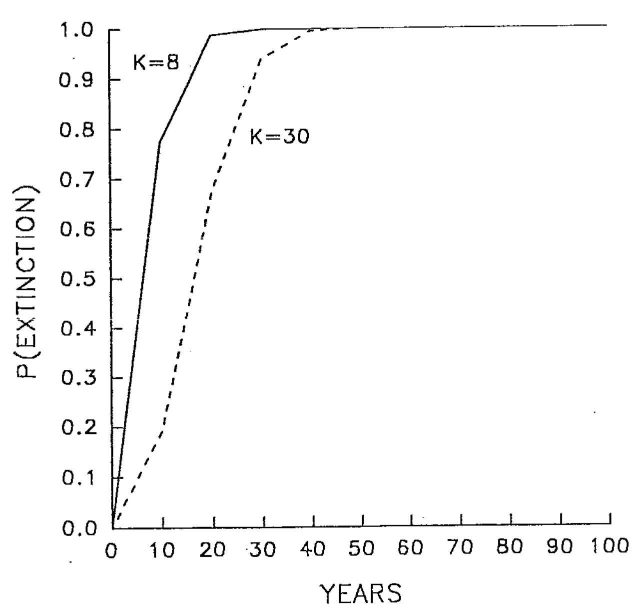
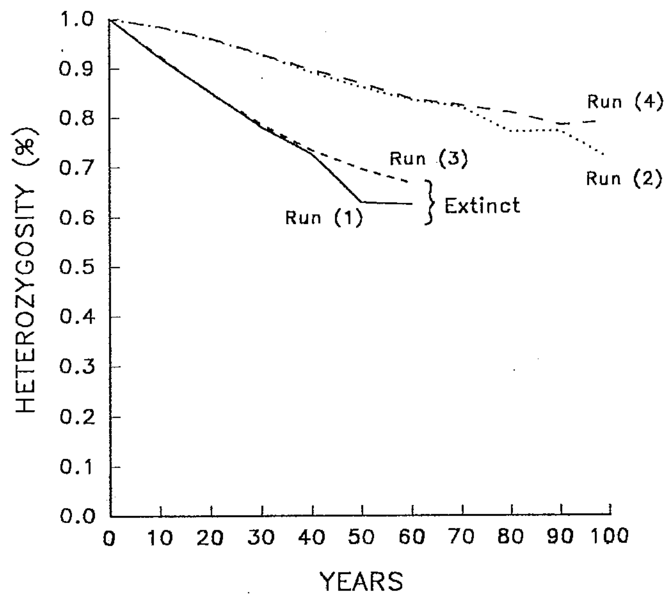


Figure 5
Black Lion Tamarins: Morro do Diabo
(See Table 4)



RESULTS: BLACK-FACED LION TAMARINS

The black-faced lion tamarin was modelled at 165 animals using the same life-history parameters as was used for the GLT in Poço das Antas Biological Reserve. Table 5 shows the results.

TABLE 5.

RUN	MODEL DESCRIPTION	Probability of Extinction within 100 years	
		EV*=NORMAL	EV*=HIGH
1	Superagui, K=125	> 99%	> 99%

RUN	MODEL DESCRIPTION	% Heterozygosity Retained	
		EV*=NORMAL	EV*=HIGH
1	Superagui, K=125	----*	----*

----* All simulations extinct by year 100. No heterozygosity estimates available.

Assuming the Superagui population has similar life-history and population characteristics than the GLTs in Poço das Antas, the extinction probability of this population within 100 years is almost 100%.

CONCLUSIONS:

Extinction rates in all current populations modelled, except Una, failed to meet the minimum tolerances of 2% probability of extinction in 100 years set by the conservation objectives under the set of assumptions considered most realistic for these populations.

The golden lion tamarin population at Poço das Antas has a 15% probability of extinction at 100 years. The model suggests that the long-term survival of the population could be greatly enhanced if its carrying capacity were increased to 500 animals. However, it is clear that an important factor in the conservation value of this population is the severity of inbreeding depression. Conservation strategies should be based on available knowledge. Data from the captive population suggests that inbreeding depression is present in this species at the level used in this model and has the potential to drive the population to extinction.

Una Biological Reserve is the most secure tamarin population as modelled here with a limited set of parameters. However, because PVA models do not consider all factors affecting population viability, extinction probabilities can be expected to be underestimates. Therefore, these results should not be interpreted as meaning that the Una population is totally secure for the time frame considered.

Extinction probabilities are high for the two GHLT populations outside of the Una reserve (Lemos and ESCAN).

In the black lion tamarin, the Caitetus population is extremely vulnerable to extinction (78% chance of going extinct within the next 10 years) and the Morro do Diabo population does not even meet the extinction tolerance criteria over a 20 year period (Figure 4). These populations, as they currently stand, are not sufficient for the conservation of the species.

In summary, these results clearly support the recommendations that call for the immediate need to identify and protect additional habitat for all lion tamarins.

LEONTOPITHECUS

POPULATION VIABILITY ANALYSIS

WORKSHOP REPORT

STATUS OF CAPTIVE POPULATIONS

EMERGENCE OF THE CAPTIVE POPULATION OF GOLDEN-HEADED LION TAMARINS

(*Leontopithecus chrysomelas*)

Jonathan D. Ballou and Georgina Mace

INTRODUCTION AND BACKGROUND

The captive population of golden-headed lion tamarins (*Leontopithecus chrysomelas*) currently stands at about 297 individuals distributed in 25 institutions world-wide. Ten years ago, the population consisted of fewer than 20 individuals in one institution. This paper reviews the history of how the current captive population was established and discusses its current genetic and demographic status.

The golden-headed lion tamarin (GHLT) is one of three species (but see below) of the genus *Leontopithecus*. The taxonomic relationships among the lion tamarins are somewhat unclear despite numerous efforts at clarification. Morphological differences (pelage color, dentition, size, cranial morphology) clearly distinguish the three forms (Coimbra-Filho, 1972), however, genetic analyses show very little allozyme difference between the three forms (Forman et al, 1986). Levels of genetic distance are equivalent to differences normally found within populations of other mammals. So, in the parlance of the SSP program, we do not know the esu status of these taxa but are managing them and will continue to manage them as three (four) separate taxa.

The golden-headed lion tamarin is present in populations in the state of Bahia. One population is concentrated in Una Reserve (6,000 forested hectares). An extremely rough estimate of this population size may be maximum of 500 animals. Other isolated and fragmented populations (possible 12-15) are eminently threatened by deforestation. The GHLT is probably the least threatened of the wild lion tamarins. The golden lion tamarin (GLT) and black lion tamarin (BLT) are much more restricted in range; the BLT may have as few as 100 individuals left.

ORIGINS OF THE CAPTIVE POPULATION

The three forms also differ significantly in their status in captivity. The GLTs currently have a captive population of about 550 animals distributed among 100 zoos world-wide. The SSP program is well established and has been supporting a reintroduction program since 1983. The population of black lion tamarins is extremely fragile and exists only in two institutions: the Sao Paulo Zoo and the Rio de Janeiro Primate Center. In total, there are about 60 animals.

The captive golden-headed lion tamarin population has only recently been established. Historically, GHLTs have been kept only rarely in captivity. London Zoo had them in 1869 and Rio de Janeiro had them in 1961. The only institution currently holding GHLTs that had them in the past was the Rio de Janeiro Primate Center, which had held the animals since 1971 (Mallinson, 1988).

The current captive population was founded primarily by animals that were originally illegally exported from Brazil in 1983. The story of how they were eventually returned to Brazil and used as the founding of the current captive population is an interesting case history and an excellent example of how pressure brought to bear by international governmental and non-governmental conservation organizations can achieve successful conservation strategies.

In 1983 approximately 60 animals were illegally removed from the wild population and exported from Brazil through Bolivia or Guyana to animal dealers in Belgium and Japan. The shipment of animals to Belgium was discovered in the fall of 1983 when a Belgium animal dealer offered to sell GHLTs at >1,000 each. He stated that he had received the animals legally from Guyana (neither Belgium nor Guyana had signed the CITES agreements restricting trade in endangered species when he received the animals in 1983) and that he was legally entitled to the animals.

At about the same time, GHLTs were noted in a small zoo in central France, La Palmyre Zoo, as well as in a private collection in Paris. Both claimed that they had the animals prior to France's signing the CITES agreement in 1977. Additionally, in Japan, animals dealers were also offering GHLTs for sale to Asian zoos.

The International conservation community immediately took note of these animals and began to pressure the individuals and institutions holding GHLTs to turn the animals back over to Brazilian authority. This movement was spearheaded in large part by Jeremy Mallinson, the Zoological Director of the Jersey Wildlife Preservation Trust.

The first move the get these extremely valuable animals into more viable situations occurred in November, 1983, when the Hong Kong Zoo, with the approval of the Brazilian authorities and the GLT Management Committee, agreed to legally purchase 3 of the 12 animals in Japan from a Japanese animal dealer and place them in breeding situations within their zoo.

In November of 1984, the Brazilian Institute for Forestry Development (IBDF) called for the establishment of the International Recovery and Management Committee to coordinate the establishment of a viable captive population and support the efforts of international and national conservation organizations in returning GHLTs to Brazilian trusteeship. Jeremy Mallinson and Adelmar F. Coimbra Filho were requested to be co-advisors of the Committee.

Between late 1984 and 1985, international pressure was brought to bear on the holders of the illegally exported animals by a number of international organizations and governmental agencies, including the World Wildlife Fund (Belgium), WWF-Traffic (Japan) and Jersey Wildlife Preservation Trust as well as the Belgium Ministry of Agriculture, Brazilian Ministry of Foreign Affairs, and IBDF. By late 1985, after two years of quiet negotiations and international politics, agreements were made to begin to return the animals to Brazilian trusteeship. In November, 1985, 16 of 24 animals held by the Belgium animal dealer was returned to the Rio de Janeiro Primate Center and one month later the La Palmyre Zoo, in France, agreed to participate in the international program. They turned their 11 animals over to Brazilian trusteeship, but the animals remained in France.

The Brazilian government wanted to reintroduce the animals that had been returned to them back into the Una reserve. However, because of the possible threat of these animals to the remaining wild population (disease, disruption of wild groups) and the experience with releasing golden-lion tamarins in the Poco das Antas Biological Reserve, which indicated that simply releasing animals without pre-or post release monitoring or assistance would result in high mortality, the International Management Committee strongly recommended that the animals be used to establish a secure captive population. Because of severe space and resource limitations at the Rio de Janeiro Primate Center, it was recommended that some of these animals be used to establish captive colonies outside of Brazil.

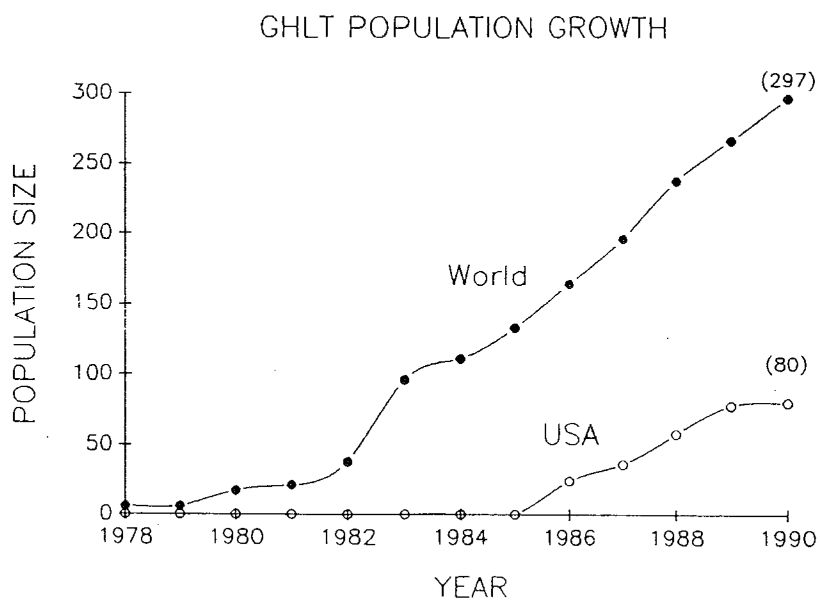
This was accomplished in March, 1986, when IBDF abided by these recommendations and 20 animals were sent from the Rio de Janeiro Primate Center to North America in order to establish breeding pairs at the National Zoo, Los Angeles Zoo and Brookfield Zoo.

The remaining known animals from the original 1983 illegal export were finally made available to the Management Committee in July 1986 when the 8 animals remaining in Belgium were sent to the Antwerp Zoo where ownership of offspring is shared by the animal dealer and the Brazilian government. In September, the 12 animals in Japan were sent to the Sao Paulo Zoo.

In summary, after 6 years of intensive lobbying by numerous individuals representing many organizations and agencies, 39 of the 1983 illegally exported animals have been returned to the trusteeship of the Brazilian government and/or made available to the International Recovery and Management Committee as part of the globally managed population. These animals have been dispersed to numerous institutions throughout the world and help provide a foundation for the development of a secure captive population. A more detailed summary of these events is presented by Mallinson (1988).

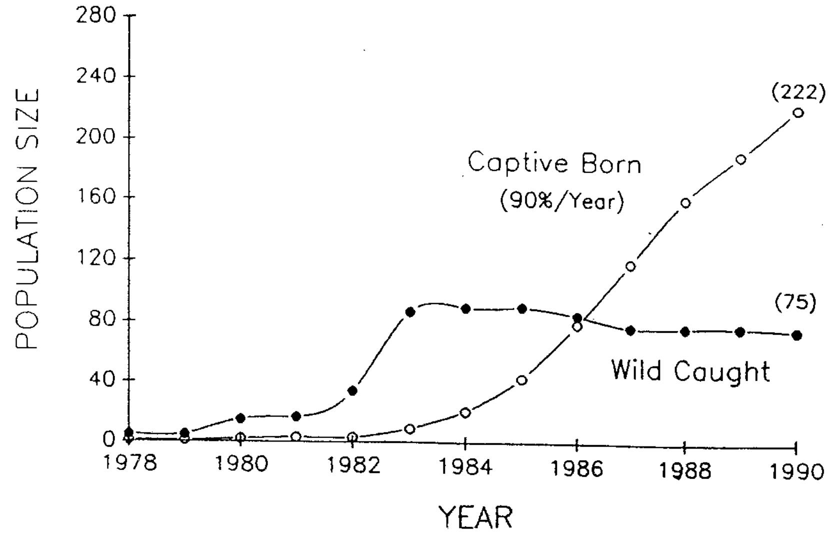
Unfortunately, illegal exports of GHLTs continue to threaten the wild population. A second illegal export was discovered in July, 1987, when 6 animals were confiscated by authorities in French Guiana. They have not yet been returned to Brazil trusteeship but this is in process. Animals of unknown origin have also appeared in the Portugal (Lisbon Zoo and at a private collection) and at a private collection in Mexico. However, upon being notified that they were illegally exported from Brazil, the zoo authorities in both zoos immediately made the animals available to the Management Committee and turned over ownership to the Brazilian government.

The only location known to have GHLTs but which has not signed the Management Agreement is a private collection in Paris owned by Dr. Henry Quinque. The origin of the animals is unknown but it is claimed that the animals were acquired before 1977, when France first signed the CITES trade agreements for endangered species. All other known animals in the population are under the management authority of the International Recovery and Management Committee and all wild-caught animals and the F1 offspring are owned by the Brazilian government.



STATUS OF THE CURRENT POPULATION

The global population of GHLTs has grown rapidly over the last few years as a result of the new breeding pairs established from the 1983 illegal exports from Brazil. Figure 1 shows the growth of the world population since 1978. This growth is due almost entirely to captive reproduction (Figure 2). During its most rapid period of growth, the captive population almost doubled each year due to captive propagation alone.



The growth has been particularly rapid in the United States. The 20 animals originally imported in 1983 were supplemented with a second import of 6 animals from the Sao Paulo Zoo to the Riverbanks Zoo in 1989. GHLTs are now distributed at 11 institutions in the United States.

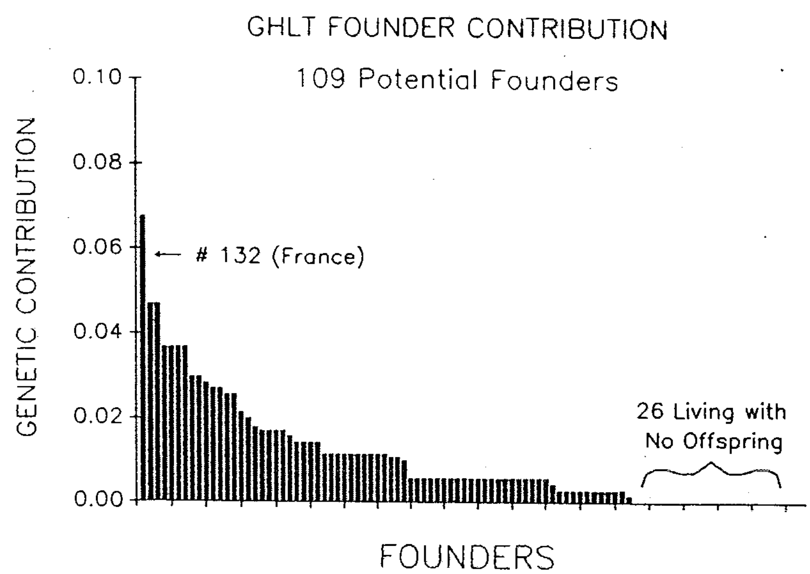
The current world population stands at approximately 300 individuals in 25 zoological institutions (up-to-date counts are not available for Europe and Asia since the 1989 International Studbook is current through August 1989, Table I). The population in the United States stands at 80 animals (44.27.9) in 11 institutions. We have 12 (7.5) wild-caught animals. About 50% of the world population still remains in South America.

Table 1. Distribution and Status of the World Captive GHLT Population. Data in USA current through April, 1990. Other regions current through August, 1989.

	USA	Europe	Asia	S. America	Total
Institutions	11	4	1	9	25
Animals	80	64	9	144	297
Founders	16	27	5	69	83

The current gene pool of the world population has descended from 83 wild-caught and assumed wild-caught individuals. Another 26 wild-caught individuals are still alive but have not yet contributed living offspring to the gene pool; they can only be counted as potential founders (Table 2). However, as in most, if not all, captive populations, the genetic contributions of these different founders to the gene pool is heavily skewed. Figure 3 shows the contribution of the 109 founders to the 1990 gene pool. Founders are not individually identified, only ranked by their founder contribution. The largest single contribution (6%) comes from a breeding male in La Palmyre Zoo, in France. This 6% is actually much less than the largest single contributions in most other species. In golden lion tamarins, for example, the largest single individual contribution is 15%.

Unequal genetic contribution among the founders results in less effective preservation of genetic diversity in the population. Another factor that decreases the maintenance of the founders' genetic diversity is loss of founder alleles due to bottlenecks in the pedigree. If a founder produces only one offspring, only 50% of its alleles are passed on to the F1 generation; 75% if it produces 2 offspring, etc. Similar effects can occur at each generation in the pedigree resulting in the loss of the founder alleles over time. If 50% of a founder's alleles are retained in the population (referred to a Retention), the founder can be considered to be only 1/2 as effective



as a founder whose alleles have all survived in the population. Thus, loss of alleles due to pedigree effects erode the original levels of genetic diversity in the population. Gene drop analyses tell us that in the GHLT population, on the average only 78% of each founder's genomes still survive in the population (Table 2).

Table 2. Summary of the Genetic Status of the Captive GHLT Population.

	REALIZED	POTENTIAL
Number of founders:	83	109
Mean Retention of Founder Alleles:	.78	.92
Founder Genome Equivalents:	31.8	90.4
Fraction of wild gene diversity retained:	0.98	0.99
Fraction of wild gene diversity lost:	0.02	0.01

REALIZED = Includes only those founders that have contributed offspring to the gene pool. POTENTIAL = Includes living wild- caught animals that have not yet contributed living offspring.

A more realistic measure of the number of founders in a population takes into consideration both the unequal founder contribution and the loss of alleles due to pedigree effects. This is the basis for the concept of Founder Genome Equivalents (Lacy, 1989). It is the number of founders that would be required to achieve the observed levels of genetic diversity in the population if all founders were equally represented and had retained all their alleles. Table 2 shows that the founder genome equivalent for GHLTs is 32 for the realized population but would be 90 if all living wild-caught were to breed in an ideal manner. This number of founders is usually considered an adequate sample of the wild population's genetic diversity.

The results of the gene drop analysis also shows that between 1 and 2% of the genetic diversity has already been lost from the population. However, this is a deceptively small amount of loss of diversity given that the majority of the population has been in captivity for only one tamarin generation (est 6 years). The population has had an effective size of 25 over the last 6 years. Generic genetic conservation goals recommend that 90% of the population's original diversity be maintained for 200 years (33 tamarin generations). If the population were to continue with this trend (effective size of 25), 50% of the population's genetic diversity would be lost in 200 years. Management strategies must be incorporated to reduce the loss of genetic diversity.

CURRENT POPULATION MANAGEMENT STRATEGIES

The GHLT population is currently being managed by the International Recovery and Management Committee co-chaired by Mr. Jeremy Mallinson from the Jersey Wildlife Preservation Trust and Dr. A. F. Coimbra Filho, Director of the Rio de Janeiro Primate Center. The program has been designed similarly to the GLT Conservation program and institutions interested in joining the program and receiving animals are required to sign a Cooperative Management Agreement and abide by the recommendations of the Committee. A studbook (current through August 1989) has been compiled by Georgina Mace (Zoological Society of London) with the assistance of Jeremy Mallinson. Jonathan Ballou is the North American Regional Coordinator.

One of the major issues facing the International Management Committee is the potential competition among the lion tamarins for space is zoos. The golden lion tamarin population is currently at 550 animals and there is already a need for additional zoos to hold non-breeding GLTs. With an increase in numbers of GHLTs in captivity, the carrying capacity of zoos to hold lion tamarins will be severely strained. Records from ISIS (ISIS, 1987)and IZY (Olney, 1985) suggest that world zoos hold about 2800 callitrichids. This can be used as an estimate of the world cage capacity for callitrichids. If this cage space is divided evenly among the 9 endangered callitrichids currently in captivity, each threatened or endangered species will be able to establish a population size of about 300 individuals. We have already exceeded our allotment for golden lion tamarins and the problem will become more severe with any increase in the GHLT population.

The issue of competition for cage spaces was discussed at the July, 1989 GLT Masterplan Meeting in Front Royal, Va. Since the black lion tamarin is recognized as the most endangered lion tamarin, but has yet to be securely established in captivity outside of Brazil, it was tentatively recommended that the growth of both the GLT and GHLT populations be limited to allow for future growth of the more endangered black lion tamarin. At that time, it was recommended that the GHLT population be limited to approximately 300 individuals with 100 residing in North America, 100 in Europe and 100 in South America. These numbers are sufficient to maintain over 85% of the population's genetic diversity for 200 years. Efforts are already underway to bring the population growth down as the population has already approached that level. Four of the original five wild-caught females brought into the country in 1986 have already produced more than their share of offspring and now carry contraceptive implants to stop them from reproducing any further.

A second major issue facing the Management Committee is the need to find additional zoos to join the program and hold the growing population. There is particular need to find institutions in Europe since only 3 institutions now hold GHLTs. However, we also need institutions in the United States to join the program and we are inviting any zoo that is interested in joining the program to contact either Jonathan Ballou or Jeremy Mallinson. The Management Committee must receive an application and approve an application for each zoo before they can receive GHLTs.

REFERENCES

Coimbra-Filho, A. F., and R. A. Mittermeier. 1972. Taxonomy of the genus Leontopithecus; Lesson, 1840. In D. D. Bridgwater (ed): Saving the Lion Marmoset. Wheeling, WV: Wild Anim. Propagation Trust, pp. 7-22.

Forman, L., D. G. Kleiman, R. M. Bush, J. M. Dietz, J. D. Ballou, P. G. Phillips, A. F. Coimbra-Filho, and S. J. O'Brien. 1986. Genetic variation within and among lion tamarins. Am. J. Phys. Anthro. 71: 1- 11.

ISIS. 1987. International Species Inventory System Database, June, 1987. Minneapolis, MN: ISIS.

Lacy, R. C. 1989. Analysis of founder representation in pedigrees: founder equivalents and founder genome equivalents. Zoo Biology 8: 111-123.

Mallinson, J. J. C. 1988. International efforts to secure a viable population of the golden-headed lion tamarin. Primate Conservation 8:124-125.

Mace, G. M. 1989. International Studbook for Golden-headed Lion Tamarin Leonntopithecus chrysomelas. No. 2. pp. 42. Jersey Wildlife Preservation Trust.

Olney, P. J. S. 1985. International Zoo Yearbook. London: Zool. Society London.

Soule, M., M. Gilpin, W. Conway, and T. Foose. 1986. The Millenium Ark: how long a voyage, how many staterooms, how many passengers?. In K. Ralls and J. D. Ballou (eds): Proceedings of the workshop on Genetic Management of Captive Populations. Zoo Biology (5), pp. 101-113.

1989 INTERNATIONAL STUDBOOK

GOLDEN-HEADED LION TAMARIN

(*Leontopithecus chrysomelas*)

B. Status of the captive population 31st August 1989

	South America	North America	Europe	Asia	TOTAL
Number of living animals	63.62.19 (144)	38.22.8 (68)	26.29.9 (64)	3.3.3 (9)	130.116.39 (285)
Number of participating institutions	9	8	4	1	22
Number of founders	69	16	27	5	83
Number of living founders	49	12	11	3	75
Founder genome equivalents	18.8	9.3	8.0	1.7	31.2
percentage heterozygosity lost	3	5	7	30	1.4

SUMMARY OF MASTERPLAN ANALYSES FOR CAPTIVE GOLDEN LION TAMARINS

(Leontopithecus rosalia)

BACKGROUND

The long-term management goal of the captive population of golden lion tamarins is to establish and maintain a captive population of sufficient size to:

- assure demographically security;

- retain significant levels of genetic diversity to allow the population to continue to adapt to changing environments; and

- reinforce the survival of existing or re-established wild populations.

Strategies to accomplish these goals have changed since the Golden Lion Tamarin Conservation Program begin in 1972. In the early years of the Program, a major focus was to improve reproduction among the small numbers of animals present in the captive population. More recently, as the population has grown to over 500 animals, the focus of management has been to slow population growth.

Today, the captive population is managed by the Golden Lion Tamarin Management Committee, which consists of 12 members (7 elected) from institutions in North America, Europe, Australia and South America. The Management Committee sets policy regarding the captive management and reviews applications from institutions interesting to acquire golden lion tamarins for their collections. All zoos must be reviewed by the Management Committee before being approved to receive golden lion tamarins.

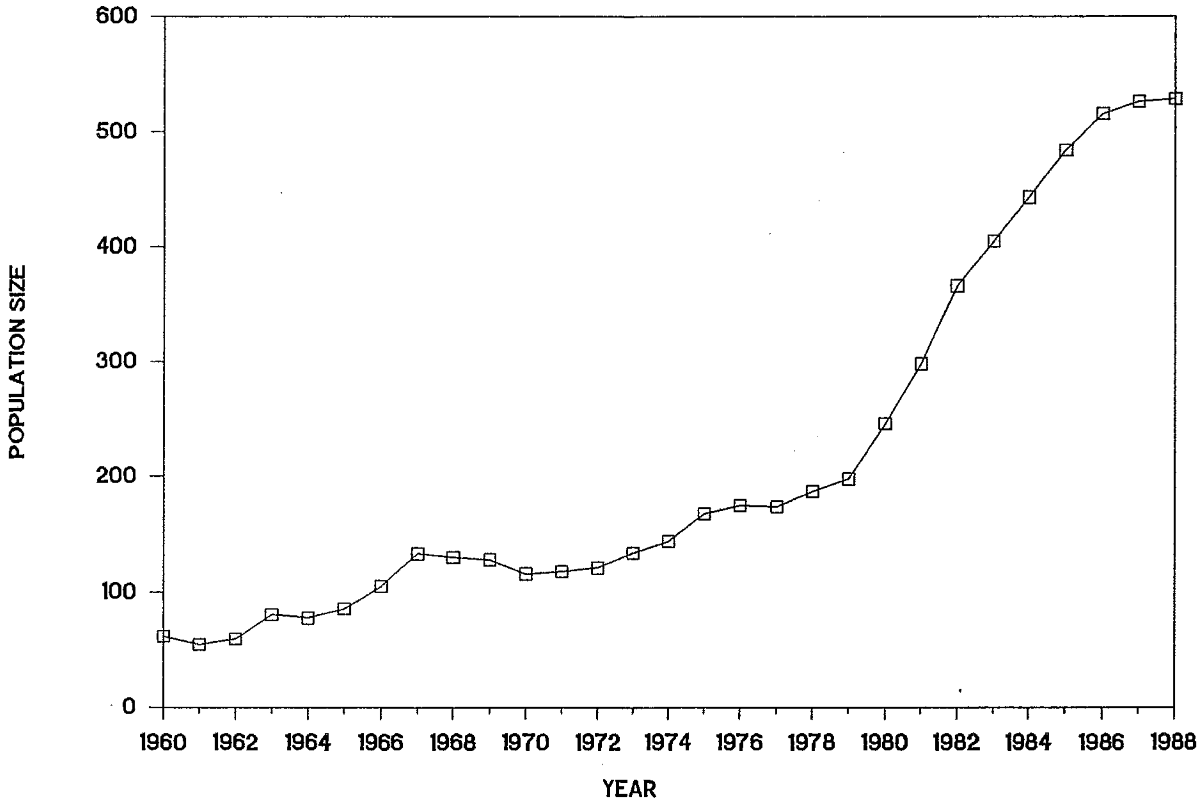
Decisions regarding placement of animals, which animals are to breed and who is to breed with whom are made by the Studbook Keeper. These decisions are based on demographic and genetic analyses of the captive population using the International Golden Lion Tamarin Studbook as the data base for all analyses. The Studbook contains basic life-history and husbandry data for every animal that has ever entered the population since 1960. It contains complete pedigree data of all living animals back to wild-caught imported founders. Currently, over 2200 animals are listed in the Studbook.

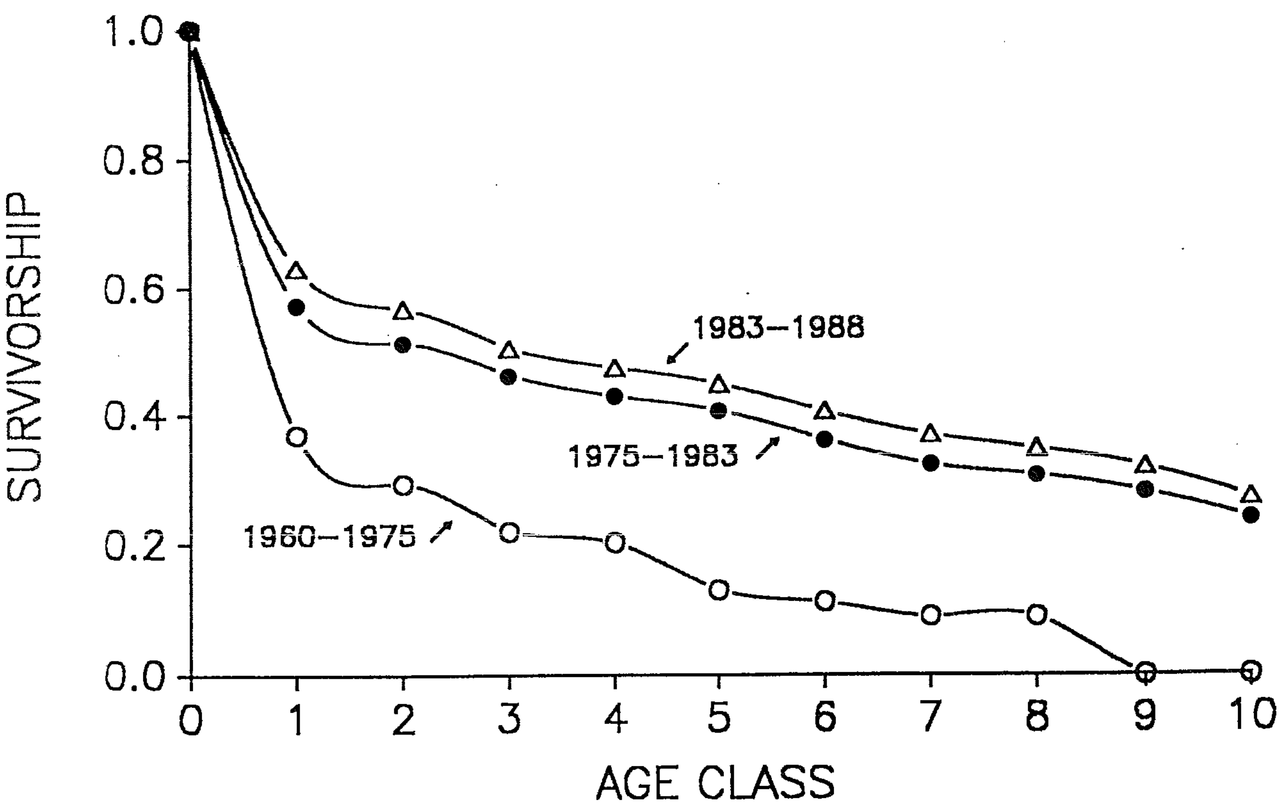
The following analyses and discussions are summaries of analyses conducted in July, 1989 and are based on the 1988 Golden Lion Tamarin Studbook.

DEMOGRAPHIC SUMMARY

Figure 1 shows the growth of the captive population since 1960. The population has experienced three different phases. Prior to the mid 1970s, the population grew slowly. Knowledge of the basic biology and husbandry of

GROWTH OF THE CAPTIVE GLT POPULATION





the species was lacking. However, as a result of intensive research efforts by a number of individuals and organizations, husbandry techniques improved and the population experienced rapid growth (average 17% per year) between 1975 and the mid 1980s. In 1983, the initiation of the reintroduction program and efforts to reduce reproduction resulted in a decline in the growth rate. In the late 1980s, the population has grown slowly, averaging only 5% per year.

Currently, the population consists of 541 individuals in over 100 institutions worldwide. One third of these animals are currently in breeding situations.

Generation length, yearly survival and fecundity rates are needed in order to develop demographic and genetic management goals for the captive population. These values are estimated from life-table estimates of the captive population. Table 1 shows the life-table for captive tamarins. Because the population has gone through different phases, the survival and fecundity rates are taken from different periods in the population's history. The fecundity rates are taken from the period of 1975 to 1983, when the population grew at its maximum rate and therefore should represent the maximum fecundity rates for captive GLTs. Survival rates have also changes over time (Figure 2). The survival rates are taken from the most recent data (1983-1988) and therefore represent our best efforts to keep tamarins alive in captivity. Survival and fertility rates are not significantly different for males and females so all demographic parameters (Table 1) are estimated using rates for females.

Table 1. Life-table calculations for captive female golden lion tamarins.

Age Class (Years)	p_x [1]	l_x [2]	m_x [3]
0	0.61	1.00	0.00
1	0.87	0.61	0.00
2	0.90	0.53	0.32
3	0.92	0.48	0.60
4	0.92	0.44	0.74
5	0.91	0.40	0.78
6	0.90	0.37	0.72
7	0.90	0.33	0.59
8	0.89	0.30	0.53
9	0.88	0.27	0.53
10	0.86	0.23	0.53
11	0.82	0.20	0.65
12	0.76	0.17	0.89
13	0.78	0.13	0.88
14	0.88	0.10	0.52
15	0.97	0.09	0.13
16	1.00	0.08	0.00
17	1.00	0.08	0.00
18	1.00	0.08	0.00
19	0.75	0.08	0.00
20	0.25	0.06	0.00
21	0.00	0.02	0.00
22	----	0.00	0.00

Demographic Calculations [4]

Net Reproductive Rate (R_o)

$$R_o = \sum_{x=1}^{21} l_x m_x = 2.43$$

<u>Lambda</u> = e^r = 1.16

<u>Generation length (T)</u>

$$T = \sum_{x=1}^{21} x*e^{-rx}*l_x m_x = 5.28$$

<u>No. female births required for zero population growth at carrying capacity of 287 females (575 total):</u>

$$= 287 * \frac{1}{\sum_{x=0}^{21} l_x} = 47.$$

1. p_x = Proportion of females surviving from age class x to age x+1.
2. l_x = Proportion of births surviving to age class x.
3. m_x = Average number of female births born to a female of age x.

GENETIC ANALYSES:

The current captive population of golden lion tamarins has descended from 46 wild-caught or presumed wild-caught founders. Most of these founders were present in the population in the 1960s and early 1970s. There are only 14 founders alive today; most of these are in South America institutions.

The genetic contribution of the founders to the living population is shown in Figure 3. Founder contribution is the proportion of the captive population's gene pool that has descended from each of the 46 founders. As can be seen from the Figure, the genetic representation of the founders is highly skewed with some founders contributing much more to the gene pool than others. These differences in founder contribution occurred early in the history of the population, when some pairs were much more successful at breeding than others.

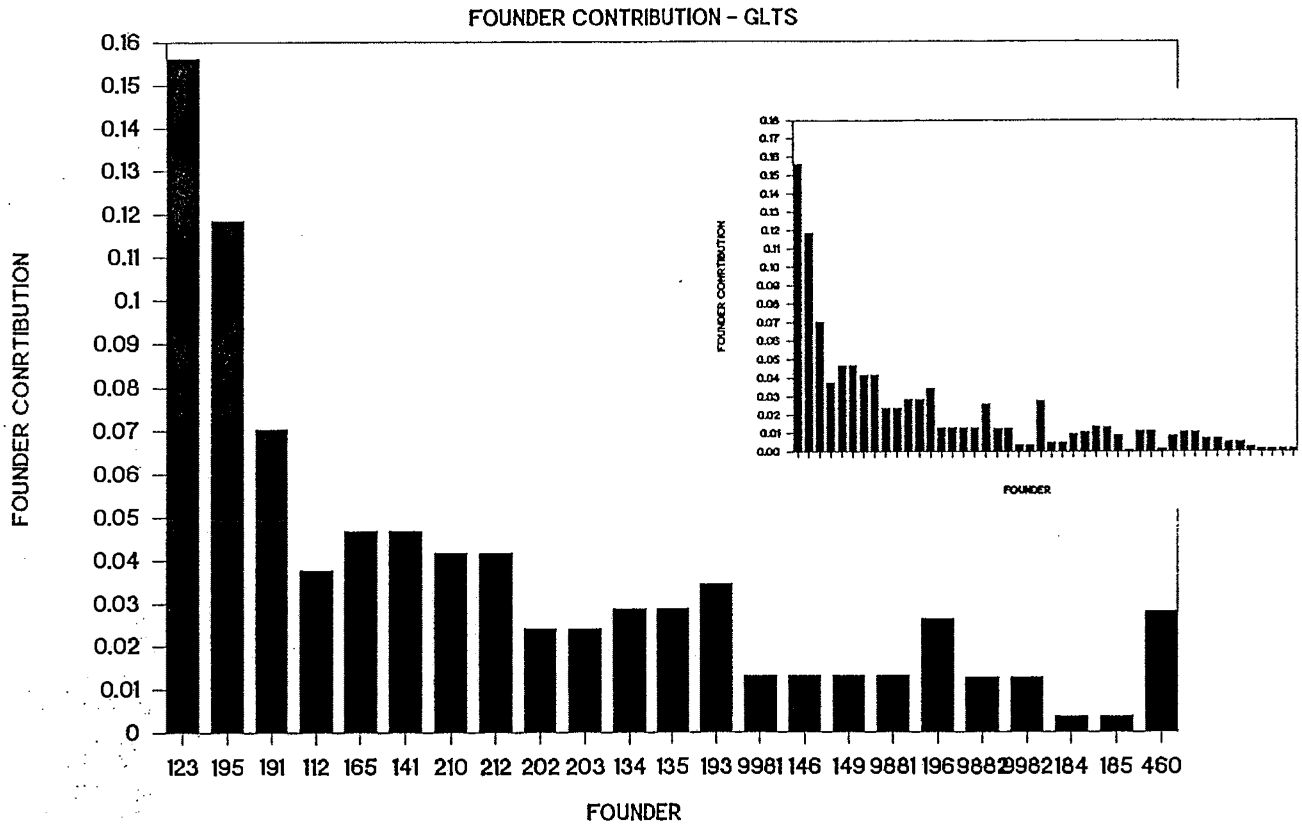
Highly skewed founder contributions result in loss of genetic diversity in the population because the genetic contribution from the under-represented founders is swamped by the contribution from the over-represented founders.

Further loss of a population's potential genetic diversity can occur through loss of founder alleles due to genetic drift or bottlenecks in the pedigree. Bottlenecks occur when the genetic contribution of a founder passes through one or only a few individuals. For example, if a founder produces only one offspring, only 50% of its genes survive to the next generation, 75% survive if it produces two offspring, etc. Bottlenecks often occur during the first generation if only one or two offspring of a founder live to reproduce. However, the genetic drift caused by these bottlenecks can occur at any point in the pedigree, resulting in the gradual erosion of the founder's alleles through the pedigree. The more "pathways" a founder's genes have to the living population, the less loss will occur. Therefore, even though a large proportion of a population's gene pool may have descended from a particular founder, only a fraction of that founder's original diversity may be present in the living population.

The proportion of a founder's original genome that has survived to the current population is referred to as gene retention. Table 2 shows the retention values (under column labeled RETAINED) for the 46 GLT founders. Note that many founders have less than 50% of their genes present in the population.

Since both skewed founder contributions and loss of alleles due to genetic drift (retention) result in the loss of the original founders' genetic diversity, the genetic contribution of the founders to the gene pool may be less than expected. One way to summarize the effects of both skewed founder contribution and genetic drift is the concept of founder genome equivalent (fge). The fge is the number of founders that could be required to obtain the levels of genetic diversity that are observed in the current population if the founders were all equally represented and had retained all their alleles in the living population.

The fge for the GLTs is 14.7 (Table 2). Clearly, the highly skewed founder contribution in combination with the loss of founder alleles has significantly reduced the effectiveness of the 46 GLT founders. Management strategies must be adopted to increase the effectiveness of these founders by 1) reducing the


FOUNDER CONTRIBUTION - GLTS
FOUNDER CONRTIBUTION
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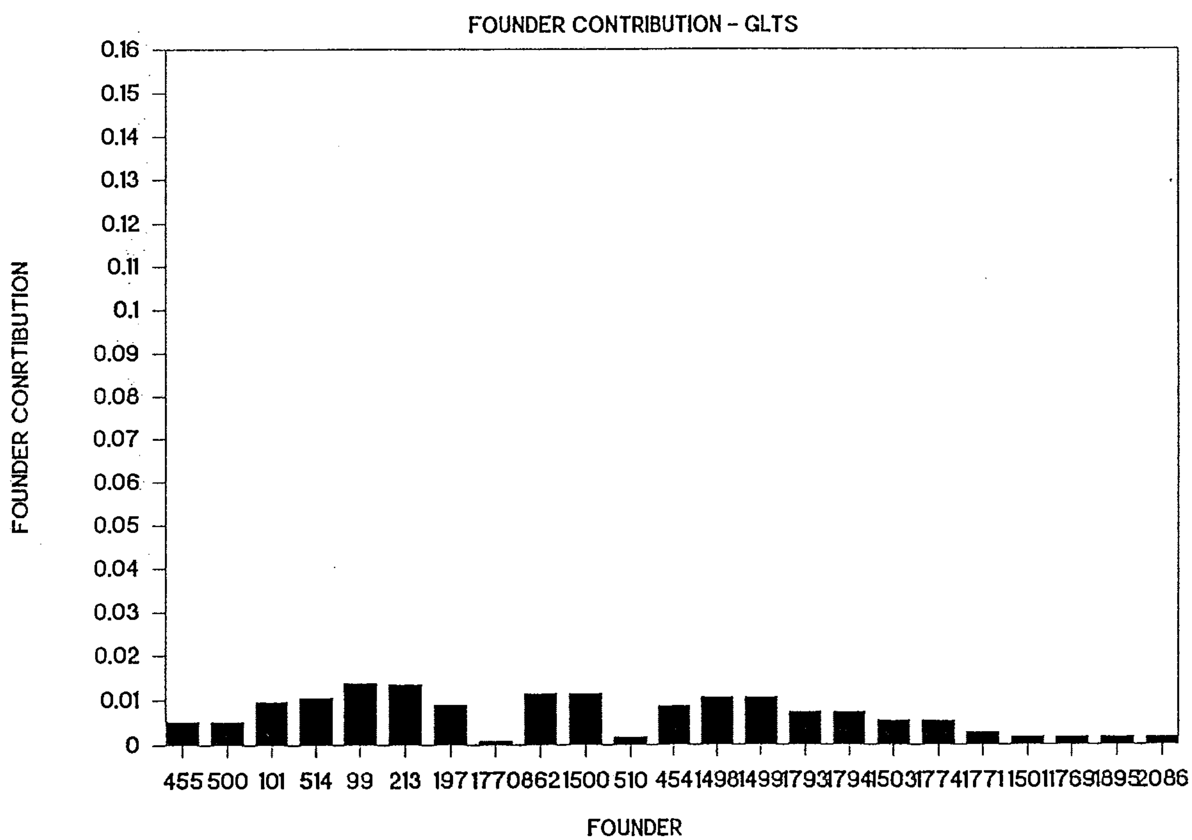
123 195 191 112 165 141 210 212 202 203 134 135 193 9981 146 149 9881 196 9882 9982 184 185 460
FOUNDER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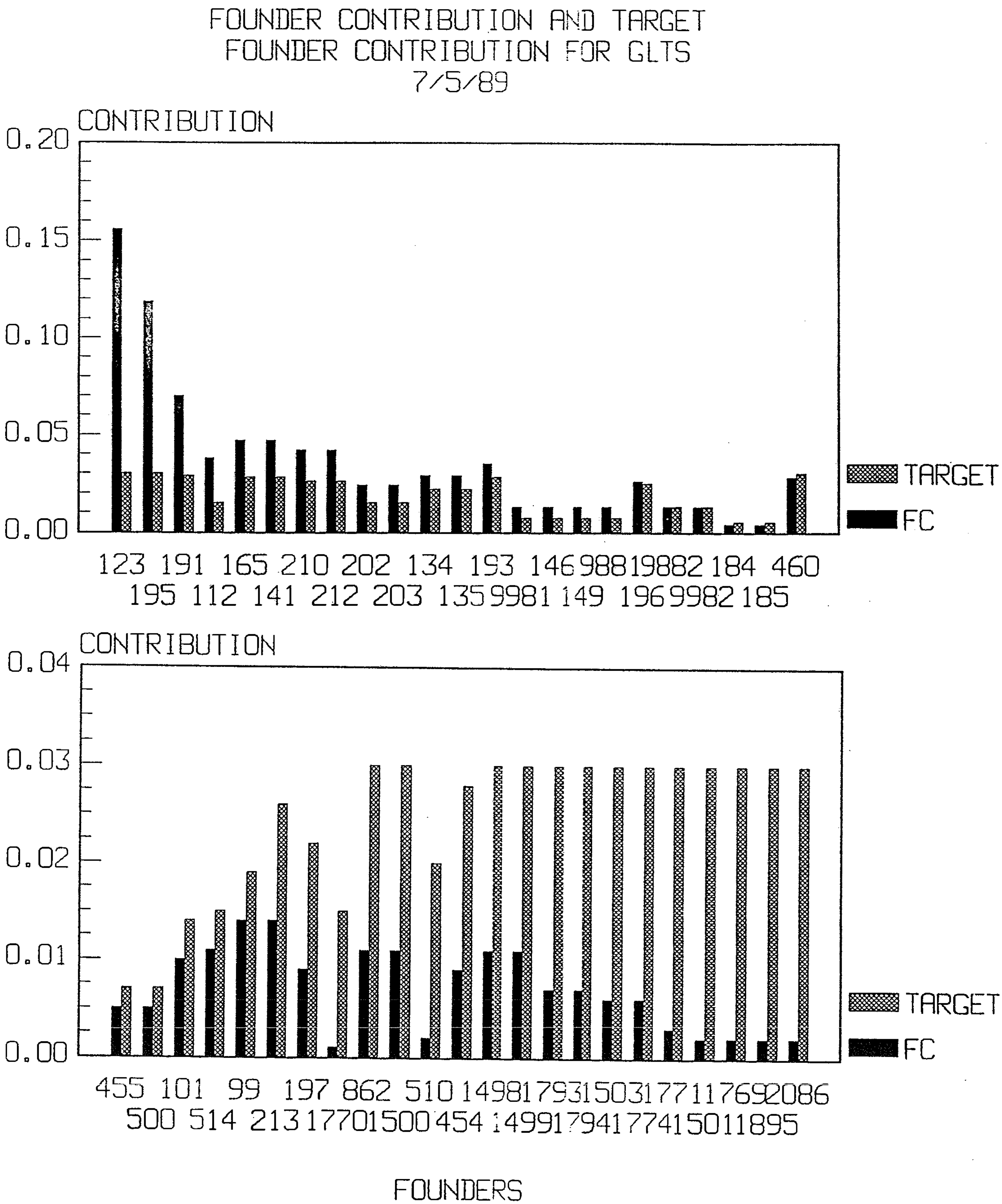
FOUNDER CONTRIBUTION AND TARGET
FOUNDER CONTRIBUTION FOR GLTS
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500 514 213 17701500 454 1499179417741501 1895
FOUNDERS

highly skewed genetic representation of the founders, and 2) assuring that pedigree bottlenecks do not take any further toll on founder alleles.

Discrepancies in founder representation in the living population can be rectified by preferentially breeding descendants from "under- represented" founders and reducing reproduction in descendants from "over-represented" founders. One approach might be to try to equalize the founder contributions of the founders.

However, the goal of equal representation of founders is inappropriate if a founder's retention is not 100%. Attempting to adjust this founder's contribution to the same level as other founders not having experienced a bottleneck will over-represent that founder's gene in the population.

For founders with low retention, the founder contribution goal must be reduced according to its level of retention. For example, if a founder's retention is 50%, it could be considered only 'one-half' of a founder and its contribution in the living population managed to a level of one-half the other founders. Genetic representation of founders with low retention should be managed at a lower level than founders with high retention. This will increase the number of unique founder alleles maintained in the population.

Therefore, rather than manage for equal founder contribution, we can define a "Target Founder Contribution" that takes into consideration the effects of bottlenecks and genetic drift within the pedigree. The target founder representation of each founder will reflect how much of their genetic diversity has survived to the living population (retention).

Table 2 shows the target founder representations for the GLTs. Pairings should be selected to shift the existing founder contributions to the target founder contributions. Table 2 also shows the difference between existing and target contribution and categorizes each founder as being over, under or at parity with its target contribution. A comparison of target and existing founder contributions are also shown in Figure 4.

MANAGEMENT OBJECTIVES:

Results from demographic and genetic analyses provide the framework for specific management objectives of the population. In particular, they provide results important for determining: 1) the population size required for retaining significant levels of genetic diversity over specified time periods (referred to as the Genetic Minimum Viable Population Size); and 2) reproductive objectives for the population as a whole and each individual.

Table 2. Founder Contribution is calculated from additive relationship matrix. Percent of founder genome surviving in current population (RETAINED) calculated from gene drop analysis with 10,000 simulations. Living founders are assigned RETENTION of 1.00 (100% genome still in population). TARGET founder contribution is the founder contribution desired if each founder is weighted by the RETENTION (i.e. founder with 50% RETENTION is counted as 1/2 a founder and its contribution should be 1/2 a great as a founder with 100% retention). DIFFERENCE is the difference between the current contribution and the target contribution. Founders with contributions within 1% of the target are labeled at "Parity".

FOUNDER	FOUNDER CONTR.	RETAINED	TARGET	DIFF-ERENCE	STATUS	
123	0.156	1.000	0.030	0.127	DEAD	OVER
195	0.119	1.000	0.030	0.089	DEAD	OVER
191	0.070	0.989	0.029	0.041	DEAD	OVER
112	0.038	0.497	0.015	0.023	DEAD	OVER
165	0.047	0.952	0.028	0.019	DEAD	OVER
141	0.047	0.953	0.028	0.019	DEAD	OVER
210	0.042	0.882	0.026	0.016	DEAD	OVER
212	0.042	0.886	0.026	0.016	DEAD	OVER
202	0.024	0.500	0.015	0.009	DEAD	Parity
203	0.024	0.500	0.015	0.009	DEAD	Parity
134	0.029	0.731	0.022	0.007	DEAD	Parity
135	0.029	0.732	0.022	0.007	DEAD	Parity
193	0.035	0.948	0.028	0.007	DEAD	Parity
9981	0.013	0.250	0.007	0.006	DEAD	Parity
146	0.013	0.250	0.007	0.006	DEAD	Parity
149	0.013	0.250	0.007	0.006	DEAD	Parity
9881	0.013	0.250	0.007	0.006	DEAD	Parity
196	0.026	0.839	0.025	0.002	DEAD	Parity
9882	0.013	0.438	0.013	-0.000	DEAD	Parity
9982	0.013	0.442	0.013	-0.000	DEAD	Parity
184	0.004	0.155	0.005	-0.001	DEAD	Parity
185	0.004	0.158	0.005	-0.001	DEAD	Parity
460	0.028	1.000	0.030	-0.001	LIVE	Parity
455	0.005	0.249	0.007	-0.002	DEAD	Parity
500	0.005	0.251	0.007	-0.002	DEAD	Parity
101	0.010	0.463	0.014	-0.004	DEAD	Parity
514	0.011	0.500	0.015	-0.004	DEAD	Parity
99	0.014	0.641	0.019	-0.005	DEAD	Parity
213	0.014	0.869	0.026	-0.012	DEAD	UNDER
197	0.009	0.743	0.022	-0.013	DEAD	UNDER
1770	0.001	0.500	0.015	-0.014	DEAD	UNDER
862	0.011	1.000	0.030	-0.018	LIVE	UNDER
1500	0.011	1.000	0.030	-0.018	LIVE	UNDER
510	0.002	0.692	0.020	-0.019	DEAD	UNDER
454	0.009	0.934	0.028	-0.019	DEAD	UNDER
1498	0.011	1.000	0.030	-0.019	LIVE	UNDER
1499	0.011	1.000	0.030	-0.019	LIVE	UNDER
1793	0.007	1.000	0.030	-0.022	LIVE	UNDER
1794	0.007	1.000	0.030	-0.022	LIVE	UNDER
1503	0.006	1.000	0.030	-0.024	LIVE	UNDER
1774	0.006	1.000	0.030	-0.024	LIVE	UNDER
1771	0.003	1.000	0.030	-0.027	LIVE	UNDER
1501	0.002	1.000	0.030	-0.028	LIVE	UNDER
1769	0.002	1.000	0.030	-0.028	LIVE	UNDER
1895	0.002	1.000	0.030	-0.028	LIVE	UNDER
2086	0.002	1.000	0.030	-0.028	LIVE	UNDER

GENETIC SUMMARY: Total Number of Founders 46

Number of Living Founders 14

Number of Founder Genome Equivalents 14.7

Genetic Minimum Population Size:

A common goal for genetic management of captive populations is to try to preserve 90% of a population's original levels of heterozygosity for 200 years. This goal was adopted for the captive GLT population. The Genetic Minimum Population Size is defined as the population size required to achieve this genetic goal and is calculated by modeling the loss of genetic diversity over time in the population in question.

The average level of inbreeding in the current population is 0.026. Therefore, to date we have retained 97.4% of the original heterozygosity. All individuals in the captive population have descended from 46 founders and these founders entered the population between 1964 and 1987. The median year of entry was 1974 so 1974 was taken as the 'founding' year for the purposes of calculating the duration of the 200 year program. We are now in the 14th year with 186 years remaining. With a generation length of 5.3 years (Table X), 35 generations will pass during the next 186 years. Therefore, we need to know the number of animals required to maintain 92.4% of the remaining heterozygosity for 186 years.

Table 3 shows number of animals required to reach this objective for a variety of generation lengths and effective population sizes. Both generation length and the ratio of effective size to real population size are expected to vary according to what demographic management options are used to have the population reach zero population growth.

Table 3. Population Sizes Required For Maintaining 90% of the Original Heterozygosity for 200 Years given that 2.6% has already been lost in 14 years.

	GENERATION				
Ne/N	4.0	4.5	5.0	5.5	6.0
1.0	298	265	227	198	178
0.5	595	529	453	395	356
0.4	741	661	566	494	445
0.3	987	873	755	659	592

The effective population size for golden lion tamarins has been estimated to be around 30% of the actual population size. However, this can probably be improved with more intensive management efforts. Generation lengths are approximately 5 to 6 years. Using 5.5 years as the generation time, we need an effective population size of 198 animals, which translates into actual population sizes of between 500 and 660 depending in the Ne/N ratio (with 575 as the mid-point). Management strategies should attempt to stabilize the population at this level.

Population Demographic Objectives:

The population size is currently at 541 animals so we should begin to manage the population for zero population growth. From table 2, we can see that to achieve zero population growth at 575 animals, we need to produce 47 female (95 total) offspring per year. Therefore, each year we need to confirm that enough, but not too many, pairs are being bred to produce 95 births.

Individual Reproductive Requirements:

From a life-time perspective, zero population growth is achieved if each individual, during its lifetime, produces only enough offspring to replace itself in the population. Therefore, each pair of golden lion tamarins, during their life-time, should produce 2.0 offspring that live to reproduce.

While each individual,on the average, should produce only enough offspring to replace itself, our genetic management objectives require us to preferentially breed individuals from under-represented founders while slowing reproduction of individuals from over-represented founders. While the average reproduction per pair should be 2 offspring who live to reproduce, the actual amount each pair produces will vary according to whether its genes are from under or over-represented founders.

One method for evaluating how under or over-represented an individuals genes are is to calculate how related it is to all the other animals in the population (calculate as mean kinship = MK). Those individuals who are very closely related to other animals carry common alleles, those who are not carry rare alleles. We can then scale our reproductive objectives for each individual according to its mean kinship value. Table 4 shows the life-time reproductive objectives for golden lion tamarins scaled to mean kinship.

Table 4. Life-time reproductive recommendations for individual golden lion tamarins based on distribution of mean kinship (MK) values in the population. The total number of offspring that should be produced and eventually bred per individual is a function of the individual's mean kinship value. Note that the mean number of births across all individuals is 2.0 - each breeding pair only replaces itself and zero population growth is achieved.

Mean Kinship Range	% of Population	Number of Offspring to be Bred
< 0.019	12%	4
0.020 to 0.034	17%	3
0.035 to 0.050	45%	2
0.051 to 0.058	14%	1
> 0.058	12%	0
		Mean = 2.0

COMITÊ INTERNACIONAL DE PRESERVAÇÃO E MANEJO DO MICO-LEÃO PRETO

Leontopithecus chrysopygus

INTERNATIONAL COMMITTEE FOR THE PRESERVATION AND MANAGEMENT OF THE BLACK LION-TAMARIN(*Leontopithecus chrysopygus*)

C A D A S T R O D E L I N H A G E M

(provisório)

P R O V I S I O N A L S T U D B O O K

1 9 8 8

MICO-LEAO PRETO **BLACK LION-TAMARIN**

ÍNDICE

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INDEX

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PALAVRAS DE INTRODUÇÃO

A sobrevivência de uma espécie está acima de qualquer discussão.

Da urgência com que se reveste o atendimento à recuperação do Mico-leão preto (Leontopithecus chrysopygus), houve tomadas de decisão bruscas correndo-se o risco de malinterpretações o que, porém, não deve desviar da meta a que se propõem os que por ela dedicam seu trabalho. Só não podemos enveredar pela desarmonia ou deixarmo-nos desnortear pelo entusiasmo a que pode induzir a raridade do objeto de nosso empenho.

Este caderno não pretende senão ser um embrião dum livro de linhagem.Está aí para ser revisto, criticado, corrigido e melhorado. Fez-se na forma em que se apresenta dentro de nossas limitações à espera de ajustes que se indiquem no sadio espírito científico para que possa ser usado com segurança no manejo criterioso duma população tão reduzida em fundadores como o é a desse símio.

Queremos deixar expresso nosso agradecimento a Jonathan D. Ballou, responsável pelo manejo populacional das coleções do National Zoological Park / USA,pela elaboração dos primeiros cálculos e tabelas iniciais com os dados que possuíamos em setembro de 1987; a Paulo E.S. Miranda,Engenheiro Naval-Analista de Suporte Técnico, pela programação de computadores domésticos a sistema que se faz necessário para as determinações de coeficientes de consanguinidade, contribuições de fundadores e pela rodagem dos programas; à Fundação Parque Zoológico de São Paulo através de seu DD. Diretor, Prof.Dr. A.M.Saliba, pelo patrocínio e apôios material e moral durante a confecção;a todos os membros do CIPMMLP e suas equipes pelo suporte e encorajamento na realização.

São Paulo, 11 de julho de 1988

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INTRODUCTORY WORDS

No one could question the need to rescue an unnaturally vanishing species.

The black Lion-tamarin's desperate situation does not allow for any delays - decisions were harshly taken by some of us even at the risk of being misunderstood but this shall never deviate from their routes those who dedicate their efforts to such goals. We must only beware of getting in inbalance of emotions or of being undully enthusiastic because of the rareness of our subject species.

We hope these notes will evolve into a definite studbook. They are now presented to be analysed, criticized, corrected, improved; must be trimmed to eventually serve their ultimate user in the proper management of a species so devoid of founders as is the BLT.

We wish to express our thankfulness to Jonathan D.Ballou,Population Manager of the National Zoological Park/USA for his tireless help and attention in preparing the first provisional tables with the data we presented him in September 87;to Paulo E.S.Miranda, Naval Engineer/Systems Analyst,for the adaptation of domestic computers to perform the necessary calculations and running the programs; to São Paulo Zoological Park Foundation, its director, Prof. Dr. A.M.Saliba,for sponsoring; to all members of ICPMBLT and their teams for the data, support and encouragement.

São Paulo, July 11, 1988

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BREVE HISTORICO DA SITUAÇÃO

Leontopithcus chrysopygus foi descrito pela primeira vez nas cercanias do município de São Paulo,SP. Distribuia-se,possívelmente, na faixa triangular limitada pelos rios Tietê,Paranapanema e Paraná. Com o desenvolvimento que se propagou no sentido Oeste, a perda de habitate deslocou o que sobrou dessa espécie ao extremo interior do Estado confinando-a hoje, pelo menos ao que se sabe, a duas áreas: a do Parque Estadual do Morro do Diabo em Teodoro Sampaio e à Estação Ecológica de Caetetús em Gália.

Durante cerca de sete décadas considerou-se extinto. No início dos anos setenta foi redescoberto no PEMD e, dum pequeno número de exemplares aí capturados, originou-se o considerável lote nascido e mantido no Centro de Primatologia do Rio de Janeiro/FEEMA (CPRJ). Em meados daquela década foi observado na EEC também.

O confinamento em pequenos territórios e por longo tempo leva, inevitávelmente, a que se conjecture serem os L. chrysopygus, os micos-leões pretos (MLPs), ainda vivos quer em vida livre como em cativeiro, produtos de estreita consanguinidade. Consequências deletérias ou favoráveis desse íntimo parentesco estão ainda por serem claramente demonstradas,requerendo-se estudos quantitativos da população, da diversidade genética e de características anátomo-fisiológicas no maior número de indivíduos possível, do contrário carecerão de credibilidade quaisquer generalizações.

Um segundo grupo em cativeiro formou-se recentemente pela transferência à Fundação Parque Zoológico de S.Paulo (FPZSP) dos MLPs resgatados na porção a ser inundada pelo fechamen-

SUMMARY OF THE SITUATION

Leontopithecus chrysopygus was first described in the outskirts of São Paulo.Its former range was probably confined to the triangular area between rivers Tietê, Paranapanema and Paraná.Due to the development noticed in this part of the country the original habitat was lost and the species became squeezed westwards in the State. Presently BLTs are known to inhabit two only refuges, Morro do Diabo State Park at Teodoro Sampaio and the Ecological Station of Caetetús in Galia.

BLT was believed extinct for 70 years. In the early seventies a group was discovered at Morro do Diabo (PEMD) and, from the small group captured at then, originated the considerable colony held at Rio de Janeiro Primatology Center (CPRJ).In the mid seventies another group was observed at the Ecological Station of Caetetús (EEC).

Due to the BLT's restriction to small isolated territories,the tamarins in the wild and in captivity face a potential inbreeding . As a result of this intimate parenthood, its advantages or disadvantages need to be clearly demonstrated if they really exist. Quantitative studies of the population, its genetic diversity and anatomic-phisiologic peculiarities have to be observed and sampled on as many individuals as possible. Otherwise, whatever generalizations will loose credibility.

A second captive group, now at the São Paulo Zoo (ZooSP), was formed during the process of a dam closure in the Paranapanema river when PEMD would loose 5% of its best forested parcel. As a result of trauma during deforestation,attack by predators or other factors many of the captured animals succumbed in a sucession of deaths which forced us to remove them from PEMD, to da barragem de Rosana no rio Paranapanema , quando o PEMO perderia 5% de sua superfície nobre. A sucessão de óbitos ocorridos quer durante as derrubadas como quando já em cativeiro por ataques de predadores, acidentes mecânicos e outros agentes obrigou à remoção "in extremis" pois o desconhecimento do tamanho da população, de sua biologia, de seu comportamento em vida livre, da capacidade suporte da mata remanescente vizinha à que ocupavam, da densidade de ocupação pelo mico por todo o parque, da densidade de predadores, da incerteza de guarda e do desconhecimento da atitude dos cidadãos locais ante a promoção e o valor que se deu ao animal não podia permitir delongas. Uma suposição otimista porém sem base experimental faria até supor a presença de pelo menos 700 indivíduos da espécie no PEMO pois 35 foram efetivamente verificados nos 5% de área acima referidos, se a distribuição do MLP pelo parque fosse homogênea. Mas as características da mata variam ao longo do eixo maior do parque, perpendicular à direção do rio e, paralelamente a este, duas estradas, uma férrea e outra uma rodovia pavimentada, constituem, quase certamente, duas barreiras topográficas artificiais que podem ter fragmentado irregularmente a população do MLP no PEMO. Do residual de micos e de sua distribuição pouco se sabe com segurança ainda. Um censo nas matas da EEC está por ser iniciado bem como outro, fazendo parte de um projeto a longo prazo de estudos amplos, no PEMO.

Pela época do fechamento da barragem de Rosana, numa reunião realizada no Instituto Florestal da SEMA de São Paulo (IF), sugeriu-se a composição dum comitê para cuidar dos assuntos relativos ao mico-leão preto, nos mesmos moldes dos dois outros do gênero Leontopithecus o que, por determinação do Instituto Brasileiro de Desenvolvimento Florestal (IBDF), foi expressamente formado. Integram-no:

then, at the lack of knowledge of its population size, biology, wild-life behaviour, carrying capacity of the adjacent forests in which they resided, density estimate of the BLT throughout the reserve, predators density, as of the unstable protection of the park, the unpredictable reactions of the locals due to the promotion and value of the species which have been told them, no further delays could be tolerated before removing.

Since 35 individuals were confirmed to occupy that 5% of the park, an optimistic estimate of the extant wild population at PEMO would ideally approximate to 700 individuals. However, this could only be considered if the reserve should show a homogeneous pattern all-over its extention. Indeed, its vegetation varies lengthwise along the reserve and, running parallel to its suthern border where the Paranapanema river flew, a paved road and also a railroad cross transversally constituting actual artificial barriers to a species like a small arboreal primate. These must for sure have irregularly fractioned the local BLT population. Knowledge of the remaining flock is still scanty. We hope that the proposed project submitted to the Committee should perform a census in a very short time.

By the time of the dam's closure, during a meeting at IF, the constitution of a committee of management of the same features of the ones already existing for the two other Leontopithecus species was suggested and soon determined by IBDF late in 1986. It is composed by:

A.F. Coimbra-Filho, CPRJ/FEEMA - BRAZIL
C.T.de Carvalho, IF/SEMA - BRAZIL
Marlise Becker, IBDF - BRAZIL
Devra G. Kleiman, Smithsonian Institution - USA
J.J.C.Mallinson, Jersey Wildlife Preservation Trust - GB

A.F. Coimbra-Filho, CPRJ/FEEMA-Rio - BRASIL
C.T.de Carvalho, IF/SEMA-SP - BRASIL
Marlise Becker, IBDF - BRASIL
Devra G. Kleiman, Smithsonian Institution - USA
Jeremy J.C. Mallinson, Jersey Wildlife Preservation Trust - GB
James Dietz, Smithsonian Institution - USA
Obdulio Menghi, C.I.T.E.S. - SUIÇA
F. Simon, FPZSP - BRASIL

Durante a remoção a São Paulo, uma fêmea fez um abortamento com perda de dois filhotes quase a termo. Esta fêmea veio a gerar em 20 de setembro de 1987 um exemplar masculino até hoje vivo e que é, até agora, o único produzido e vivo em cativeiro em São Paulo. O número de sucessos no Rio de Janeiro é maior.

Estamos, presentemente, aguardando decisões por parte do IF a pedido nosso de autorização para efetuarmos um censo dos animais que existam na Estação Ecológica de Caetetus. Convidamos para fazê-lo pessôa já experimentada na Amazônia com primata, o Saguinus midas midas, de mesmo porte e matiz tegumentar semelhante ao do MLP. Para o estudo da população no PEMD está proposto somente um projeto por enquanto, muito abrangente, porém. Esperamos que outros sejam submetidos em futuro próximo ao Comitê de Preservação e Manejo do Mico-leão preto.

Propostas de manejo têm sido discutidas com a direção do CPRJ e do IF, quer a respeito da população em cativeiro como da de vida livre e que, a seus tempos, serão submetidas a apreciação junto ao Comitê.

Dos problemas sanitários ou genéticos que assombram a população de L. rosalia, por enquanto somente uma ainda não bem fundamentada suspeita de ocorrência de hernia diafragmática surgiu fortuitamente em um animal que, ao mesmo tempo, sofre de

O. Menghi, C.I.T.E.S., CH
F. Simon, FPZSP - BRAZIL

During the transportation of the tamarins rescued at PEMD to São Paulo one of the females aborted almost ready twins. This same female gave birth to the only living BLT born in ZooSP in September 20th 1987. Successful breedings are more frequent at CPRJ.

At the moment we are waitng for decisions from the direction of IF to be allowed to perform the census of BLT in EEC. A biologist who has done a similar count in the Amazon with Saguinus midas midas accepted to do it for us. In PEMD censusing is included in the local project. We hope that other plans shall be submitted to the Committee in the earliest future.

Management of the entire population continues to be dicussed with CPRJ and IF direction and teams and any proposal will, at the proper time, be also submitted to the Committee.

Of the sanitary and genetic problems which are faced by the GLT only a still not well demonstrated diaphragmatic hernia has been suspected in one specimen. The condition was accidentally noted when the animal was presented for lameness.(It suffers of a systemic osteopathy resembling hyperparathyroidism) The whole captive population of BLT will be screened for this anomaly if this condition can really be considered to be one. But we can only start after October, when breeding season will be over, in order not to stress the couples and to avoid any harmful effect of the radiation upon te foetuses.

An intentions and management agreemet, to be signed by all interested and sponsoring institutions is our most cherished hope. Unconnected decisions or conflicting intends may so be a-uma osteopatia sistêmica que lembra hiperparatireoidismo. O conjunto todo de MLPs será, em breve, repassado sob Raio-X especificamente para a verificação de tal anomalia, se assim poderá ser chamada. Aguardar-se-á, entretanto, que termine o tempo de gestação e nasçam os novos micos em meados de setembro, evitando submeter as fêmeas gestantes e seus companheiros a tensões e mesmo colocá-los sob risco de acidentes e abortamentos ou a efeitos deletérios da radiação aos embriões.

Um acordo de intenções e de manejo esperamos que venha a ser celebrado entre todas as entidades mantenedoras e interessadas para que não venhamos a enfrentar choques e tomadas de iniciativa desconexas e que só fariam por mais em risco do que já está a sobrevivência do _Leontopithecus chrysopygus_.

***

voided. Otherwise it will not be difficult to predict the worsening of a situation already touching the borderlines of extinction - the one of this _Leontopithecus chrysopygus_.

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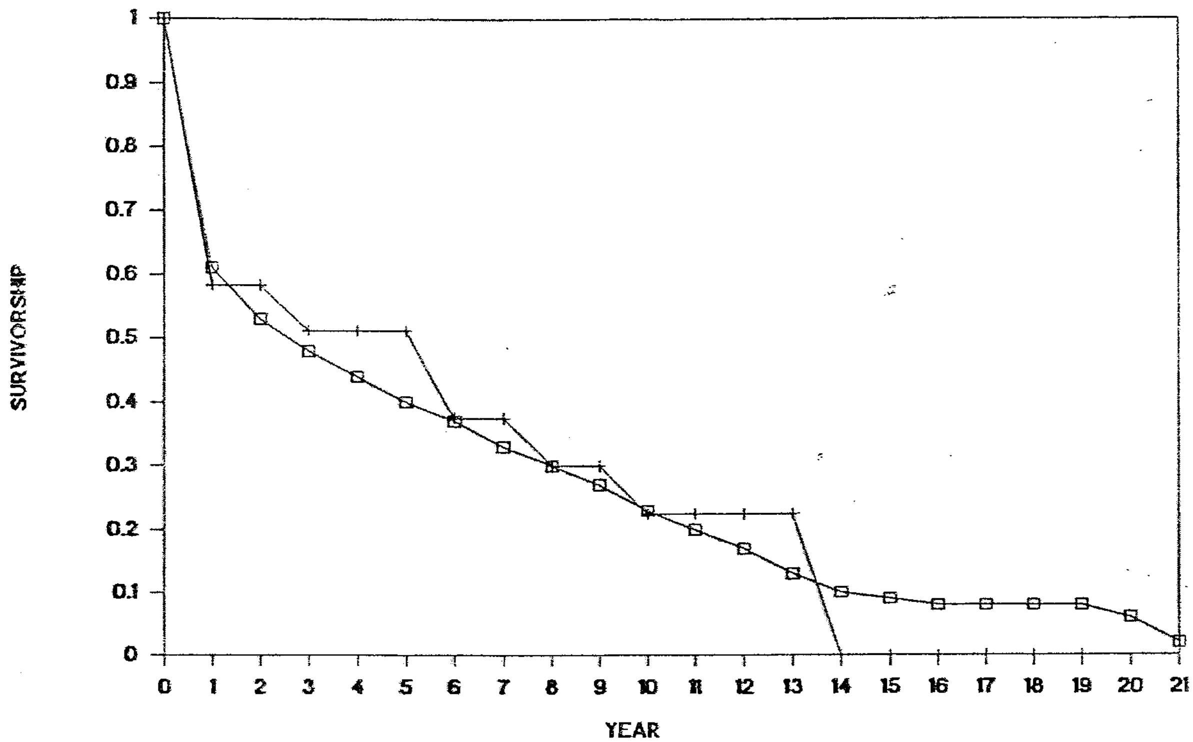
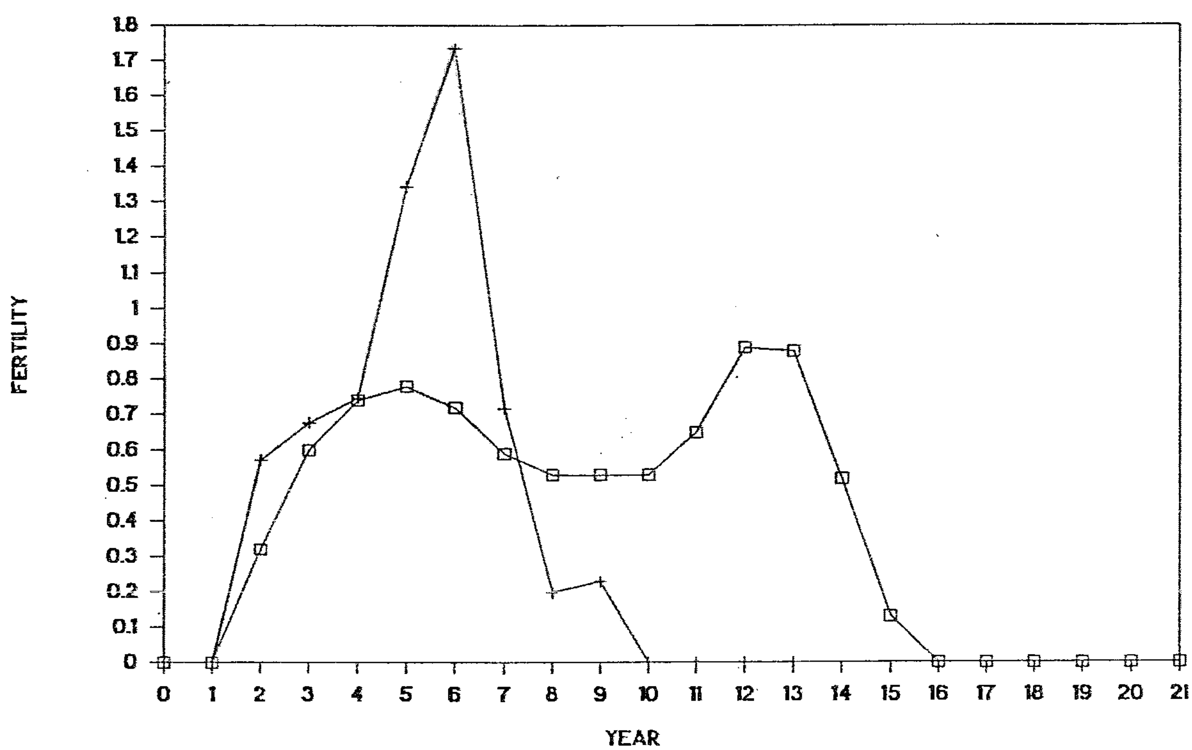
SURVIVORSHIP OF LION TAMARINS



FERTILITY OF LION TAMARINS



LEONTOPITHECUS

POPULATION VIABILITY ANALYSIS

WORKSHOP REPORT

REINTRODUCTIONS

ZOO Creating the Nation's first BioPark

National Zoological Park · Smithsonian Institution · Washington, D.C. 20008

TO: Friends of the Golden Lion Tamarin Conservation Program

FROM: Ben Beck, Coordinator of Reintroduction

RE: Reintroduction Update, Summer 1990

DATE: 18 September 1990

CURRENT STATUS

Captive-Born Reintroduced:	75	
Captive-Born Surviving:	27	(36%)
Wild-Born Reintroduced:	6	
Wild-Born Surviving:	4	(67%)
Born After Reintroduction	34	
Infants Surviving	22	(65%)
Total Reintroduced	81	
Total Currently in Wild from Reintroduction	53	(15 groups
Total Fazendas Participating:	12	
Fazendas Currently with Tamarins:	7	

Since June:

We lost five captive-born reintroduced tamarins. 04 ("Opie") was missing on 29 July. His radiocollar with traces of his hair was found on the ground. He had been reintroduced in 1987, and was the only zoo-born tamarin to have mated with a wild GLT. He sired twins born on 9 January 1990. Since 04 was the only group member wearing a radiocollar, we have lost track of his wild mate and the twins as well.

The three-member Lincoln group was not found in their territory on 29 July. The adult male L2, reintroduced in 1987, was found dead over 2 km from the nest box; the group had never before been observed to travel so far. His mate CL1 and his son L4 simply disappeared.

LA2 ("Marino"), reintroduced in 1989, disappeared on 22 August. He had never travelled very far, was poor at locomoting on natural vegetation, and had found little natural food. He had twice been rescued, debilitated and hungry, by field observers. He seemed fine when observed and fed the previous day.

Our spirits were buoyed by the recovery of four reintroduced tamarins that had previously disappeared and were thought to have been stolen. They were confiscated by Brazilian authorities and returned to our project. W3, an adult male, and his son J7, both of the Jersey group that disappeared in February 1990, have been re-released with LA2's former mate. They promptly had a territorial encounter with the Frankfurt group, which lives 3/4 km away. The two groups seem now to have settled in to separate territories. "Niko" and his mate N1, who disappeared in December 1989 were re-released in July. The recovery of this pair is especially significant since they are featured in an upcoming TV documentary (see below).

Andreia Martins, our Field Coordinator, reports that several reintroduced females appear to be pregnant. The birth season is imminent; we'll report in the next update.

The value of the US dollar has fallen by about 40% in 1990, and there has been severe inflation in prices and wages within Brazil. Thus, not only can we buy fewer cruzeiros with each dollar, but the cruzeiros buy less gasoline and fewer observer hours. Our observers have lost about 70% of their buying power and are forced to look for other jobs. Since all of our funding is in dollars, the entire project is in serious financial straits. The Wildlife Preservation Trust International has provided a grant for $15,000 for the 1990 reintroduction, which under ordinary circumstances would have covered about 80% of the direct costs of reintroduction for the year. Now, however, we need an additional $14,500 to cover the costs of the reintroduction alone. Since the new reintroductees would be totally dependent on our care for at least a year, we are reluctant to proceed with partial funding. Thus the 1990 reintroduction has been postponed. The Brookfield and Columbia groups, currently awaiting reintroduction while ranging free on National Zoo grounds, will remain outside as long as weather permits, and then will be brought inside. If we can't raise additional funds by the end of October, we will have to begin to lay off some of the reintroduction observers in order to make available funds stretch through the year.

Be sure to watch "The Keepers of Eden", to be aired nationally on PBS channels in the first week of October. Part of the acclaimed "Infinite Voyage" series, the show is a compelling and beautiful presentation of the role of zoos in conservation. The staff of the Golden Lion Tamarin Conservation Project is proud to have been included.

RE-INTRODUCTION OR TRANSLOCATION GUIDELINES

Do the appropriate conditions exist to recommend (or argue against) reintroduction of captive-born animals or translocations of wild individuals or groups?

The following chart lists 10 necessary conditions which should be met in order to recommend a reintroduction/ translocation program. Additionally, it evaluates the position of each form of lion tamarin, with respect to each criterion. Finally, a general recommendation is presented concerning whether a program of reintroduction/ translocation is warranted for each form at this time, based on the weighting of the different criteria.

1. It makes little sense to reintroduce captive-born animals or transplant wild animals if the reasons for the species' decline has not been eliminated. We suggest that this condition has not been met for chrysopygus and chrysomelas, thus dictating against a reintroduction at this time. It is questionable whether or not the reasons for the decline of rosalia are now under control.

2. A reintroduction is not warranted if there is insufficient protected habitat. We estimate that there is sufficient protected habitat available for chrysopygus, but not for chrysomelas. It is questionable whether sufficient habitat exists to warrant a reintroduction program for rosalia.

3. A reintroduction or translocation into saturated habitat is not recommended since it may cause social disruption of the native population or introduce disease. Therefore, we need to know that there are available areas with small or no populations that can accept additional animals. This condition exists for rosalia. There may be also available unsaturated habitat for chrysomelas, but with less certainty. However, there are many confiscated chrysomelas that cannot be absorbed easily into the captive population; translocation/ reintroduction may be a viable option for this subset of wildborn animals. Current conditions argue against the reintroduction of other chrysomelas. The situation for chrysopygus is not known.

4. Reintroduction should be encouraged only when there is some certainty that the release of animals from different regions (both captive and wildborn) will not jeopardize the existing native population through the transmission of disease or social disruption. We do not have this confidence for any of the three forms of lion tamarins at this time.

5. In order to evaluate the available habitat and potential success of a program of reintroduction/ translocation, one must have information about the behavioral ecology/ biology of the wild population. On a scale of 1-5, with 5 being the best case scenario, we suggest that there is sufficient information available for rosalia, totally insufficient information available for chrysomelas, with chrysopygus somewhere in the middle.

6. A conservation education program will inform the local populace and result in support for a reintroduction/ translocation effort. Both rosalia and chrysopygus conservation programs have strong educational components. The education program for chrysomelas is just developing.

7. The reintroduction of animals currently in captivity (whether captive or wild born) is inappropriate unless the captive population is secure, there is available a long-term Masterplan, and there are animals surplus to the needs of the captive population. This condition is met in rosalia, but not chrysomelas and chrysopygus. An exception are the wild born confiscated specimens of chrysomelas in captivity in Una that cannot be easily absorbed into the captive population.

8. Reintroduction/ translocations are not recommended unless there is sufficient background information or knowledge about the methods and techniques of preparation, adaptation, and release that such an effort has some likelihood of success. We currently have considerable information about these issues, however there remain many unanswered questions about the techniques that will ensure success, e.g. for the injection of single animals into established reproductive groups.

9. There is little point in the release of animals into the wild, without the resources necessary to monitor the activities and survivorship of those animals, especially since we have not yet perfected our techniques for reintroduction/ translocation. The conservation programs for chrysomelas and chrysopygus are not yet sufficiently advanced and developed, with respect to financial support and a necessary semi-permanent infrastructure, to warrant a reintroduction/ translocation effort. The rosalia program has a large well-developed infrastructure and considerable resources.

10. A reintroduction/ translocation is unnecessary unless the wild population needs augmentation in numbers or genetic diversity, and the translocation/ reintroduction will fulfill that need. This condition is met for rosalia, and not met for chrysomelas or for chrysopygus at this time.

RECOMMENDATIONS

Weighing the degree to which the necessary conditions are met for each species suggests that reintroduction/ translocation efforts are appropriate for rosalia, but not for chrysomelas or chrysopygus at this time, taking into consideration the exceptions pointed out in items 3 & 7.

Criteria for Translocation/ Reintroduction of Lion Tamarins:

[Do the necessary conditions exist? (scale 5 = best)]

	GLT	GHLT	BLT
1. The reasons for the reduction in species numbers have been eliminated (e.g. hunting; deforestation,commerce)	?	no	no
2. Sufficient habitat is protected and secure	yes	no	yes
3. Available habitat exists with low densities or without native animals	yes	yes(?)	?
4. Certainty that the release of animals will not prejudice the existing wild population	no	no	no
5. Sufficient information exists about the species' biology in the wild (e.g. demog; reprod; diet) to evaluate the program's success	5	1.5	3
6. Conservation education program	5	2	4
7. The population in captivity is secure, well-managed, and with surplus animals	yes	no	no
8. Knowledge of the methods and techniques of reintroduction and transplantation	----------3--------		
9. Resources and mechanisms to monitor the results	yes	no	no
10. The need to augment the size or genetic diversity of the wild population	yes	no	no
IS REINTRODUCTION/TRANSLOCATION RECOMMENDED?	YES	NO	NO

LEONTOPITHECUS

POPULATION VIABILITY ANALYSIS

WORKSHOP REPORT

ENVIRONMENTAL EDUCATION

Environmental Education and the Lion Tamarins

Suzana Padua, Lou Ann Dietz, Elizabeth Nagagata, Cristina Alves

Based on the studies developed in the workshop and the results of the various simulations run (see: Population Extinction Model), it is clear that the survival of the lion tamarins will depend on efforts and action in broad areas. Environmental Education is an essential tool to make people aware of the problems, the importance of conservation and provide them with ways in which they can contribute to the conservation of wildlife. In practical terms, education can contribute in many ways: in slowing deforestation; in the conservation of actual populations and the preservation of their habitats; in the protection of forests that might serve as possible reintroduction areas; facilitating the findings of new populations of lion tamarins, and the expansion of forested areas that might be needed in future reintroduction programs of new populations of these primates. Additionally, education can be effective in decreasing hunting occurrences, fires that threaten wildlife habitats, and traffic or smuggling of these animals that can achieve high prices in illegal national and foreign markets. Although the commerce of endangered species is prohibited, these primates are sought as pets to satisfy the whims of inscrupulous collectors.

The lion tamarins are charismatic species of primates from a human perspective. Environmental Education Programs have been successfully utilizing these primates as symbols for awareness and valuing of natural forests. Strategies have been applied to involve human populations which inhabit areas surrounding the primates' remaining habitat. Education Programs have provided knowledge increase and emphasize the uniqueness of these species. These primates are subjects of pride and landmarks for their localities. Consequently, the concept of forest preservation is introduced, since it is essential for the tamarins conservation. Entire ecosystems have been preserved with the idea of having a species as a main symbol for education (Farmers and ranchers in the golden lion tamarin region, Rio de Janeiro, have agreed to preserve their forests in order to receive reintroduced tamarins).

Due to the fast deforestation rates, all community members should be reached. Education programs have been used to reinforce the involvement of local communities and the general awareness to the importance of conservation. The golden lion tamarin, the black lion tamarin and more recently, the golden headed lion tamarin have had effective education programs among surrounding populations. Each of these programs have applied strategies to increase its effectiveness. Here are some of these strategies, described as recommendations, even if already in use. These might vary according to the regional context and imput of the education team:

- each human population should be seen as unique and appropriate materials should be designed and tested specifically for them - instruments should not be imposed but rather shared;
- reserves and parks employees should be seen as important participants of the tamarin conservation plans. Their input is essential for the development and establishment of 'in loco' Environmental Education Programs;
- teachers and students are effective target populations to reach the community as a whole. They should be addressed at their schools with whichever materials can be available. Schools have provided effective teacher training programs that have a multiplying effect to reach more people.;
- extension programs for students can be organized such as poetry, composition or drawing contests, visits to natural areas when possible. Students must have the experience to know the natural environment to conserve it. Presentation and discussion of videos or films about Nature, and other related activities can be organized according to the needs of the populations and the creativity of the educator;
- families can be reached through students, but special events should be designed for them (slide presentations, typical food or music contests, art and artifacts exhibits, plays, etc.);
- neighboring farmers must be visited promptly . Those who still have native forests should be invited to participate in the "emergency plan" for saving the tamarins, and those who have not, should be shown the benefits of planting local species. Educations Programs must understand farmer's needs and emphasize how conservation will relate to their needs. Landowners should be shown tax deduction benefits for keeping or growing forests;
- community leaders should be contacted and invited to contribute to the global plans for conservation;
- local politicians should be lead to see the advantages of participating in the preservation of protected areas or species. Once local people are aware, politicians will automatically become interested in issues that bring them popularity. However, the Program should not be involved or partial to any political party or individual;
- media must be furnished with information about the species and the region and any conservation activity that might spread the word of the local natural values;
- evalution methods should be planned for each education effort to continualy monitor progress and more efficiently use scores resources;
- national and international conservation groups, especially the corresponding international committees for the preservation of each

lion tamarin should be notified and consulted in any circumstance that might threaten the species or its habitat.

Through an effective Environmental Education Program the local populations can become potential defenders of the natural habitats. A continuous educational program can promote knowledge increase, the appreciation of the natural world, and the understanding of ecological concepts. This will serve as the basis of conservation among the different human communities. With the lion tamarins, the main goal is the the protection of the species itselves, through the preservation of the remaining forests that might serve as their haitats and the creation of new habitats that will enhance the increase of a viable number of individuals.

LEONTOPITHECUS

POPULATION VIABILITY ANALYSIS

WORKSHOP REPORT

DOCUMENTS FROM WORKSHOP

PROGRAMME FOR LEONTOPITHECUS CONSERVATION WORKSHOP

(GLT = L. rosalia; GHLT = L. chrysomelas; BLT = L. chrysopygus)

Co-Chairman
Celso Schenkel (Director of Ecosystems, Ibama)
Jeremy J. C. Mallinson (Zoological Director, JWPT)

Organizing Committee
Anthony B. Rylands (Federal University of Minas Gerais)
Claudio V. Padua (University of Florida, Gainesville)
Devra G. Kleiman (National Zoological Park, Washington, D. C.)
Gustavo A. B. da Fonseca (UFMG & Fundacao Biodiversitas)
Ilmar B. Santos (UFMG & Fundacao Biodiversitas)
Ulysses S. Seal (IUCN/SSC-CBSG)

DRAFT PROGRAMME

Tuesday, June 19

Arrival of participants

Wednesday, June 20

Morning

Introductions and opening remarks
Celso Schenkel, Jeremy J.C. Mallinson, Ulysses S. Seal.

Defining problems and goals

Population biology overview
Ulysses S. Seal, Georgina Mace, Jonathan Ballou.

Afternoon

Biology, status and management of wild populations

GLT: Dionizio Pessamilio; James Dietz; Andrew Baker, Carlos Peres; Laurenz Pinder
GHLT: Saturnino Neto de Sousa, Anthony Rylands, Ilmar B. Santos
BLT: A. Max, H. Faria, Cory C. T. Carvalho, Claudio V. Padua, Alexine Keuroghlian.

Biology, status and management of captive populations

GLT: Devra Kleiman, Jonathan Ballou, Jeffery French
GHLT: Jeremy J. C. Mallinson, Adelmar F. Coimbra-Filho, Georgina Mace
BLT: Faical Simon, Adelmar F. Coimbra-Filho, Claudio V. Padua

Reintroduction

GLT: Benjamin Beck, Devra Kleiman

Compilation of data for modeling.

Discussion of research and management strategies.

Draft assignments for preparation of conservation strategy report.

Evening

Working groups draft recommendations, protocols.

Thursday, June 21:

Morning

Distribution of draft minutes from Wednesday.

Presentation of results from initial model simulation; discussion of results; fine-tuning the model.

Afternoon

Veterinary considerations
Alcides Pissinatti, Richard Montali

Conservation education
GLT: Lou Ann Dietz, Denise Rambaldi
GHLT: Maria Cristina Alves
BLT: Suzana Padua

Working groups prepare draft documents, protocols.

Presentation of draft documents, protocols.

Evening

Working groups continue work on documents.

Friday, June 22

Morning

Distribution of draft minutes of Friday.

Review of draft documents, protocols.

Identification of conservation priorities and schedule of actions.

Afternoon

Final review of documents

Prepare written Concensus Agreement approved by all workshop participants.

Distribute final copies of documents.

Saturday, June 23

Morning

Joint meeting of the International Recovery and Management Committees GLT, GHLT, BLT with representatives from Ibama.

Afternoon

Elaboration and approval of Ibama edict for the three committees and membership changes.

Leontopithecus PVA Workshop

Minutes

20/6/90

Biology of Lion Tamarins in the field.

A. *Leontopithecus caissara*

1. V. Persson (Curitiba Natural History Museum).

Callitrichids reported in north of Parana 1850s. Last few years, reports of small monkeys on island. *Leontopithecus caissara*: local population of people very helpful; caissara = name of local people. Different from other species; tail hands feet all different colour to other species. Larger than others; approximately 39 % larger than GLT. Intermediate size between GLT and BLT. Diagram presented comparing body measurements with other species. Distribution: Parana coastline; Island of Superagui only, Baia of Paranagua; Island = 14000 ha; animal not present over whole island; National Park; 10000 ha of island (4000 ha not on park). Animals found in area NOT in National Park; animals found close to seashore, in edges and outside the park;
approximately200 observations of the animals in and out of the park. Animals seen on forest edge, near coast, near degraded areas (grazing). Animals may be affected by tourist activities planned for the region (resort)

Q. Faiçal Simon: are all animals seen similar to skin presented;

A: Seven animals seen, all the same.

Q. FS: graph refers to one only; or more specimens measured?

A. One only

2. Dante M. Teixeira

Action plan prepared at National Museum; will distribute at the meeting; IBAMA will have crucial role in protection of the animals from hunters; word has spread amongst local people of the discovery.

3. Miguel Von Beher, IBAMA representative in region. Need to protect habitat in the region, even though the number of parks in the region is high (including park on the island).

Celio: Suggest immediately put proposal - emergency request - to IBAMA; priority action required.

Answer: Include this species in Brazil Governments list of species endangered. Working Group formed immediately

B. Black Lion Tamarin.

1. Francisco Serio, Instituto Forestal da São Paulo

Morro do Diabo national park contract with power company; compensation for flooding by dam, national park

agreement reached 1989; some money left over another agreement with state government of São Paulo; institution of an environment education programme, also a research centre; proposal is with governor; soliciting support.

2. H Faria

Forest engineer, hired in 1986 to work on BLT park programme

now director (for last 2 months) of Morro do Diabo park 5 programmes - education, habitat restoration, research. To date most research carried out on BLT; intention to implement project to recover degraded areas; proposal submitted to government of São Paulo.

3. J Max

Director of ecological systems, São Paulo state. BLT in the area: Caitetus: Caitetus - 2078 hectares, originally part of a farm, suggested for a hunting area, coffee trees, farming; state reservation = ecological station; research; cash and resource shortage; one ranger only; hunting problems (serious); trying to involve more people (locals); much degradation by local people and forest fires; help got from neighbours and farmers; perhaps greater resources with signature of agreement.

4. Claudio Padua

BLT's in Morro do Diabo, work started in 1983; initial plan: inventory, then genetics, then demography of captive population; now working in ecology and behaviour; captive breeding at Rio primate centre; preliminary data on behavior of BLT; eventually reintroduction of animals, probably not to Morro do Diabo

34000 ha wood 'island'; badly degraded area over last 20 years; very moist habitat in South, close to the river, through to dry vegetation in North; groups studied in 2 extreme habitats and 2 intermediate habitats; looking for ecological adaptations;

15 groups located in Morro do Diabo; close to where Coimbra got his first animals in 1973; there are Tamarins there now.

BLT's don't need running water to survive; 20000 ha available for BLT's, each study group occupies 200 average ha

--- 100 groups, 4.5/group = 450 animals. Predation - not observed; killed by porcupines, natural causes; birds of prey; snake - disregarded by BLT's.

Dispersal: Group1 followed for a year, plus another, adjacent group: males exchanged between groups, plus a baby; this year, alpha male was run out of group1 by 2 other males; he was found dead later; Group1 : helper moved out of the group, wandering round, fighting, always expelled by the 2 invaders; another group, 2 animals disappeared and invaded another group; yet another group, male and young female ejected the alpha male; he subsequently died.

** Can't decide yet if monogamous; more study needed;

In August, will carry out another deep survey of area, looking for further groups of BLT's. If other groups found, may form reserve etc; also look for locations for reintroductions. Also, a brown morph born at Rio primate centre;

Summary - Morro do Diabo particularly well protected; well managed; except garbage recently dumped at airport near park - when told, authorities stopped; perhaps trains will run again through park on disused tracks emphasis in next few years on repair of degradation and reintroductions.

Q. Faiçal Simon: pity not possible do necropsy on dead animals; might give us information on causes of death, including predation; he has some information on post mortems he has done on BLT's.

A. Ulie: we need to re-apprise taxonomic status of all lion tamarins

5. Alexine Keuroghlian

6 months at Caitetus: wanted to do census: failed in 6 months got only 2 months worth data. Time budgets, activity, time budget of food resources, diet variation, frequency of use of sleeping sites; home ranges (no data). Rest, travelling and foraging show significant difference between Nov and Dec. Rest value low - cf GLT and other callitrichids: fruits = 90%, range = 2289 m, travel furthest 2 hours before and 2 hrs after activity bouts.

Jon Ballou:

Q to Alexine: ? encounters?. A. no encounters seen

Q to Claudio: lots of encounters at end of year (at time of Alexine's study)

Q to Alexine; what area of reserve not censused?

Claudio: 2000 ha reserve, 200 ha HR/group, means max 10 groups in reserve,;

Jon B: Minimum of 2 groups in Caitetus reserve (one seen, one suspected); max 10 would fit, agreed correct.

Christina: Una surveyed 200 ha over 24 days; no GHLT's found; therefore, must beware of assuming that there might be 10 groups at Caitetus.

Claudio: In 24 days, could have missed the animals completely.

Alexine: Agreed with Christina - 10 groups too generous.

Cecilia: Are there areas outside Morro do Diabo with BLT's??

Claudio: Yes, he thinks so; wait for 13 areas to be surveyed.

Jon: ? Isolation of the reserves from other possible BLT habitat.

Claudio: Both reserves completely isolated.

C. BHLT

1. Anthony Rylands

Map of distribution of GHLT with vegetation shown - available. Dispersal common via truck drivers, who dump the animals at the roadside. coca plantations: historically, this maintained pockets of forest habitat, which the GHLT's could exploit; there is much forest degradation in the area; rate of forest destruction has decreased in the last few years, but still goes on; most populations of GHLT's occur in isolated forest pockets.

Ilmar: There are some areas on the map where there are gaps in the data, not necessarily no animals.

Densities of GHLT (sympatric with *C kuhli*)

4.63 - 16.67 ind/sq km (*kuhli* 50 - 68)

0.33 - 3.03 groups/sq km (*kuhli* ? -?)

Group size GHLT (ditto)

6.67 (N=3) (*kuhli* 6.56, N=8)

Feeding (cf *kuhli*)

GHLT eat fruit, flowers, not exudates;

kuhli eat less fruits and flowers, more exudates

GHLT - first 2 spp contribute 58-63 %; *kuhli* 48-50%

Range:

GHLt 36 - 40 ha (*kuhli* - approximately 10 ha)

Day range:

GHLT 1410 - 2175 m (*kuhli* 827 - 1196 m)

Range use

GHLT: more even, no core (*kuhli* less even, core)

+Food source distribution

GHLT: no correlation; *kuhli*: correlation

Range overlap

GHLT 7%; *kuhli* 50%

Sleeping sites

GHLT: holes in tree trunks, few; *kuhli*: dense vegetation, many

Two Q's:

The variety of habitats where these animals live is vary large; animals are not so isolated as we thought before; they use secondary forest very effectively.

1. Can we compare and contrast these species (*Leontopithecus* cf *Callithrix*); all are rare; naturally more so than *Callithrix*;
2. Why can't lion tamarins adapt themselves to permanent residence in secondary forest, although they can use it

2. GHLTs in the field - Saturnino
Una reserve.

Created to preserve GHLTs; area selected by government, advised by Coimbra, in 1976; Forestry dept suggested area 11 K ha; government purchased 5342 ha between 1976 and 1982 - reserve became badly degraded; last four years - attempts to increase area; 80 families compensated to get them out; farmers not allowed to expand; 243 ha purchased 1989 - corridor joining two halves of the reserve (Fundação Biodiversitas, WWF-US, and JWPT). Slides: much regeneration of forest following departure of farmers, fire. Saturnino begged Celso Schenkell to create by-laws and legislation for the managers of reservations.

Schenkell response to Saturnino: IBAMA will now go to federal government (after consultation with government departments and NGO's) to ensure the better legal status of preserves.

Christina: no study of GHLT since Anthony's; plea for more work.

Schenkell: Una reserve; federal law allowed some owners to take back some of their land, and to chop trees, etc; some of this is occurring on IBAMA land; decision now reversed; can we (the meeting) write a letter to state governor, congratulating him on his decision to reverse the previous law.

<u>Jon Ballou's Q's on GHLTs</u>
Where is Una reserve on the map?

12 = CAN
11 = Una
17 = Lemos Maia

CAN - Possibility of this becoming an IBAMA reserve?

Saturnino answered, see GHLT working group report

Celio: Possibility that federal government will SELL this area - this shouldn't be allowed; important that this area be TRANSFERRED to IBAMA, not bought; important that this message be passed to IBAMA

Ulie: Lets do all this tomorrow as Part of the modelling exercise.

Manoel (IBAMA): Possibility of a road being built across this area.

Q. ? Are there estimates for population sizes in any of the protected areas?

Christina: No; no estimates have been made; extrapolations from other guesses and from other areas;

Anthony: No.

Saturnino: Officially 6500 ha protected area, plus 3000 other ha (not including the CEPLAC area). Much of the CEPLAC area devastated by farming experiments.

Christina: has a list of farms and areas that have GHLTs on them; many are private areas, and some are large (eg 2500 ha); must ensure that these private areas remain and support be given to their owners. Christina will provide the list.

<u>Captive populations of BLT's and GHLT's</u>

A. BLT's in captivity

1. Faiçal Simon

At Rio CPRJ and Zoo, São Paulo CPRJ: started with 7 founders only.

Coimbra: No negative effect of inbreeding

Faiçal: Total number passing through captivity (alive and dead) = 146. 118 in Rio, 28 at São Paulo. Living: 53 living animals (Dec 1 1989) at CBRJ, 19 at São Paulo. Today, Rio: 20.17.?16; 2 of the males are founders, all rest born in captivity; 3 of the females are founders, of which 1 is no longer reproductive (17 years old). São Paulo 10.6 - of males, 4 founders; of the 6 females, 5 founders.; presently of 12 births at São Paulo, 7 living; of the 5 dead, 2 were abortions, 2 more were premature births; therefore of the 8 good births, 7 are alive; the dead one died at the age of 2.

Post mortem carried out on dead animals always; commonly, dental problems seem to be very important; hypoglycaemia may be important; not diabetes, poor nutrition (before they arrived in São Paulo).

Suggestion that there be an increase the captive population; Faiçal feels that the São Paulo zoo is the target for unfair criticism with regard to breeding of BLTs.

2. Pissinati - Rio Primate Centre

Presented a table showing data from 1972 to 1990 on all three species lots of data on abortions, still births etc, but this was core data:

	No. births	No. babies
GLT	59	107
GHLT	63	112
BLT	62	107

Second table on sexual dimorphism

Third table on survivorship

	% survivorship to 1 year
GLT	59
GHLT	43
BLT	59

Saturnino: ?Births 8 days apart;

Pissinati: Never seen; prolonged labour has been observed, but he hasn't seen such a thing;

Simon: Has seen 2 births from same gestation 8 days apart.

Pissinati: Talked about dietary effect, etc: to be considered more fully tomorrow. There are 140 animals at CPRJ (27:40:??-GLT:GHLT:BLT); not enough space (the numbers here don't add up) in particular, too many GHLT's; this leads to disease and diet problems; believes that this may have led to problems with depressed reproduction

Q. If CPRJ is too crowded, why not break them up?

Pissinati: For the committees to decide Saturday.

Faiçal: Trying to dispose of animals to Brasilian zoos; requirement that such zoos prove that they are fit to look after the animals; note also that everything in Brasil changes every five years; president, governors, mayor etc etc; zoos are not seen to be important. eg the other zoo in São Paulo; want to build place for Lion Tamarins; plans have been shelved.

Claudio: Graphs of survivorship and fertility of GLT's cf BLT's data to 1988; date of last studbook CP with Jon Ballou;

Note - survivorship curves for the two species essentially identical. Fertility curves less similar, but due primarily to a particular individual's contribution; graph of BLT population growth (wild caught and captive born). Age structure table on overhead; at end 1987: 17.13. Lambda = 1.21 (1984, lambda = 1.1)

Problem: population concentrated in two colonies only; subdivision needed soon. Problem: age at first reproduction approximately 41/42 months (cf GHLT 18-20 months).

Pissinati: Better husbandry is the solution.

Claudio's last suggestion: embryo transfer from BLT into surrogate GHLT mothers.

Leontopithecus workshop, 21 June 1990, morning session

A. GHLT: captive data

1. Jeremy Mallinson

Summary of work of international GHLT committee provided in the briefing pack, in English and Portuguese.

2. Jo Gipps

Speaking for Georgina Mace, of Institute of Zoology, London Zoo, GHLT studbook keeper.

** a. Captive population at 31 Aug 1989
** b. Captive pop, 1978 - 1990
** c. Captive population growth, world and USA, 1978 - 1990
** d. Age distribution, 31 Aug 1989
** e. Founder analysis, 31 Aug 1989
** f. Founder contribution
** g. Demographic statistics, 1985 - 1989

** Reproduction of figures and tables from August 89 studbook or Ballou AAZPA paper (briefing document).

** Graph presented of survivorship comparison of the three species;
** Ulie spoke, Jon, Devra, Jeremy, Adelmar;

NB subsequent information showed the figure for survivorship of GHLTs to be spurious: infant mortality wasn't high enough.

<u>B.</u> <u>Golden Lion Tamarin - captive population management.</u>

1. Jon Ballou

Aim to establish a stable population, and to maintain, as a minimum, at least 90% genetic heterozygosity for 200 years.

Studbook/pedigree maintained; 2200 animals; all usual studbook details.

Calculate demographic statistics; computer analysis to aid management

** Graph of population growth presented; phases - research, exponential, stabilisation phase (need to leave room for other endangered species)

** Graph of survivorship curves presented (3 periods)

Now 560 animals in 160 zoos

** Table of genetic summary presented 46 founders, 14.7 Fge, 14 living founders, observed heterozygosity 97.6%, expected heterozygosity 96.6.

Aim to stabilise population at 500 - 600 animals; contraceptive implants used.

Devra: founders may not be founders.

Jon: assume that all wild caught animals are unrelated; likely not true, ie founders may be related to each other; 'Fge' may be even lower than presented. If family groups brought into captivity, allowance made for this.

Ulie: new genetic technologies (DNA fingerprinting etc) may enable us to sort this out at some future date.

2. Jeff French

1983 - research colony at U of Nebraska - over-represented animals.

Endocrinological research: Ovulation cycles; reproductive maturation, males and females; intra-family aggression, urinary oestrogen, graph presented of Urinary. Oestrogen over 48 days; average cycle length 19.8 days (14 - 28).

Graph presented of cycle of one female through 3 non-conception cycles, followed by a pregnancy. Gestation 120 - 125 days. Assay developed for luteinising hormone. Graph of Oestrogen and LH secretion in one female presented. LH peak at initiation of long oestrogen cycle.

b. Reproductive suppression

. Investigated reproductive (endocrine) status of non reproductive females in the presence of their parents; surprising that urinary oestrogen cycles not different to that of adult (breeding) females;

. Graph of 1-yr, 2-yr and adult female (in a group) presented; no female less than 16 months has shown ovulatory cycle

. Graph presented of testosterone levels in subadults and adult males in same group - no differences.

c. Intra-family aggression

. Family aggression mostly initiated by adult and juvenile females, not by adult males; juveniles (males and females) were most frequently the recipients; juvenile males attack juvenile males; adult females attack juvenile females (daughters); 5/46 attacks on juvenile males resulted in death; 12/37 attacks on juvenile females resulted in death.

C. Golden Lion Tamarin: management of the wild population

1. Dionisio Pesamilio

a. Poço das Antas:

. 40 % degraded habitat; speculation (building) going on; only protected area for GLT;

. Island surrounded by forest predation (tree fellers ??)

. Railway line through reserve; station closed (used to bring in hunters).

. Dam in reserve led to river drainage, leading to 200 ha of dead vegetation (used to hold GLTs); downstream from dam, wet area now dry (?1000 ha); hence many forest fires since dam was built; fires very difficult to put out; often have to wait for rain to put fires out; application to WWF and Japanese Government for radio and fire fighting equipment.

. Not enough staff to prevent hunting, nor enough resources

. Need also to build in situ captive breeding facility in reserve

b. Research

. 1983 - agreement between IBAMA and NZP

. Ecological study of GLTs in natural environment; translocation of animals from deforested areas; environmental education; habitat reforestation

. Reforestation needed very urgently, carrying capacity of reserve already reached

Coimbra: Agree with urgent need to enlarge the reserve (5500 ha; 30 % only adequate for GLTs); suggest that daily food supply is perhaps the limiting factor (including fruit diversity and invertebrates); need to preserve particular food species; reforestation needed with native species in the long term; suggest that Eucalyptus be planted in the short term to provide nest sites etc;

. Present situation: many small islands of forest

. Suggestion: 1000000 seedlings of Eucalyptus, to provide adequate forest cover quickly (5 years); Eucalypti will provide support for native trees, brought in naturally (birds etc); natural regeneration will occur; may have to import epiphytes etc

Ulie: Suggestion that Restoration Ecology as a discipline will have to be addressed in the future for all three species; this probably not, though, the time for a major discussion on this topic; another meeting, with the relevant experts.

Celso Schenkell: there is a general policy of the elimination of exotic tree species in national parks in Brasil; there are native species that show similar growth rates, and are therefore perhaps more suitable; also, Eucalyptus may require special husbandry methods to flourish (insecticides etc); basically IBAMA has reservations, including legal aspects.

2. Jim Dietz

. GLT research at Poço das Antas since 1983;

. GLT demographic data from the reserve

. K, N, lx, mx;

. Group size, territoriality etc; Group size is dynamic - daily changes; groups defend territories;

** overhead presented with data, including:

	No. GLT	No. Gp	ha
1984	20	4	200
1985	39	|	|
1986	56	|	|
1987	71	|	|
1988	83	|	|
1989	110	20	1000

** also, age distribution data on males, females and unknowns presented

** also, data presented on composition of groups with respect to breeding females

.reproduction: 1984-88 1.64 infants/group low rain, poor food
1989 1.84 high rain, good food
zoos 1.88 good conditions

. survival: emigrants 106
immigrants 32
ie 30% of tamarins left one group to join another

. Carrying capacity
Group home range average = 41.4 ha (6.7-116.8, SD 21.1)
approximately= 1 GLT/7ha. No correlation between group size and resource availability. Food resources do not regulate GLT group home range size. 2900 ha good GLT habitat, 1 GLT/10 ha of optimal habitat gives approximately300 GLTs. 2600 ha degraded habitat
5150 ha of nearby and adjacent forest - being cut down at an increasing rate. 429 GLTs in this 'adjacent' forest area.

Thus total currently is around 500, in and out of the reserve; future of this population will depend on the fate of the adjacent areas - will they become permanently available for GLTs?

3. Andrew Baker - GLTs at Poço das Antas

8 groups, studied between 1986 and 1989, each group observed 1 - 3 times per week

a. No of live offspring/female/yr

No	cases	%
0	6	19
1	2	6
2	16	52
3	2	6
4	5	17

Infant mortality.
60 infants observed, 8 died during nursing = 13.3%, survival 86.7%

Juvenile/subadult mortality:
20 individuals observed between infant and 2 yrs: 90% survival
this leads to approximately 80 % survival to 2 years old
(cf captivity: 55-60% survival to 2 years old)

Dispersal mortality:
5/15 dispersing males died: 66.7% survival, not enough data for females; think survival rate of dispersing females probably lower than for males.

Adult mortality:
Males: 6 deaths in 42.6 years of observation: 14% annual mortality. Females: 4 deaths observed in 27.2 years of observed: 15% annual mortality.

Social organisation
Approximately 40% of groups have more than one male; probably only one reproduces.

?How many GLTs in the population are reproducing??
45 groups: 45 males breeding
<u>48</u> females reproducing
94 GLTs reproducing = effective population size

Although there about 290 GLTs in the reserve, the effective population size is probably approximately 1/3 of this.

4. Cecilia Kierulff, UFMG

. Studying GLTs outside Poço das Antas reserve
. Interviews with farmers etc to get information on sightings
. Travels throughout previous (historical) range of GLTs
. Mostly north of Rio
. Started in area nearest reserve
. Much degraded habitat; a few small groups of GLTs in forest islands
. The forest islands are some protected areas on private land, but many of them are relict areas with no protection
. Much hunting goes on in this area;
. GLTs invade banana plantations, and get used to people; the hunters provide food, and can sometimes catch them with bare hands
. There are some natural corridors between the reserve and some of the forest islands
. A possible total of 8 groups in this area (some seen, some heard, some seen by other people

. By the end of this survey work, hope to be able to pinpoint some more suitable areas for preservation of GLTs
. Plea to IBAMA - please persuade farmers to stop cutting down the forest islands

Ibsen: there's a naval area near the town of ??; there has been a suggestion that this be created as a reserve; there is some sympathy to this idea from the naval authorities; suggestion that a resolution from this workshop would help persuade them

Lou-Ann: farmers are afraid to commit their patches of forest, because of future (?planned) agrarian reforms; they are afraid to lose the land.

Christina: there's a law in Bahia concerning some aspect of land use (20% of any farm must be non-productive)

Selso: law to be voted at the end of year; IBAMA will work to convince the federal government that forest land should NOT be regarded as unproductive. Also IBAMA will propose that the private reserve areas be given special consideration with respect to tax etc

Devra: the use of playbacks of Tamarin long calls could be a very effective census technique.

Christina: use a whistle!

Ballou presentation:

Life History Age structure Inbreeding depression Environmental variation Catastrophes Carrying capacity Harvest/Supplement	POPULATION	Population projections Prob of extinct ??????

Data sources: Poço das Antas biological research - JD and AB
- . Neonatal mortality: 61 infants - 13%
- . Mortality between infancy and adulthood: 35 animals = ?? %

Population characteristics : annual growth 9%, generation length 6 years.

Catastrophe models; note: catastrophe leads to very small population, which increases the probability of the population going extinct because of inbreeding depression.

Data on BLT population modelling at Caitetus

- reproduce at 3 yrs
- 1 litter/year: 25% = 0 babies
  25% = 1

50% = 2

- survival: no sex differences
  47% survive to age 3
  19% annual adult mortality

- inbreeding depress and environmental variation: same as GLT

- mean group size BLT = 4.5 (GLT =- 5.3; GHLT = 6.6)

** graph presented of extinction probabilities
2 groups: very high probability of extinction
10 groups: 50% probability of extinction after 25 years;

100% probability of extinction after 40 yrs

<u>A. NEW SPECIES - IBSEN CAMARA</u>

1. Protected areas:
   . Enlarge Superagui National Park; animals found in "protected" area,
   . Possible development in the area; also buffalo farming
   . Main threat = illegal capture of the new species; for sale
   . Total number of individuals unknown
   . Census required immediately.
   . Intensify research

2. Protection
   . Include in Brasilian list of species
   . Information for IBAMA to enlarge protected areas
   . Review protection of surrounding areas
   . Environment education for local people
   . Eventually, captive breeding programme

<u>B. Black Lion Tamarins - Claudio Padua</u>

Protected areas
Morro do Diabo (20% degraded)
Caitetus
Total protected area = 37000 ha

Threats
railway through Morro do Diabo;
possibility of invasion
hunting in Caitetus

Other
2500 ha in Paranapatamba area; belong to construction co, Texas King ranch, other small farm

Population nothing known, Biology data very sparse. Environment much variation. Other: inventory, census, reintroduction etc

Captive: BLTs in 2 institutions only; action plan will be drafted urgently for captive management.

C. GOLDEN-HEADED LION TAMARINS - Anthony Rylands

All this information incorporated into GHLT interim report

POPULATION IN THE WILD
Data not fully collected/analysed

Protected areas:
** overhead map presented showing:
Una, Lemos Maia (CEPLAC), ESCAN (CEPLAC)
Una: 5000 ha, then 243 ha recently as corridor
corridor soon to Lemos Maia, 3km away
possible ESCAN transfer from CEPLAC to IBAMA
later, private areas could become reserves

No of animals protected:
Una: 5580 ha; 500 v good forest
LM 500 ha, 100 ha good habitat

Carrying capacity:
Una: if full, 971.93 animals at Una (6.5/ha)
if half full, 465 BHLT
Escan: if totally isolated, at most 10 groups, = 78 tamarins
LM: 20 individuals in 3 groups

Future:
Una: purchase more land to make it more circular; land already part of the government decree
LM: purchase corridor between Una and LM
ESCAN to hold more animals, need more land

D. GOLDEN LION TAMARINS - Devra Kleiman

All this information passed to GLT working group

GLTs in the wild

Habitat

Aim to have enough to hold 2000 by the year 2025

Poço das Antas -

Other areas around have been identified as suitable, and some have had animals reintroduced; mostly not formally protected; if protected, might add 2000 ha; most would only hold 1 or 2 groups

4 other areas, totalling 5150 ha

**	naval base	1000 ha	
**			2000 ha
**			
**			

Note - no possibility of migration between these areas;
10600 potentially available ha for GLTs, which would contain 800 animals.

2000 animals by 2025 would need 26400 ha; ie need to find 16K ha in the next 35 years

Carrying Capacity:

Poço das Antas 420 animals

Threats to wild population:

disease at Poço das Antas - lose 50% - perhaps 1% prob in 100 yrs

railway - possible catastrophe - i=unlikely

fire - reduces K at Poço das Antas by 30%/year; without fire, could increase population by 2 animals/year, to carrying capacity of 420.

Effective population size at Poço das Antas = 73, out of total of 230

GLTs in captivity:

46 founders, but only 14.7 founder equivalents: captive population needs more founders.

Master plan document will be incorporated in proceedings of Workshop; contains many useful statistics, include recommendations for captive pop.

Re-introductions:

73 re-introductions to date, of which 28 survive

34 births to reintroductions, 21 survive

Also, there have been some translocations

52 surviving wild GLTs as result of re-introduction programme (note potential for max 400 in

Poço das Antas reserve)

Russ: fires are a real threat

Devra: fires affect regenerating forest most, so set back progress to full carrying capacity; agree that fire prevention is major aspect

<u>ULIE's SUMMING UP AT THE END OF DAY TWO</u>

. Mapping of protected and unprotected areas is very useful; this information will identify future problems and constraints.
. Depressing picture: looks like in many cases we are coming to the problem very late in the day, and we're faced with a 'rescue'.
. Make every attempt to come up with an estimate for Carrying Capacity.
. We shall probably have to use some of the GLT life-history characteristics, with estimates of extinction risks, to come up with estimate of extinction probabilities, using the models.
. Careful thought will have to be given to the role of the captive pops in the conservation of the four species over the next 35 years; it doesn't look as though phasing-out of the captive populations will be an option.

22 June 1990, First Morning Session

A. VETERINARY MATTERS

1. Diseases of captive Lion Tamarins - Dick Montali

. Many of diseases in captivity probably not relevant to wild
eg parasites and others from other captive primates
. Stress, nutrition, housing etc all v important
. ?Potential for carry-over of these diseases into the wild
. Clear implications for re-introductions

a) Infectious diseases

Viral: herpes (New world and simian); measles; encephalomyocarditis; callitrichid hepatitis (CH)
CH: 10 zoos in USA, 12 outbreaks in 10 years, 40 deaths; very mild symptoms, including lethargy; pm = jaundice, subcutaneous bleeding, etc; easily reproduced in C jacchus - virus not finally identified
Bacterial: Klebsiella, Streptococcus spp (equine), Yersinia pseudotuberculosis, Salmonella spp, Pasteurella multocida (wound sepsis, tooth abscesses).
Parasitic: Toxoplasmosis, Trichospirus leptostomes (pancreas), Prosthenorchis elegans, Pterygodermatites ? (P?)

P?: cockroach intermediate host; v heavy infection can build up in gut

b) Congenital and familial problems

Malformations of skull or diaphragm.

Diaphragm: first seen 1978 in 9.5 yr old female; 11/130 between 1978-80; 10/11 closely related; affected animals well over-represented in captive pop; breeding tests confirmed familial, over-represented hypothesis; 1975-80 11%; 1981-85 1.9%; 1986-89 0%.

Metabolic: cystine gallstones; hyperbilirubinemia

Implications for re-introductions, and prevention

Pterygodermatites: egg screen and test

CH: sero screen and quarantine

Diaphragm abnormality: herniagrams and selection

Cholelithiasis: effect of captive diet

Hyperbilirubinemia: further studies reqd

NB anyone finding a dead tamarin in the field should conduct a simple post mortem exam on the spot

2. Diseases of captive callitrichids - Pissinatti

Agreed with Montali concerning need for comparison of health problems in captive and wild animals; although different, there is need for transfer of veterinary information between field and captivity.

Rope tethering can lead to gut adhesion

Lead shot found in some animals

Fighting can lead to mutilations

Fur pulling also occurs; can spread to other group members

Wasting marmoset syndrome: an intermittent condition, long-term, anorexia, alopecia, anaemia, susceptibility to infection, difficult to treat; no clear pm symptoms (gross or histological), except minor gut changes

Analysis of gut flora: reduced diet in captivity leads to changed gut biochemistry, altered gut flora, leading to increased susceptibility to infection; there are marked differences in the gut flora between marmosets with and without Marmoset Wasting Syndrome.

Malformations also seen: two-headed, digit fusion

Buccal area pathology: cavities (particularly BLT, particularly in animals confiscated as ex-pets: presumably associated with captive diet); confiscated animals also often have cut-down teeth, leading to buccal infections, inability to feed properly; they also commonly have a form of tartar

Parturition problems much more common in GHLT compared with GLT and BLT; still births much more frequent.

Stomach overload syndrome can cause great stomach muscle distention, when the animal over-eats dramatically (eg a whole banana)

One animal died from snake (possible spider) bite

Birth problems sometimes occur, particularly breach birth

Commonest bacterial problem = Salmonella

Parasites: a wide variety, including cestodes, filarial worms, etc also, ectoparasites, including Cuteriba (bot-fly): BLTs only

B. CONSERVATION EDUCATION

1. GLT/Poço das Antas Environmental Education Programme - LouAnn Dietz

Programme was started by LD, now being run by five Brasilian trained kindergarten teachers. Funding from IBAMA, WWF, and others

Methods

Define the problem, identify public, constraints, select a set of methods, monitor effectiveness
Must involve the local community, at all levels

Objectives

Get agreement of scientists; reduce deforestation; reduce fires; reduce trade in GLTs; set up private reserves; increase local awareness

. Interviews with members of the local community, at all levels, before starting, in order to find out about local peoples' views on the reserve, and its animals; tried to find out best communication methods (TV, radio, newspapers).

. Local population knew very little about GLTs or about the existence of the reserve

. Aim to explain to the people about the need to conserve not only the GLTs, but also the forest ecosystem in which they are found.

. Since the reserve is closed to the public, had to explain why necessary to protect from disturbance

. TV used extensively; prints for notebooks; press releases; leaflets; slides/photos; bumper stickers; t-shirts,=; buttons; film shows

. Lectures to teachers, farmers, local people, biologists

. Established local group of supporters

. Field trips by school groups to the reserve

. Carnival parade featuring GLTs

Monitoring progress of the programme

Q. do you recognize GLT? - marked increase in 'yes' from adults in areas where the education programme was active, little increase in areas where not; similar increase in 'yes' from school students.

Q. What's the name of the animals in the picture? mostly MLD, some ML.

Q. Is the tamarin beneficial? Marked increase in 'yes' following programme, decreasing the number of 'don't know'

Q. How much do you know about Poço das Antas reserve? Increase in number saying 'something' and 'a lot'

Q. What do if find monkey in forest? Increase in number who said 'leave it', drop in number saying 'take home'

2. Education centre, Poço das Antas reserve

. Education centre attracts urban rather than rural people
. At the time of the fire, the education programme meant that many local volunteers (firemen, students, etc) came to help;
. Much publicity in local area, in Brasil, and around the world
. Much collaboration and helped generated by the emergency of the fire

Remainder of time taken for working groups, presentations of the reports and documents prepared, and additional simulations.

Formal meeting ended Friday evening.

Work on draft document continued through Saturday.

PATHOLOGY SPECIMENS FROM TAMARINS

NOTES FOR OBTAINING IN THE FIELD

Richard Montali, D.V.M.

I. Collection and preservation of specimens and observations:

(1) Equipment and supplies: Standard dissection kit with scalpel, forceps and scissors; small jars (baby food size) of 10% buffered formaldehyde solution (obtainable commercially); note pad and pencil; culturettes for obtaining bacterial cultures (commercially available).

(2) Procedure: If tamarin carcass is fresh and can be delivered to a necropsy lab within 24 hours refrigerated or on ice (DO NOT FREEZE IT), send it. If not, take pathological samples as follows:

A. Examine carcass for signs of trauma - bite wounds, injuries, ectoparasites, etc. Antemortem injuries should have hemorrhage associated with them; postmortem mutilation (by conspecifics or scavengers) shows no hemorrhage.

B. Make a midventral longitudinal incision behind sternum to inguinal area. Pull skin back - appraise nutritional status. Note absence of subcutaneous and cavity fat storage. Carefully examine diaphragm for defects and hernias (refer to notes in GLT Studbook or Husbandry Protocol).

C. Examine all abdominal and thoracic organs. Look for any abnormal colorations, spots, or lumps (lesions). Culture any lesions by forcing swab into a "clean" lesion and putting into swab holder without touching surroundings. With scalpel and forceps, take thin sections of all organs but specifically lung (from 3 or 4 lobes), liver (multiple lobes), spleen, kidneys, pancreas, adrenals, gonads and urinary bladder. Be sure to collect lesions if they exist. Sections should be no thicker than 1 cm for proper fixation. Open hollow, visous organs (stomach, gut, other tubular organs, gall bladder, and take any parasites or stones. Take 1 cm snips of intestinal wall and a small amount of feces and place in formalin solution. Make notes about observations. The amount of formalin in the jar should be approximately 10 times the volume of the tissue sample.

II. Prevent the introduction of any infectious, parasitic or other communicable disease condition that may have adapted themselves to these animals while in captivity by:

(1) Use of standard quarantine procedures prior to reintroduction.

(2) Use of pre-shipment health examinations just prior to reintroduction to include: hemogram, serum chemistry profiles, screen for ecto- and endoparasites, tuberculosis test, serological tests for certain infectious diseases (including Herpes, Callitrichid Hepatitis and others), and other diagnostic procedures to identify pertinent infectious problems.

(3) Health screening of personnel caring for tamarins for potential zoonotic diseases that may be transmitted, just before or during reintroduction process.

III. Prevent any developmental or metabolic abnormalities that might be reproduced in the offspring of reintroduced tamarins by:

(1) Screening the animals to be reintroduced by appropriate methods to identify phenotypic abnormalities, for example:

A. Use of inverted herniagram to deselect tamarins with potential diaphragmatic defect.

B. Use of biochemical screening methods for metabolic disorders.

WORKSHOP - CONSERVAÇÃO DOS MICOS-LEÕES

LION TAMARIN CONSERVATION WORKSHOP

MOTION No. 02

Submitted by: Célio Valle - Fundação Biodiversitas & UFMG

Topic: Measures to be adopted for the protection of the new Lion Tamarin species.

Title: Immediate actions to be carried out so as to protect Leontopithecus caissara.

To: Ibama _ Brazilian Environment and Renewable Natural Resources Institute

Text:

Whereas:

- a new species of lion tamarin, named Leontopithecus caissara, has recently been located in a small area in the Northern part of the Superagui Island, township of Guaraquecaba, state of Parana;

- the known distribution area is located outside the limits of the Superagui National Park;

- the new species population seem to be very small;

- local circumstances are a serious threat to the survival of the species;

The participants of the Workshop on Lion Tamarins (held in Belo Horizonte hereby emphatically recommend to the Ibama President that the following actions be immediately taken:

- to issue an ordinance including this new species on the list of Brazilian Fauna Threatened with extinction;

- to stablish special permanent monitoring and law enforcement in the island wherein the species is found, including the use of vehicles, boats, fuel and trained personnel;

- to see to it that Park is enlarged, so as to include in the near future the whole Northern part of the island, the beach and its surrounding beach habitat;

- to carry out surveys to evaluate population size and the effective distribution area.

STATUTE

The present statute establishes the norms for the functioning of the Recuperation and Management Committee for L. rosalia....

Article 1 -- The Committee will be responsible for dealing with populations of L. spp. in captivity and in the wild, interacting with researchers and institutions relating to the species, that shall provide the President of the Committee with the necessary information, and guaranteeing the rights of authorship to the providers.

Article 2 -- The Committee will propose to IBAMA an Action Plan for the conservation of the species, that will serve as a basis for action by the Institute, and a Management Plan for the species that will be implemented as a legal instrument.

a. The Committee will be available for consultation to IBAMA re. the species.

Article 3 -- The Committee will be composed of specialists recognized for their contributions to the management of and research on L...., in captivity and in the wild. The Committee will also contain 2 representatives from IBAMA: the Chief of the Division of Fauna and Flora and an additional specialist in the area.

Article 4 -- The representatives from IBAMA on the Committee will represent the Brazilian Government.

Article 5 -- The Committee will meet at least one time each calendar year, preferable in Brazil.

Article 6 -- The composition of the Committee will be reviewed at least once each three years in order that the Committee may make necessary alterations in its composition.

Article 7 -- The Committee will elect a President and a Vice President which will be substituted or reelected each 3 years.

Article 8 -- The responsibilities of the President of the Committee include:

a. Represent the Committee in its interactions with IBAMA.

b. Interact with other Committees for the preservation of similar species.

c. Designate one or more members of the Committee as responsible for elaboration of a "studbook" for the species, that will be updated each year and distributed to members of the

Committee.

d. Propose an agenda for meetings and Distribute to Committee Members in time for revision and comment.

Article 9 -- This Statue may be altered by the Committee, in a meeting attended by at least 2/3 of its members, who have been advised of the proposed changes at least 30 days prior to the meeting date.

Article 10 -- Cases not covered by this Statute will be resolved by the Committee in meetings or by correspondence as necessary.

LEONTOPITHECUS

POPULATION VIABILITY ANALYSIS

WORKSHOP REPORT

APPENDICES

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GENETICS GLOSSARY

DNA

Deoxyribonucleic Acid; a chain of molecules contain units known as nucleotides. The material that stores and transmits information inherited from one cell or organisms to the next. The principle DNA is located on the chromosomes in the nucleus of cells. Lesser but still significant DNA is located in the mitochondria.

GENE

The segment of DNA that constitutes a functional unit of inheritance.

LOCUS

The section of the DNA occupied by the gene. Gene and locus (plural: loci) are often used interchangeably.

ALLELE

Alternative forms of a gene. Most strictly, allele refers to different forms of a gene that determine alternative characteristics. However, allele is used more broadly to refer to different copies of a gene, i.e. the 2 copies of each gene that every diploid organism carries for each locus.

ALLELE OR GENE FREQUENCY

The proportion of all copies of a gene in the population that represent a particular allele.

GENOTYPE

The kinds of alleles that an individual carries as its two copies of a gene. As an example, if there are two alleles (A, a) possible at a locus, there are then three genotypes possible: AA, Aa, and aa.

GENOTYPIC FREQUENCY

The proportion of individuals in the population that are of a particular genotype.

HETEROZYGOSITY

The proportion of individuals in the population that are heterozygous (i.e., carry functionally different alleles) at a locus.

HARDY-WEINBERG EQUILIBRIUM

A principle in population genetics that predicts frequencies of genotypes based on the frequencies of the alleles, assuming that the population has been randomly mating for at least one generation. In the simplest case, where there are two alleles (A, a) at a locus and these alleles occur in the frequency p_A and p_a, the Hardy-Weinberg law predicts that after one generation of random mating the frequencies of the genotypes will be: AA = p_A^2; Aa = $2p_Ap_a$; aa = p_a^2.

EXPECTED HETEROZYSITY

The heterozygosity expected in a population <u>if</u> the population were in Hardy-Weinberg equilibrium. Expected heterozygosity is calculated from allele frequencies, and is the heterozygosity expected in progeny produced by random mating. 1 - SUM p_i's, where p_i = the frequency of allele i.

GENE DIVERSITY = FOUNDER ALLELE DIVERSITY

The expected heterozygosity of the current population relative to the wild population from which the founders have derived. Gene diversity is sometimes symbolized by P. $P = H_t/H_0$ where H_t and H_0 are the expected heterozygosities at times t and 0. Thus, the gene diversity of the population is the fraction of the wild heterozygosity retained.

GENOME

The complete set of genes (alleles) carried by an individual.

GENETIC DRIFT

The change in allelic frequencies from one generation to the next due to the randomness (chance) by which alleles are actually transmitted from parents to offspring. This random variation becomes greater as the population, and hence sample of genes, transmitted from one generation to the next, becomes smaller.

BOTTLENECK

A generation in the lineage from a founder when only one or a few offspring are produced so that not all of the founder's alleles may be transmitted onto the next generation.

FOUNDER

An animal from a source (e.g., wild) population that actually produce offspring and has descendants in the living derived (e.g., captive) population.

FOUNDER REPRESENTATION

The percentage or fraction of all the genes in the population at any given time that have derived from a particular founder.

EXISTING REPRESENTATION

The existing percentage representation of founders in the population.

TARGET REPRESENTATION

The desired or target percentage representation of founders. These target figures are proportional to the fraction of each founder genome that survived in the population. Achieving these target representation values will maximize preservation of genetic diversity.

ORIGINAL FOUNDER ALLELES

The total number of alleles (copies) of each gene carried at each locus by the founders. The number of original founder alleles is twice the number of original founder genomes.

ORIGINAL FOUNDER GENOMES

The set of all genes in a founder. The sum of all such sets are the founder genomes. The number of original founder genomes is half the number of original founder alleles.

FOUNDER ALLELES SURVIVING

The number of alleles still surviving at each locus in the population assuming that each founder carried two distinct alleles at each locus into the derived (captive) population.

FOUNDER GENOMES SURVIVING

The number of original founder genomes still surviving in the population. This metric measures loss of original diversity due to bottlenecks in the pedigree of the population.

FOUNDER GENOME EQUIVALENTS

The number of newly wild caught animals required to obtain the genetic diversity in the present captive population. This metric reflects loss due to both bottlenecks and disparities in founder representation.

FOUNDER EQUIVALENTS

The number of equally represented founders that would produce the same gene diversity as that observed in the surviving population, acknowledging the founder alleles that have already been lost due to bottlenecks. Founder equivalents measures the loss of genetic diversity due to the uneven representation of founder lineages in the surviving population.

EFFECTIVE POPULATION SIZE

A concept developed to reflect the fact that not all individuals in a population will contribute equally or at all to the transmission of genetic material to the next generation. Effective population size is usually denoted by N_e and is defined as the size of an ideal population that would have the same rate of genetic drift and of inbreeding as is observed in the real population under consideration. An ideal population is defined by: sexual reproduction; random mating; equal sex ratio; Poisson distribution of family sizes, i.e. total lifetime production of offspring; stable age distribution and constant size, i.e. demographic stationariness.

COEFFICIENT OF RELATEDNESS

The probability that an allele selected at random from one individual in the population is present in a second individual because of inheritance of that allele from a common ancestor. Equivalently, the proportion of genes in two individuals that are the same because of common descent. The inbreeding coefficient of an animal is equal to 1/2 the relatedness of the parents.

AVERAGE RELATEDNESS

The average or mean coefficient of relatedness between an animal and all animals (including itself) in the living, descendant (i.e., excluding the founders) population. The mean relatedness is twice the proportional loss of gene diversity of the descendant population relative to the founders and is also twice the mean or average inbreeding coefficient of progeny produced by random mating.

DEMOGRAPHY GLOSSARY

Age Age class in years.

P_x Age-specific survival.

Probability that an animal of a given age will survive to the next age class.

L_x Age-specific survivorship.

Probability of a newborn surviving to a given age class.

M_x Age-specific fertility.

Average number of offspring (of the same sex as the parent) produced by an animal in the given age class. Can also be interpreted as average percentage of animals that will reproduce.

r Instantaneous rate of change.

If $r < 0$ ...... Population is declining

$r = 0$ ...... Population is stationary (Does not change in number)

$r > 0$ .... Population is increasing

lambda Percent of population change per year.

If lambda < 1 ...... Population is declining

lambda = 1 ...... Population is stationary (Does not change in number)

lambda > 1 ...... Population is increasing

R_o Net reproductive rate.

The rate of change per generation.

If $R_o < 1$ ...... Population is declining

$R_o = 1$ ...... Population is stationary (Does not change in number)

$R_o > 1$ ...... Population is increasing

T Generation Time.

Average length of time between the birth of a parent and the birth of its offspring. (Equivalently, the average age at which an animal produces its offspring)

VORTEX

Simulation model of stochastic population change
Version 8.0

Written by Robert Lacy
Chicago Zoological Park
Brookfield, IL 60513

20 August 1990

Stochastic simulation of population extinction

Life table analyses yield average long-term projections of population growth (or decline), but do not reveal the fluctuations in population size that would result from variability in demographic processes. When a population is small and isolated from other populations of conspecifics, these random fluctuations can lead to extinction even of populations that have, on average, positive population growth. The VORTEX program (earlier versions called SIMPOP) is a Monte Carlo simulation of demographic events in the history of a population. Many of the algorithms in VORTEX were taken from a simulation program, SPGPC, written in BASIC by James W. Grier of North Dakota State University (Grier 1980a, 1980b, Grier and Barclay 1988).

Fluctuations in population size can result from any or all of several levels of stochastic (random) effects. First demographic variation results from the probabilistic nature of birth and death processes. Thus, even if the probability of an animal reproducing or dying is always constant, we expect that the actual number reproducing or dying within any time interval to vary according to a binomial distribution with mean equal to the probability of the event (p) and variance given by $Vp = p * (1 - p) / N$. Demographic variation is thus intrinsic to the population and occurs in the simulation because birth and death events are determined by a random process (with appropriate probabilities).

Environmental variation (EV) is the variation in the probabilities of reproduction and mortality that occur because of changes in the environment on an annual basis (or other time scales). Thus, EV impacts all individuals in the population simultaneously -- changing the probabilities (means of the above binomial distributions) of birth and death. The sources of EV are thus extrinsic to the population itself, due to weather, predator and prey populations, parasite loads, etc.

VORTEX models population processes as discrete, sequential events, with probabilistic outcomes determined by a pseudo-random number generator. VORTEX simulates birth and death processes and the transmission of genes through the generations by generating random numbers to determine whether each animal lives or dies, whether each adult female produces broods of size 0, or 1, or 2, or 3, or 4, or 5 during each year, and which of the two alleles at a genetic locus are transmitted from each parent to each offspring. Mortality and reproduction probabilities are sex-specific. Fecundity is assumed to be independent of age (after an animal reaches reproductive age). Mortality rates are specified for each pre-reproductive age class and for reproductive-age animals. The mating system can be specified to be either monogamous or polygynous. In either case, the user can specify that only a subset of the adult male population is in the breeding pool (the remainder being excluded perhaps by social factors). Those males in the breeding pool all have equal probability of siring offspring.

Each simulation is started with a specified number of males and females of each pre-reproductive age class, and a specified number of male and females of breeding age. Each animal in the initial population is assigned two unique alleles at some hypothetical genetic locus, and the user specifies the severity of inbreeding depression (expressed in the model as a loss of viability in inbred animals). The computer program simulates and tracks the fate of each population, and outputs summary statistics on the probability of population extinction over specified time intervals, the mean time to extinction of those simulated populations that went extinct, the mean size of populations not yet extinct, and the levels of genetic variation remaining in any extant populations.

A population carrying capacity is imposed by a probabilistic truncation of each age class if the population size after breeding exceeds the specified carrying capacity. The program allows the user to model trends in the carrying capacity, as linear increases or decreases across a specified numbers of years.

VORTEX models environmental variation simplistically (that is both the advantage and disadvantage of simulation modelling), by selecting at the beginning of each year the population age-specific birth rates, age-specific death rates, and carrying capacity from normal distributions with means and standard deviations specified by the user. Thus, EV is simulated by sampling a normal distribution, with the standard deviations specifying the annual fluctuations in probabilities of reproduction and mortality and in carrying capacity.

Unfortunately, rarely do we have sufficient field data to estimate the fluctuations in birth and death rates, and in carrying capacity, for a wild population. (The population would have to be monitored for long enough to separate, statistically, sampling error from demographic variation in the number of breeders and deaths from annual variation in the probabilities of these events.) Lacking any data on annual variation, a user can try various values, or simply set EV = 0 to model the fate of the population in the absence of any environmental variation.

VORTEX can model catastrophes, the extreme of environmental variation, as events that occur with some specified probability and reduce survival and reproduction for one year. A catastrophe is determined to occur if a randomly generated number between 0 and 1 is less than the probability of occurrence (i.e., a binomial process is simulated). If a catastrophe occurs, the probability of breeding is multiplied by a severity factor specified by the user. Similarly, the probability of surviving each age class is multiplied by a severity factor specified by the user.

VORTEX also allows the user to supplement or harvest the population for any number of years in each simulation. The numbers of immigrants and removals are specified by age and sex. VORTEX outputs the observed rate of population growth (mean of N[t]/N[t-1]) separately for the years of supplementation/harvest and for the years without such management, and allows for reporting of extinction probabilities and population sizes at whatever time interval is desired (e.g., summary statistics can be output at 5-year intervals in a 100-year simulation).

Whenever VORTEX is run, it creates a file called VORTEX.BAT that contains the input data, ready for resubmission as a batch file. Thus, the simulation can be instantly rerun by using VORTEX.BAT as the input file. By editing VORTEX.BAT, a few changes could easily be made to the input parameters before rerunning VORTEX. Note that the file VORTEX.BAT is over-written each time that VORTEX is run. Therefore, you should rename the batch file if you wish to save it for later use.

Overall, the computer program simulates many of the complex levels of stochasticity that can affect a population. Because it is a detailed model of population dynamics, often it is not practical to examine all possible factors and all interactions that may affect a population. It is therefore incumbent upon the user to specify those parameters that can be estimated reasonably, to leave out of the model those that are believed not to have a substantial impact on the population of interest, and to explore a range of possible values for parameters that are potentially important but very imprecisely known.

VORTEX is, however, a simplified model of the dynamics of real populations. Some of its artificialities are the independence of environmental variation in birth and death rates (except during catastrophes), and the lack of density dependence of birth and death rates except when the population exceeds the carrying capacity. The first of these simplifications will likely lead to underestimates of extinction rates, because the various risks to a population occur independently in the model and are therefore distributed more evenly over time than may be the case in most natural populations. The lack of density dependence may cause underestimation or overestimation of extinction, depending on whether the population responds positively (increased breeding and reduced mortality) when numbers are low, as might be expected if intra-specific competition or aggression were common, or negatively, as might occur in social species or if mates are difficult to find.

VORTEX accepts input either from the keyboard or from a data file. By using data file input, multiple simulations can be run while the computer is unattended. (Depending on the computer used, the simulations can be relatively quick -- a few minutes for 100 runs -- or very slow.) Output can be directed to the screen or to a file for later printing. I would recommend that VORTEX only be used on a 80386 (or faster) computer with a math co-processor. It should run on slower machines, but Version 8.0 requires the math co-processor (and it would be hopelessly slow without one even if it worked). Presumably, the program should also run equally well on OS/2 systems and MS-DOS systems, but I have only tested it on MS-DOS machines.

The program can make use of any extended memory available on the computer (note: only extended, not expanded, memory above 1MB will be used), and the extra memory will be necessary to run analyses with the Heterosis inbreeding depression option on populations of greater than about 450 animals. To use VORTEX with expanded memory, first run the program TUNE, which will customize the program EX286 (a Dos Extender) for your computer. If TUNE hangs up DOS, simply re-boot and run it again (as often as is necessary). This behavior of TUNE is normal and will not affect your computer. After TUNEing the Dos Extender, run EX286, and then finally run VORTEX. TUNE needs to be run only once on your computer, EX286 needs to be run (if VORTEX is to be used with extended memory) after each re-booting of the computer. Note that EX286 might take extended memory away from other programs (in fact it is better to disable any resident programs that use extended memory before running EX286); and it will release that memory only after a re-boot.

VORTEX is not copyrighted nor copy protected. Use it, distribute it, revise it, expand upon it. I would appreciate hearing of uses to which it is put, and of course I don't mind acknowledgement for my efforts. James Grier should also be acknowledged (for developing the program that was the base for VORTEX) any time that VORTEX is cited.

A final caution: VORTEX is continually under revision. I cannot guarantee that it has no bugs that could lead to erroneous results. It certainly does not model all aspects of population stochasticity, and some of its components are simply and crudely represented. It can be a very useful tool for exploring the effects of random variability on population persistence, but it should be used with due caution and an understanding of its limitations.

References:

Grier, J. 1980a. Ecology: A simulation model for small populations of animals. Creative Computing 6:116-121.

Grier, J.W. 1980b. Modeling approaches to bald eagle population dynamics. Wildlife Society Bulletin 8:316-322.

Grier, J.W. and J.H. Barclay. 1988. Dynamics of founder populations established by reintroduction. Pages 689-701 in T.J. Cade, J.H. Enderson, C.G. Thelander, and C.M. White, eds. Peregrine Falcon Populations: Their Management and Recovery. The Peregrine Fund, Boise, Idaho.

Lacy, R.C, Flesness, N.R., and Seal, U.S. 1989. Puerto Rican parrot population viability analysis. Report to the U.S. Fish and Wildlife Service. Captive Breeding Specialist Group, Species Survival Commission, IUCN, Apple Valley, Minnesota.

Lacy, R. and T.W. Clark. 1989. Population viability assessment of the eastern barred bandicoot in Victoria. In T.W. Clark and J.H. Seebeck (eds.), The Management and Conservation of Small Populations. Chicago Zoological Society, Brookfield, Illinois. (In press.)

Seal, U.S. and R.C. Lacy. 1989. Florida panther population viability analysis. Report to the U.S. Fish and Wildlife Service. Captive Breeding Specialist Group, Species Survival Commission, IUCN, Apple Valley, Minnesota.

VORPLOTS

Plotting program for use with VORTEX

VORPLOTS creates files from VORTEX output, in HPGL (Hewlett-Packard Graphics Language). These can then be plotted on an HP plotter, or on a printer (e.g., an HP LaserJet with the appropriate font cartridge) that can be create plots from HPGL files.

To plot results from VORTEX:

1) Be sure that you specify in the data input that you want data files produced for plotting. VORTEX will then place appropriate summary data into files:

POPSIZE.VOR -- mean population size (of extant populations) across years
EXTINCT.VOR -- number of simulation populations going extinct in each time interval
EXTANT.VOR -- proportion of simulated populations still extant at each year
HET.VOR -- mean proportion of initial (expected) heterozygosity remaining at each year

INBREED.VOR -- mean inbreeding coefficient at each year

As you do additional sets of runs (set = one set of input parameters to be simulated), VORTEX appends the plotter data to previously existing files (if any). Thus, the above data can be plotted for several sets of runs on one plot.

If you specified that you wanted plotter files for each run, as well as means across runs, VORTEX will also create:

NDATA -- population sizes each year of each run
HDATA -- expected heterozygosity each year of each run
HODATA -- observed heterozygosity each year of each run
NADATA -- number of alleles each year of each run
ENADATA -- effective number of alleles each year of each run

Note: the above files can be quite large, as they contain data from each year of each simulated population. For the above five files, VORTEX will over-write results from previous sets of runs when creating these files. Thus you must rename the files if you want to save results for plotting each run at a later time.

2) Edit the above files to produce the subsets that you want to plot.

For POPSIZE.VOR, HET.VOR, INBREED.VOR, EXTANT.VOR, and EXTINCT.VOR, the files will contain data from all the runs you have done. Delete those that you do not want to plot. (Important note: Copy the VOR file to a different name or directory before editing, if you plan to produce plots from various sets of simulations.)

The plotting program, VORPLOTS, scales the x and y axes appropriately for the first data set encountered in the file. Therefore, you should put the data from the largest population, with the longest simulation (in years) at the top of the file. Otherwise, some lines on the plot may go beyond the end of the axes.

3) Run program VORPLOTS.

VORPLOTS will create .PLT files from each of the .VOR files. Not all .VOR files need to exist (assuming that you do not want to produce all possible plots).

4) Reassign the output to the serial port (rather than the parallel port usually used for sending output to a printer). To do this, type:

MODE LPT1:=COM1:

Note: You may have to redefine the serial port communications protocol to match that expected by the plotter. Get help from your local computer expert on this matter, if need be. On Lacy's computer, the command PLOT will set the appropriate protocol for you.

After you are done plotting, you will need to reassign output to the parallel port before you can send output to a printer. To reassign output for printing, type:

MODE LPT1:
(or re-boot your computer).

5) Load paper in the plotter, be sure that the plotter is turned on and connected to the computer, and then type

PRINT POPSIZE.PLT
    (or EXTINCT.PLT or NDATA.PLT or EXTANT.PLT or ...)

VORPLOTS tries to pick appropriate axes, labels, etc. for the graphs. Obviously, it cannot anticipate every type of data, and every desire you may have regarding the style of graph. If you know (or are willing to learn) the fairly simple commands of HPGL, you can modify the .PLT files to customise graphs to your taste.

APPENDIX

Sample input session with VORTEX computer simulation of population viability.
User responses in **bold.**

Welcome to VORTEX.
Written by R.C. Lacy, Chicago Zoological Park.
Version 2.0, 3 November 1989.

Maximum number of living animals = 200
Maximum number of founders (with living descendants) = 200
Maximum number of animals in an age-sex class = 100
Maximum age of first breeding = 5
Maximum litter size = 5
Maximum number of years = 200

Input file name? (CR for keyboard)
lions.inp

Output file name? (S for screen)
panthers
Do you want data files produced for plotting? **y**

How many times do you want the simulation repeated? **100**
Do you want the full table printed (first four runs only)? **n**

Do you want to incorporate inbreeding depression? **y**
You can choose either a general HETEROSIS model, in which selection against homozygotes does not remove the genetic load, but which allows for user-defined number of lethal equivalents, or a RECESSIVE LETHALS model in which each founder starts with one unique, recessive lethal allele (and a unique, dominant non-lethal), and in which selection against homozygotes for the lethal alleles removes those alleles from the population.
Do you want a general HETEROSIS model (specify H) or a RECESSIVE LETHALS model (specify L)? **h**

How many lethal equivalents per diploid genome within the population? **3.4**

At what age do the animals normally begin breeding? **3**
What is the maximum number of young per litter? **5**
What percent of adult females produce 0 young? **50**
What percent of adult females produce 1 young? **5**
What percent of adult females produce 2 young? **10**
What percent of adult females produce 3 young? **20**
What percent of adult females produce 4 young? **10**
What percent of adult females produce 5 young? **5**
Monogamous (M) or polygamous (P) breeding? **p**
Is it the case that all adult males are in the breeding pool,
    and equally likely to sire offspring? (Y or N) **y**

What is the percent mortality between ages 0 to 1? **50**
What is the percent mortality between ages 1 to 2? **30**
What is the percent mortality between ages 2 to 3? **25**
What is the annual percent mortality of adults (age > 3)? **25**

What is the population carrying capacity at present? **45**
Is there a trend projected in the carrying capacity? (Y or N) **y**
Over how many years is the carrying capacity expected to change? **50**
What percent annual increase (positive) or decrease (negative) is projected? **-1**

Enter levels of environmental stochasticity as
  factors to be applied to the indicated variances.
  If you have no idea, guess one of the following:
    0 = no year-to-year variation
    1 = minimal year-to-year variation
    10 = moderate year-to-year variation
    100 = much year-to-year variation

    Reproductive rates: Binomial variance for breeding success x ? **2**
    Mortality rates: Binomial variance x ? **2**
    Carrying capacity: Poisson variance x ? **2**

Enter the probability of catastrophe type I (as a percent): **1**
Enter the severity of type I catastrophes as a mean multiplicative effect
(to which will be applied a binomial variance).
Note: 0 = total catastrophe, 1 = no effect.

Severity with respect to reproduction? **.5**
Severity with respect to survival? **.5**

Enter the probability of catastrophe type II (as a percent): **2**
Enter the severity of type II catastrophes as a mean multiplicative effect
(to which will be applied a binomial variance).
Note: 0 = total catastrophe, 1 = no effect.

Severity with respect to reproduction? **.3**
Severity with respect to survival? **.8**

How many years do you want the simulation to run? **200**
At what time interval do you want extinction reports? **5**

How many males, females of age 1 are in the initial population? **4,4**
How many males, females of age 2 are in the initial population? **3,4**
How many male, female adults (age > 3) are in the initial population? **15,15**

For how many years do you want to harvest/supplement the population? **3**
How many males, females of age 1 are to be
added (positive integer) or subtracted (negative) each year? **-1,-1**
How many males, females of age 2 are to be
added (positive integer) or subtracted (negative) each year? **0,0**
How many male, female adults (age > 3) are to be
added (positive integer) or subtracted (negative) each year? **-1,-1**

[computer's response during running of the program ...]

Run 1 ....

Population did not survive. Extinction at year 26.

Run 2 ....

Population did not survive. Extinction at year 9.

Run 3 ....

Population did not survive. Extinction at year 4.

Run 4 ....

Population did not survive. Extinction at year 15.

Run 5 ....

Population did not survive. Extinction at year 9.

...

Run 98 ....

Population did not survive. Extinction at year 7.

Run 99 ....

Population did not survive. Extinction at year 4.

Run 100 .

Population did not survive. Extinction at year 1.

Do you want to run another simulation? **n**

Sample output from VORTEX (with above input parameters)

VORTEX -- simulation of genetic and demographic stochasticity

panthers   Input parameters:

HETEROSIS model of inbreeding depression
with 3.40 lethal equivalents per diploid genome

First age of reproduction: 3
50.00 percent of adult females produce litters of size 0
5.00 percent of adult females produce litters of size 1
10.00 percent of adult females produce litters of size 2
20.00 percent of adult females produce litters of size 3
10.00 percent of adult females produce litters of size 4
5.00 percent of adult females produce litters of size 5

50.00 percent mortality between ages 0 and 1
30.00 percent mortality between ages 1 and 2
30.00 percent mortality between ages 2 and 3
25.00 percent annual mortality of adults (age > 3)

Carrying capacity of 45
with annual percent change of -1.000 over 50 years

Environmental stochasticity:

Reproductive success binomial variance x 2.000
50.00 percent females produce litters
binomial SD = 12.91 percent
SD in annual RS due to environmental variance = 18.26 %

Mortality binomial variance x 2.000
50.00 mortality from age 0 to 1
binomial SD = 7.45 percent
SD in mortality rate due to environmental variance = 10.54 %

30.00 mortality from age 1 to 2
binomial SD = 6.83 percent
SD in mortality rate due to environmental variance = 9.66 %

30.00 mortality from age 2 to 3
binomial SD = 6.83 percent
SD in mortality rate due to environmental variance = 9.66 %

25.00 mortality from age 3 to 4
binomial SD = 6.45 percent
SD in mortality rate due to environmental variance = 9.13 %

Carrying capacity poisson variance x 2.000
mean K = 45
Poisson SD = 6.71
SD in K due to environmental variance = 9.49

Frequency of type I catastrophes: 1.000 percent
with 0.500 mean multiplicative effect on reproduction
and 0.500 mean multiplicative effect on survival

Frequency of type II catastrophes: 2.000 percent
with 0.300 mean multiplicative effect on reproduction
and 0.800 mean multiplicative effect on survival

Population simulated for 200 years, 100 runs
Initial population size:
4 males, 5 females 1 years old
3 males, 3 females 2 years old
15 male, 15 female adults (age > 3)

Population managed with supplementation/harvest through year 3:

-1 males, -1 females 1 years old

0 males, 0 females 2 years old

-1 male, -1 female adults (age > 3)

Deterministic population growth rate:

r = -0.065

lambda = 0.937

R0 = 0.685

Generation time = 5.78

Stable age distribution:

Age class	Proportion
0 to 1	0.302
1 to 2	0.160
2 to 3	0.118
3 to 4	0.088
4 to 5	0.070
5 to 6	0.055
6 to 7	0.044
7 to 8	0.035
8 to 9	0.028
9 to 10	0.022
10 to 11	0.017
11 to 12	0.014
12 to 13	0.011
13 to 14	0.009
14 to 15	0.007
15 to 16	0.005

Year 5

N[Extinctions] = 28, P[E] = 0.2800

N[Survivals] = 72, P[S] = 0.7200

Population size = 10.43 (0.61 SE, 5.18 SD)

Expected heterozygosity = 0.8704 (0.0076 SE, 0.0647 SD)

Observed heterozygosity = 0.9981 (0.0014 SE, 0.0117 SD)

Number of extant alleles = 11.72 (0.57 SE, 4.86 SD)

Effective number of alleles = 9.21 (0.42 SE, 3.60 SD)

Year 10
N[Extinctions] = 49, P[E] = 0.4900
N[Survivals] = 51, P[S] = 0.5100
Population size = 8.59 (0.62 SE, 4.43 SD)
Expected heterozygosity = 0.7870 (0.0128 SE, 0.0915 SD)
Observed heterozygosity = 0.9600 (0.0126 SE, 0.0900 SD)
Number of extant alleles = 7.00 (0.40 SE, 2.84 SD)
Effective number of alleles = 5.38 (0.27 SE, 1.90 SD)

Year 15
N[Extinctions] = 66, P[E] = 0.6600
N[Survivals] = 34, P[S] = 0.3400
Population size = 7.35 (0.89 SE, 5.19 SD)
Expected heterozygosity = 0.7300 (0.0144 SE, 0.0841 SD)
Observed heterozygosity = 0.9233 (0.0180 SE, 0.1049 SD)
Number of extant alleles = 5.09 (0.31 SE, 1.82 SD)
Effective number of alleles = 4.05 (0.21 SE, 1.23 SD)

Year 20
N[Extinctions] = 82, P[E] = 0.8200
N[Survivals] = 18, P[S] = 0.1800
Population size = 6.11 (1.03 SE, 4.38 SD)
Expected heterozygosity = 0.6454 (0.0312 SE, 0.1323 SD)
Observed heterozygosity = 0.8340 (0.0400 SE, 0.1697 SD)
Number of extant alleles = 4.17 (0.40 SE, 1.69 SD)
Effective number of alleles = 3.24 (0.31 SE, 1.30 SD)

Year 25
N[Extinctions] = 91, P[E] = 0.9100
N[Survivals] = 9, P[S] = 0.0900
Population size = 4.56 (0.99 SE, 2.96 SD)
Expected heterozygosity = 0.5169 (0.0401 SE, 0.1203 SD)
Observed heterozygosity = 0.6821 (0.0509 SE, 0.1526 SD)
Number of extant alleles = 3.00 (0.44 SE, 1.32 SD)
Effective number of alleles = 2.21 (0.22 SE, 0.66 SD)

Year 30
N[Extinctions] = 99, P[E] = 0.9900
N[Survivals] = 1, P[S] = 0.0100
Population size = 10.00 (0 SE, 0 SD)
Expected heterozygosity = 0.8000 (0 SE, 0 SD)
Observed heterozygosity = 0.9000 (0.0509 SE, 0.1526 SD)
Number of extant alleles = 6.00 (0 SE, 0 SD)
Effective number of alleles = 5.00 (0 SE, 0 SD)

Year 35
N[Extinctions] = 99, P[E] = 0.9900
N[Survivals] = 1, P[S] = 0.0100
Population size = 10.00 (0 SE, 0 SD)
Expected heterozygosity = 0.7700 (0 SE, 0 SD)
Observed heterozygosity = 1.0000 (0.0509 SE, 0.1526 SD)
Number of extant alleles = 6.00 (0 SE, 0 SD)
Effective number of alleles = 4.35 (0 SE, 0 SD)

Year 40
N[Extinctions] = 100, P[E] = 1.0000
N[Survivals] = 0, P[S] = 0
Population size = 0 (0 SE, 0 SD)

In 100 simulations of 200 years:
100 populations went extinct and 0 survived.
This gives a probability of extinction of 1.0000 (0 SE),
or a probability of success of 0 (0 SE).

Mean time to extinction was 11.84 years (0.81 SE, 8.13 SD).

During 3 years of harvest/supplementation
mean lambda was 0.8763 (0.0021 SE, 0.1922 SD)

Without harvest/supplementation, prior to carrying capacity truncation, mean lambda was 0.9580 (0.0031 SE, 0.2835 SD)
22 SD)

Captive Breeding Specialist Group

Species Survival Commission
International Union for the Conservation of Nature and Natural Resources
U. S. Seal, CBSG Chairman

POPULATION VIABILITY ANALYSIS DATA FORM - MAMMAL

Species:

Species distribution:

Study taxon (subspecies):

Study population location:

Metapopulation - are there other separate populations? Are maps available?:
(Separation by distance, geographic barriers?)

Specialized requirements (Trophic, ecological):

Age of first reproduction for each sex (proportion breeding):

a)Earliest:

b)Mean:

Gestation period (days or weeks):

Litter size (N, mean, SD, range) (at birth? at weaning?):

Birth Season:

Birth frequency (interbirth interval):

Reproductive life-span (Male & Female, Range):

Life time reproduction (Mean, Male & Female):

Adult sex ratio:

Adult body weight of males and females:

12101 Johnny Cake Ridge Road, Apple Valley, MN 55124, USA tel. 612-431-9325 fax 612-432-2757
(home) 9801 Pillsbury Ave. S., Bloomington, MN 55420, USA tel. 612-888-7267 fax 612-888-5550

Social structure in terms of breeding (random, pair-bonded, polygyny, polyandry, etc; breeding male and female turnover each year?):

Proportion of adult males and females breeding each year:

Dispersal distance (mean, sexes):

Migrations (months):

Territoriality (home range, season):

Birth sex ratio:

Birth weights (male and female):

Ovulation - induced or spontaneous:

Implantation - immediate or delayed (duration):

Estrous cycles (seasonal, multiple or single, post partum):

Duration of lactation:

Post-lactational estrus:

Age of dispersal:

Maximum longevity:

Population census - most recent. Date of last census. Reliability estimate :

Projected population (5, 10, 50 years) :

Past population census (5, 10, 20 years - dates, reliability estimates):

Population sex and age structure (young, juvenile, & adults) - time of year :

Fecundity rates (by sex and age class):

Mortality rates and distribution (by sex and age) (neonatal, juvenile, adult):

Population density estimate. Area of population. Attach marked map.

Sources of mortality - % (natural, poaching, harvest, accidental, seasonal?):

Habitat capacity estimate (Has capacity changed in past 20, 50 years?) :

Present habitat protection status:

Projected habitat protection status (5, 10, 50 years).

Environmental variance affecting reproduction and mortality (rainfall, prey, predators, disease, snow cover ?):

Is pedigree information available?:

Attach Life Table if available.

Date form completed:

Correspondent/Investigator:

Name:
Address:
Telephone:
Fax:

References:

Comments:

DEVELOPMENT OF AN SSP MASTERPLAN

1. DATA COMPILATION

The first step in development of an SSP Masterplan is to compile the basic data required for population analysis.

This compilation will often be in the form of a Studbook. However, ISIS should be involved in the compilation process: initially as a source of data for studbook development; ultimately as a repository of the assembled data. An important part of the compilation process is a "clean up" of the ISIS data.

The basic data required on each animal for population analysis and management are:

(A) **Individual identification - a simple numeric lifetime identity.**

To achieve this identification, it may be necessary to link a series of different ID numbers the animals has had as it moved from one institution to another in its captive history, e.g. the local ISIS specimen ID numbers.

(B) **Sex**

(C) **Birth date**

(D) **Death date**

(E) **Parentage - if captive born**

(F) **Place of capture - if wild caught**

(G) **Institutions/facilities where it has been, with dates**

(H) **Available information on circumstances of death**

With these data, genetic and demographic analyses can be performed.

2. GENETIC ANALYSES

(A) Construct the pedigree for each animal in the population.
This process may be literally the construction of a pedigree chart or more often will be an inherent part of various algorithms and computer programs, e.g. the additive relationship matrix or various "gene drop" computations.

(B) Identify all the founders of the population.

A founder is an animal:

(a) which is from outside the population (usually the wild)

(b) which has no known relationship to any other individual at its time of entry into the population.

(c) which has descendants in the living population.

(C) Compute the representation of founders ("bloodlines"), or better the probable distribution of founder alleles, in living individuals and the present population as a whole.

(D) Hence, determine the relative representation of founders (bloodlines) or probable distribution of founder alleles in the population.

(E) Locate any extreme bottlenecks in the history of particular founder lineages or bloodlines.

This step may be an inherent part of more sophisticated algorithms that calculate probable distributions of founder alleles rather than just crude founder representation.(i.e. gene drop analysis)

(F) Calculate the founder representation or founder allele distribution in offspring of the possible matings of living members of the population.

(G) Determine of the number and sex ratio of animals that actually reproduce in the population.

(H) Calculate the number of offspring of each living individual in the population and hence the mean and variance of lifetime family sizes.

(I) **Estimate the genetically effective population size (N_e) of the population and then the N_e/N ratio, where N is the total number of animals in the population.**

(J) **Calculate the inbreeding coefficients of existing individuals in the population and of the potential offspring of possible matings between these animals.**

(K) **Conduct various biochemical analyses that measure genetic variability (e.g. electrophoretic, DNA, and karyotypic studies).**

3. DEMOGRAPHIC ANALYSES

(A) **Determine the size of the current population and the number of institutions over which it is distributed.**

It will also usually be necessary to know this information roughly for other taxa with similar "captive ecologies", i.e. space and resource requirements, e.g. the Siberian Tiger SSP needs to be cognizant of the other tiger and large felid populations.

(B) **Determine the age and sex structure of the population.**

(C) **Compute the age-specific survivorships and fertilities of the population, i.e. construct a life table consisting of demographic parameters.**

(D) **Establish a carrying capacity that is a compromise between a minimum viable population (MVP) for genetic and demographic viability and a maximum number that will not preclude other taxa from the zoo ark.**

This carrying capacity should specify the number not only of animals but of the facilities over which they should optimally be distributed.

The lower limit of the carrying capacity, the MVP, will be determined primarily by reference to the long-term genetic objectives of the program and the biological characteristics of the population.

The genetic objectives of relevance are:

(a) The kind of genetic diversity that is to be preserved, e.g. average heterozygosity or allelic diversity.

(b) The amount of the original genetic diversity that is to be preserved.

(c) The period of time this level of genetic diversity is to be preserved.

The biological characteristics of the population of relevance are:

(a) The generation time of the population (under probable patterns of mortality and various actual or managed schedules of reproduction) and hence the number of generations that will occur during the absolute period of time (e.g. 200 years) over which the propagation program is to operate.

Generation times should actually be computed from demographic parameters. It is presumed the schedule of reproduction in the SSP population will be regulated to extend generation time for genetic reasons.

In any case, dividing the absolute number of years over which the propagation program is intended to operate by this generation time for the population will indicate the number of generations over which diversity is to be preserved.

(b) The effective number of founders that have established the population.

Bottlenecks in lineages of some founders may reduce them to only fractional effectiveness in the living population.

(c) The N_e/N ratio in the population.

(d) The growth rate of the population from founder number to carrying capacity.

In the absence of more refined or species-specific recommendations on the long-term genetic objectives, the guideline of 90% of average heterozygosity for 200 years may be used as a crude starting point. Reference to the graphs or algorithms that have been generated, considering effective number of founders, will prescribe an MVP for these genetic objectives.

This MVP will be in terms of effective population number N_e. Realities of managing the species (e.g., the need for or problem of uneven sex ratios for gregarious species, especially with difficult to manage males) should be considered to estimate likely N_e/N ratios, i.e. effective number to total number. Dividing the MVP by this N_e/N ratio will indicate the actual number of animals that must be maintained to produce the desired MVP.

A secondary consideration for determination of the MVP is demographic stochasticity and is significant if the MVP prescribed by genetic considerations is fewer than 50-100. Populations (N's) smaller than 50 and possibly even 100 may be particularly vulnerable to "crashes" or extinctions due to random demographic causes, e.g. epidemic diseases, natural disasters, or sex-ratio distortions.

The upper limit on carrying capacity should be derived by an analysis of:

(1) The amount of captive habitat (space and resources) that seems to be available for this and other taxa (esu's ?) with similar "zoo ecologies" (i.e. enclosure requirements, exhibit value, etc.)

(2) The number of taxa (esu's) that are in need of assistance from captive propagation and may be competing for this captive habitat.

The size of current populations and information on expansion plans can be used to estimate the captive habitat available. Information on status and trends of wild populations as well as considerations of taxonomic uniqueness can be used to decide the number of taxa that are in need of captive propagation.

Simple division of available habitat by the number of taxa will suggest the upper limit on carrying capacity.

If this number is less than the MVP, then prioritization and selectivity of the competing taxa will be necessary.

(E) Using the data on these demographic parameters, analyze

(a) The rate of change, i.e. the growth or decline, of the population.

(b) Hence, the capacity of the population for self-sustainment.

(c) Whether the population is at, or when it will be at, the carrying capacity.

(d) How the fertilities and survivorships can be managed by "removals" of animals and regulation of reproduction (birth control) to stabilize the population at the desired carrying capacity.

This process may entail much "what if" analysis to determine how managemental modifications to the patterns of survivorship and fertilities will affect population size, growth rate, age distribution, etc.

(F) If the survivorships and fertilities are not adequate for the population to be self-sustaining, devise a program of research in reproductive, behavioral, other biology to resolve the problem.

4. POPULATION MANAGEMENT

Once these genetic and demographic analyses are performed, an SSP Masterplan for propagation and management of the population can be formulated.

The SSP Masterplan should provide recommendations, institution by institution and animal by animal, for every individual in the population maintained by SSP Participants

Specifically, the Masterplan should:

(A) Designate which animals are surplus because they are

- **(a) from over-represented bloodlines or lineages**
- **(b) too old to reproduce**
- **(c) have already produced their share of offspring and have attained the oldest age class necessary or allowable for a stable age distribution in the SSP population.**

(B) State explicitly that surplus animals should not be reproduced again.

Further recommendations on disposal of surplus will vary from program to program, time to time, and institution to institution. The issue of euthanasia will have to be confronted in this regard.

(C) Recommend which animals should reproduce.

(a) When.

A schedule over at least the next 1 to 5 years is needed.

(b) With whom.

These recommendations of course may entail relocation of animals between facilities.

(D) Explain the genetic and demographic criteria or objectives on which the surplus and reproduction recommendations are based. There should also be an explanation of how the Masterplan arrived at the particular carrying capacity established.

Normally, these genetic and demographic guidelines will include:

- **(a) An attempt to rapidly expand and stabilize the population at its established carrying capacity.**
- **(b) A strategy to maximize preservation of genetic diversity.**

Currently, the best methods to achieve this objective seem to be:

- **Adjust existing representation of founder lineages to be proportional to the probable distribution of alleles surviving from founders at initiation of the program. (i.e. toward target distribution)**

  Founder alleles are lost through random genetic drift, especially due to "bottlenecks" in pedigrees. Estimating the probability of loss and retention of alleles is possible through so-called "gene-drop" algorithms.

  Computer programs are available to calculate both the existing and target founder distributions. Arranging matings to change founder representation from the existing to the target distribution will maximize retention of genetic diversity.

  Adjustment of bloodlines may require considerably unequal reproduction by various individuals to rectify disparities that have developed in the past.

- **Equalize lifetime family sizes.**

  This process will become fully operative only once the past inequalities in founder representation have been corrected.

- **Manage inbreeding coefficients.**

  Observe that this is not the primary criteria for genetic management. Frequently, there should be an attempt to minimize inbreeding coefficients within the constraints of the previous criteria. However, there may be cases when inbreeding is deliberately employed to achieve some objective or solve some problem, e.g. purge of deleterious alleles in the Speke's gazelle program.

- **Perhaps subdivide the population into several parts or demes between which gene flow (i.e., usually exchange of animals but also increasing of gametes or embryos) is regulated.**

5. HUSBANDRY STANDARDS

Husbandry standards for the taxon, ideally culminating in production of a **Handbook** which can be kept current as new advances occur.

6. REVIEW AND RATIFICATION

Once the SSP Masterplan is formulated, it should be reviewed, revised if appropriate, and ratified by the Propagation Group.

The Masterplan should then be submitted to the SSP Subcommittee for their evaluation and hopeful endorsement. The SSPSC may suggest some modifications to the Masterplan.

7. IMPLEMENTATION

Once approved, the Masterplan should be distributed to each of the Participating Institutions through its Institutional Representatives. The Species Coordinators and Propagation Group should provide follow-up to encourage and facilitate implementation.

LION-TAMARINS REFERENCE LIST

Abbott,DH; Hearn,HP (1979): The effects of neonatal exposure to testosterone on the development of behavior in female marmoset monkeys. Sex, Hormones and Behaviour: Ciba. Foundation. Symposium. 62, 299-327.

Albrecht,P; Lorenz,D; Klutch,MJ; Vickers,JH; Ennis,FA (1980): Fatal measles infection in marmosets. Pathogenesis and prophylaxis. Infection.and. Immunity. 27, 969-978.

Altmann-Schonberner,D (1965): Beobachtungen uber aufzucht und entwicklung des verhaltens beim grossen lowenaffchen, Leontocebus rosalia. Zool. Gart. 31, 227-239.

Anonymous (1971): Fazenda Paraiso: Ultimo reduto da fauna paulista. Trofeu. (9), 28-32.

Baldwin,LA; Patterson,TL; Teleki,G (1977): Field research on Callitrichid and cebid monkeys: an historical, geographical and bibliographical listing. Primates. 18(2), 485-507.

Ballou,JD (1986): 1985 International Golden Lion Tamarin Studbook. National Zool. Park, Washington, D.C.

Ballou,JD (1987): 1986 International Golden Lion Tamarin Studbook. National Zool. Park, Washington, D.C.

Ballou,JD (1988): 1987 International Golden Lion Tamarin Studbook. National Zool. Park, Washington, D.C.

Ballou,JD (1989): 1988 International Golden Lion Tamarin Studbook. National Zool. Park, Washington, D.C.

Barnhart,DD; Gengozian,N (1975): Actively induced thrombocytopenia in the marmoset: a possible autoimmune model. Clin. Exp. Immunol. 21, 493-500.

Barnhart,DD; Gengozian,N (1975): An evaluation of the mixed lymphocyte culture reaction in marmosets. Transplantation. 20, 107-115.

Beck,BB; Dietz,JM; Kleiman,DG; Castro,MI (1986): Reintrodução dos micos-leões-dourados (L. rosalia, Linnaeus, 1766)(Callitrichidae, Primates) de cativeiro, em seu ambiente natural. In: Resumos do XIII Congresso Brasileiro de Zoologia. 1st ed. Vol. Sociedade Brasileira de Zoologia, Cuiaba, MT, 211. (Abstract)

Beck,BB; Dietz,JM; Kleiman,DG; Castro,MI; Lemos de Sa,RM; Luz,VL (1985): O projeto mico-leão. Reintrodução dos micos-leões-dourados (L. rosalia, Linnaeus, 1766)(Callitrichidae, Primates) em seu ambiente natural. In: Resumos do XII Congresso Brasileiro de Zoologia. 1st ed. Sociedade Brasileira de Zoologia, Campinas, SP, 319. (Abstract)

Bender,MA; Mettler,LE (1960): Chromosome studies of primates. ii. Callithrix, Leontocebus and Callimico. Cytologia. 2, 400-404.

Benirschke,K; Layton,W (1969): An early twin blastocyst of the golden lion marmoset, Leontocebus rosalia. Folia. Primat. 10, 131-138.

Benz, JJ;French,JA;Ledger,BW (1990) Sex differences in vocal structure in a Callitrichid primate, Leontopithecus rosalia. Int. Jour. Prim. 21, 257-264.

Bertram,BCR (1982): Management and breeding of New World monkeys at London Zoo, England, U.K. 1972-1981. International Zoo Yearbook. 22, 84-87.

Blakely,M; Curtis,L (1977): Notes on birth in the golden lion marmoset L. rosalia. Proc. of the Amer. Assoc. of Zool. Parks and Aquariums. 50, 5-7.

Box,HO; Maclean,I (1975): The social life of marmosets. Wildlife, 64-67.

Bradley,DW; Krushak,DA; Maynard,JE (1974): Viroids and viral hepatitis in marmosets. Nature. 248, 172.

Brand,HM (1980): Influence of season on birth distribution in marmosets and tamarins. Laboratory Animals. 14, 301-302.

Bridgwater,DD (1972): Saving the Lion Marmoset. Wild Animal Propagation Trust, Wheeling, WV.

Brown,K; Mack,DS (1978): Food sharing among captive Leontopithecus rosalia. Folia Primat. 29, 268-290.

Burke,S (1978): Zoos share marmoset breeding success. Smithsonian Institution Research Report. 22, 7.

Bush,M; Custer,RS; Whitla,JC; Smith,EE (1982): Hematologic values of captive golden lion tamarin, Leontopithecus rosalia, variation with sex, age and health status. Lab. Animal Science. 32, 294-297.

Bush,RM; Montali,RJ; Kleiman,DG; Randolph,J; Abramowitz,MD; Evans,RF (1980): Diagnosis and repair of familial diaphragmatic defects in golden lion tamarins. J. Amer. Vet. Med. Assoc. 177, 858-862.

Buss,DH (1975): Composition of milk from a golden lion marmoset. Lab. Primate News. 14, 17-18.

Byrd,GB (1981): Sequences of dental ontogeny and Callitrichid taxonomy. Primates. 22, 103-118.

Caminiti,B (1983): Fertility and birth rates among captive nonhuman primates: a bibliography, 1968-198. Seattle Primate Information Center, Seattle, WA.

Carroll,JB (1982): Breeding the golden lion tamarin Leontopithecus rosalia rosalia at the Jersey Wildlife Preservation Trust. Dodo, Journal of the Jersey Wildlife Preservation Trust. 19, 42-46.

Carvalho,JCM (1971): Three marmosets of the genus Leontideus in Brazil. Biol. Cons. 4(1), 66.

Cicmanec,JL (1977): Medical problems encountered in a Callitrichid colony. In: The Biology and Conservation of the Callitrichidae. (Ed: Kleiman,DG) Smithonian Institution Press, Washington, DC, 331-336.

Cicmanec,JL; Campbell,AK (1978): Notes on comparative reproduction of selected Callitrichidae in the laboratory. Prim. Med. 10, 84-87.

Clapp,NK; McArthur,AH; Carson,RL; Henke,MA; Peck,ON; Wood,JD (1987): Visualisation and biopsy of the colon in tamarins and marmosets by endoscopy. Lab. Anim. Sci. 37 (2), 217-219.

Coimbra-Filho,A; R.e.Silva,R; Pissinatti,A (1981): The diet of the Callitrichidae in captivity. Revista Bioterios. 1, 83-93.

Coimbra-Filho,AF (1965): Breeding lion marmosets at Rio de Janeiro Zoo. International Zoo Yearbook. 5, 109-110.

Coimbra-Filho,AF (1969): Mico-leão, Leontideus rosalia; Linnaeus,1766 situação atual de espécie no Brasil (Callithricidae-Primates). Anais da Academia Brasileira de Ciências. 41, 29-52.

Coimbra Filho,AF (1970): Acerca da redescoberta de Leontideus chrysopygus e apontamentos sobre sua ecologia. Revista Brasileira de Biologia 30(4), 609-615.

Coimbra Filho,AF (1970): Considerações gerais e situação atual dos micos-leões-escuros, Leontideus chrysomelas (Kuhl, 1820) e Leontideus chrysopygus (Mikan, 1823). Revista Brasileira de Biologia. 30(2), 249-268.

Coimbra Filho,AF (1972): Mamíferos ameaçados de extinção no Brasil. Chap. 1. In: Especies da Fauna Brasileira Ameacadas de Extinção. 1st ed. Academia Brasileira de Ciências, Rio de Janeiro, 13-98.

Coimbra-Filho,AF (1973): Distribution and ecology of the genus Leontopithecus in Brazil. Primates. 14, 47-66.

Coimbra Filho,AF (1976): As saguis do gênero Leontopithecus Lesson, 1840 (Callitrichidae, Primates). Master Thesis, Universidade Federal do Rio de Janeiro. 72 p. (Non Published)

Coimbra Filho,AF (1976): Leontopithecus rosalia chrysopygus (Mikan, 1823), o mico-leão do Estado de São Paulo (Callitrichidae, Primates). Silv. S. Paulo. 10(1), 1-36.

Coimbra-Filho,AF (1977): Natural shelters of Leontopithecus rosalia and some ecological implications, Callitrichidae: Primates. In: The Biology and Conservation of the Callitrichidae. (Ed: Kleiman,DG) Smithsonian Institution Press, Washington, DC, 79-89.

Coimbra-Filho,AF (1981): Animals preyed or rejected by the marmoset Leontopithecus rosalia rosalia, Primate, Callitrichidae, in its original area of occurrence. Rev. Bras. Biol. 41(4), 717-732.

Coimbra Filho,AF (1982): Nossos primatas ameaçados. Ciência Hoje 1(2), 62-69.

Coimbra Filho,AF (1984): A situação atual dos calitriquídeos que ocorrem no Brasil. In: A Primatologia no Brasil. 1st ed. Vol. 1. (Ed: Thiago de Mello,M) Sociedade Brasileira de Primatologia, Brasília, DF.

Coimbra Filho,AF (1985): Saui-preto ou mico-leão-preto. FBCN Inf. 9(3), 3.

Coimbra Filho,AF; da Rocha e Silva; Pissinatti,A (1984): Cromogenia anômala em Leontopithecus chrysopygus (Mikan, 1823). In: A Primatologia no Brasil. 1st ed. Vol. 1. (Ed: Thiago de Mello,M) Sociedade Brasileira de Primatologia, Brasilia DF.

Coimbra-Filho,AF; Magnanini,A (1972): On the present status of Leontopithecus and some data about new behavioural aspects and management of L. rosalia rosalia. In: Saving the Lion Marmoset. (Ed: Bridgwater,DD) Wild Anim. Propagation Trust, Wheeling, WV, 59-69.

Coimbra Filho,AF; Magnanini,A; Mittermeier,RA (1975): Vanishing gold. Last chance for Brazil's lion tamarin. Anim. King. 78(6), 21-27.

Coimbra-Filho,AF; Maia,AD (1979): Seasonal characterization of reproduction in L. rosalia, Callitrichidae, Primates. Rev. Brasil. Biol. 39, 643-651.

Coimbra-Filho,AF; Maia,AD (1979): The process of molting of the fur in L. rosalia rosalia, Callitrichidae, Primates. Rev. Brasil. Biol. 39, 83-93.

Coimbra-Filho,AF; Mittermeier,RA (1972): Taxonomy of the genus Leontopithecus (Lesson, 1840). In: Saving the Lion Marmoset. (Ed: Bridgewater,DD) Wild Animal Propagation Trust, Wheeling,WV, 7-22.

Coimbra-Filho,AF; Mittermeier,RA (1973): Distribution and ecology of the genus Leontopithecus; Lesson, 1840 in Brasil. Primates. 14, 47-66.

Coimbra-Filho,AF; Mittermeier,RA (1976): Hybridization in the genus Leontopithecus, L. r. rosalia; Linnaeus, 1766 x L. r. chrysomelas; Kuhl, 1820, Callitrichidae, Primates. Rev. Brasil. Biol. 36, 129-137.

Coimbra-Filho,AF; Mittermeier,RA (1977): Conservation of the Brasilian lion tamarins Leontopithecus rosalia. In: Primate Conservation. (Eds: Rainier,P; Bourne,GH) Academic Press, New York, NY, 59-94.

Coimbra-Filho,AF; Mittermeier,RA (1978): Reintroduction and translocation of lion tamarins: a realistic appraisal. In: Biology and Behaviour of Marmosets. (Eds: Rothe,H; Wolters,HJ; Hearn,JP) Eigenverlag H. Rothe, Gottingen, 41-48.

Coimbra-Filho,AF; Mittermeier,RA (1982): Hope for Brasil's golden lion tamarin. I.U.C.N./S.S.C. Pri. Spec. Newsletter. 2, 13.

Coimbra-Filho,AF; Mittermier,RA (1976): Exudate-eating and tree-gouging in marmosets. Nature. 262, 630.

Coimbra-Filho,AF; Pissinatti,A; Ruco,NDC (1980): Morphophysiology of the cecum and its correlation with the odontologic type in Callithricidae Platyrrhini, Primates. Rev. Bras. Biol. 40, 177-186.

Crown,K; Mack,DS (1978): Food sharing among captive Leontopithecus rosalia. Folia. Primatologica. 29, 268-290.

Della Serra,O (1951): Divisão do gênero Leontocebus em dois subgêneros sob bases de caracteres morfológicos. Pap. Av. Depart. Zool. 10(8),147-154.

Dennis,JV (1980): Golden lion and other monkeys. Wildlife, London. 22(8), 20-23.

Dietz,J; Kleiman,DG (1986): Reproductive parameters in groups of free-living golden lion tamarins. Prim. Rep. (14), (abstract).

Dietz,JM; Coimbra-Filho,AF; Pesamilio,DM (1986): Projeto mico-leão I. Um modelo para a conservação de uma espécie ameaçada de extinção. In: A Primatologia no Brasil. 1st ed. Vol. 2. (Ed: Thiago de Mello,M) Sociedade Brasileira de Primatologia, Brasília, DF, 217-222.

Dietz,LA; Nagagata,EY (1985): Captive-born golden lion tamarins released into the wild: A report from the field. Prim. Conserv. 6, 21-27.

Dietz,LA; Nagagata,EY (1986): Projeto mico-leão V. Programa de educação comunitária para a conservação do mico leão dourado L. rosalia (Linnaeus, 1766). Desenvolvimento e avaliação de educação como uma tecnologia para a conservação de uma espécie em extinção. In: A Primatologia no Brasil. 1st ed. Vol. 2. (Ed: Thiago de Mello,M) Sociedade Brasileira de Primatologia, Brasilia, DF, 249-256.

DuBrul,EL (1965): The skull of the lion marmoset, Leontideus rosalia. Amer. J. Phys. Anthrop. 23, 261-276.

DuMond,F (1971): Comments on minimum requirements in the husbandry of the golden marmoset Leontideus rosalia. Lab. Primate. Newsl. 10, 30-37.

DuMond,F (1972): Recommendations for a basic husbandry program for lion marmosets. In: Saving the Lion Marmoset. (Ed: Bridgwater,DD) Wild Anim. Propagation Trust, Wheeling, WV, 120-136.

DuMond,FV; Hoover,BL; Norconk,MA (1972): Social communications by olfactory signals in marmosets. International Zoo Yearbook. 12, 36-42.

DuMond,FV; Hoover,FL; Norconk,MA (1979): Handfeeding parent-reared golden lion tamarins, Leontopithecus r. rosalia, at Monkey Jungle. International Zoo.Yearbook. 19, 155-158.

Eisenberg,JF (1977): Comparative ecology and reproduction of New World monkeys. In: The Biology and Conservation of the Callitrichidae. 1st ed. Vol. 1. (Ed: Kleiman,DG) Smithsonian Institute Press, Washington, DC, 13-22.

Epple,G (1970): Maintenance, breeding and development of marmoset monkeys, Callithricidae, in captivity. Folia. Primat. 12(1), 56-76.

Epple,G (1970): Quantitative studies on scent marking in the marmoset. Folia. Primatologica. 13, 48-62.

Epple,G (1973): The role of pheromones in the social communication of marmoset monkeys (Callithricidae). J. Reprod. Fert. Suppl. 19, 447-454.

Epple,G (1975): The behavior of marmoset monkeys, Callithricidae. In: Primate Behavior. Vol. 4. (Ed: Rosenblum,LA) Academic Press, New York, NY, 195-239.

Epple,G (1978): Reproductive and social behavior of marmosets, with special reference to captive breeding. Primates in Medicine. 10, 50-62.

Erwin,J (1983): Captive breeding of primates. Bison. 1, 4-7.

Fontaine,R; Hench,M (1982): Breeding new world monkeys at Miami's Monkey Jungle, Florida, U.S.A. International Zoo Yearbook. 22, 77-84.

Ford,SM (1980): Callitrichids as phyletic dwarfs, and the place of the Callitrichidae. Primates. 21, 31-43.

Forman,L; Kleiman,DG; Bush,RM; Dietz,JM; Ballou,JD; Phillips,PG; Coimbra-Filho,AF; O'Brien,SJ (1986): Genetic variation within and among lion tamarins. Am. J. Phys. Anthro. 71, 1-11.

French,J; Stribley,J (1987): Synchronization of ovarian cycles within and between social groups in the golden lion tamarin. Amer. J. Prim. 12, 469-478.

French,JA; Inglett,BJ (1989): Female-female aggression and male indifference in response to unfamiliar intruders in lion tamarins. Anim. Behav. 37, 487-497.

French,JA; Inglett,BJ; Dethlefs,TM (1989): The reproductive status of nonbreeding groups members in captive golden lion tamarin social groups. Am. J. Primatology. 18, 73-86.

French,JA; Stribley,JA (1985): Patterns of urinary oestrogen excretion in female golden lion tamarins (Leontopithecus rosalia). J. Repro. and. Fertility. 75, 537-546.

Goff,ML; Whitaker,JO; Dietz,JM (1986): A new species of Microtrombicula (Acari: Trombiculidae) from the golden lion tamarin in Brazil. Int. J. Acarol. 12(3), 171-174.

Green,KM (1979): Vocalizations, behavior, and ontogeny of the golden lion tamarin, Leontopithecus rosalia rosalia Unpub. D.Sc. Dissert. Johns Hopkins University, Baltimore, MD.

Green,KM (1980): An assessment of the Poço das Antas Reserve, Brazil, and prospects for survival of the golden lion tamarin. Umpublished Report to World Wildlife Fund, Washington, DC.

Hagler,E (1975): Einige notizen zur zucht und haltung von zwei paar lowenaffchen Leontopithecus rosalia rosalia im Oklahoma City Zoo. Z. Kolner. Zoo. 18, 126-127.

Hampton,SH (1972): Golden lion marmoset conference. Science. 177, 86-87.

Hampton,SH; Hampton,JK (1962): Rearing marmosets from birth by artificial laboratory techniques. Lab. Animal. Care. 17, 1-10.

Hearn,JP (1975): Conservation of marmosets. Nature. 257, 358-359.

Hearn,JP (1976): Immunization against pregnancy. Proc. R. Soc. London. 195, 149-160.

Hearn,JP; Burden,FJ (1979): "Collaborative" rearing of marmoset triplets. Lab. Anim. Sci. 13, 131-133.

Hearn,JP; Short,RV; Lunn,SF (1975): The effects of immunizing marmoset monkeys against the b-subunit of hcg. In: Physiological Effects of Immunity Against Hormones. (Eds: Edwards,RG; Johnston,MH) Cambridge University Press, Cambridge, MA, 229-247.

Hoage,RJ (1977): Parental care in Leontopithecus rosalia rosalia: sex and age differences in carrying behavior and the role of prior experience. In: The Biology and Conservation of the Callitrichidae. (Ed: Kleiman,DG) Smithsonian Institution Press, Washington, DC, 293-305.

Hoage,RJ (1978): Biosocial development in the golden lion tamarin, Leontopithecus rosalia rosalia. Primates: Callitrichidae. Unpub. Ph.D. Dissert. Univ. of Pittsburgh, Pittsburgh, PA.

Hoage,RJ (1981): The integration of captive and field research among nonhuman primates with special reference to marmoset and tamarin monkeys. In: Anthropological Careers: Perspectives on Research, Employment and Training. (Eds: Landman,R; Bennett,LA; Brooks,A; Chock,P) Anthro. Soc. of Washington, Washington, DC, 159-180.

Hoage,RJ (1982): Social and physical maturation in captive lion tamarins L. rosalia rosalia, Primates, Callitrichidae. Smithsonian. Contrib. Zool. 354, 1-56.

Hodgen,GD; Wolfe,LG; Ogden,JD; Adams,MR; Descalzi,CS; Hildebrand,DF (1976): Diagnosis of pregnancy in marmosets: hemagglutination inhibition test and radioimmunoassay for urinary chorionic gonadotropin. Lab. Anim. Sci. 26, 224-229.

Hunt,RD; Anderson,MP; Chalifoux,LV (1978): Spontaneous infectious diseases of marmosets. Primates in Medicine. 10, 239-253.

Inglett,BJ; French,JA;Deflet, A (1990) Contextual influences on social preferences in a monogamous primate. Journ. Comp. Psych. 104, 131-139.

Inglett,BJ; French,JA; Simmons,LG; Vires,KW (1988): Dynamics of intrafamily aggression and social reintegration in lion tamarins. Zoo Biology 8, 67-78.

Jones,M (1973): 1972 International Studbook for Golden Lion Tamarins.

Keuroghlian,A (1990): Observations on the behavioural ecology of the black lion tamarin (Leontopithecus chrysopygus) at Caetetus Reserve, São Paulo, Brazil. Unpublished Master's Thesis, College of Agriculture and Forestry, West Virginia University, Morgantown. 76pp.

King,G (1975): Feeding and nutrition of the Callitrichidae at the Jersey Zoological Park. Jersey Wildlife Preservation Trust. 12th. Annual. Report, 81-90.

Kingston,WR (1975): The breeding of endangered species of marmosets and tamarins. In: Breeding Endangered Species in Captivity. (Ed: Martin,RD) Academic Press, New York, NY, 213-222.

Kinzey,WG (1982): Distribution of primates and forest refuges. In: Biological Diversification in the Tropics. 1st ed. Vol. 1. (Ed: Prance, TG) Columbia Univ. Press, New York, NY.

Kleiman,DG (1972): Recommendations of Research Priorities for the Lion Marmoset. In: Saving the Lion Marmoset. (Ed: Bridgewater,DD) Proceedings of the WAPT conference, Wheeling,WV, 137-139.

Kleiman,DG (1977): The Biology and Conservation of the Callitrichidae. Smithsonian Institution Press, Washington, D.C.

Kleiman,DG (1977): Characteristics of reproduction and sociosexual interactions in pairs of lion tamarins Leontopithecus rosalia during the reproductive cycle. In: The Biology and Conservation of the Callitrichidae. (Ed: Kleiman,DG) Smithsonian Institution Press, Washington, D.C., 181-190.

Kleiman,DG (1977): Progress and problems in lion tamarin, Leontopithecus rosalia rosalia, reproduction. International Zoo Yearbook. 17, 92-97.

Kleiman,DG (1977): Monogamy in mammals. Quart. Rev. Biol. 52, 39-69.

Kleiman,DG (1978): The development of pair preferences in the lion tamarin Leontopithecus rosalia: male competition or female choice? In: Biology and Behaviour of Marmosets. (Eds: Rothe,H; Wolters,HJ; Hearn,JP) Eigenverlag H. Rothe, Gottingen, 203-208.

Kleiman,DG (1979): Parent-offspring conflict and sibling competition in a monogamous primate. Amer. Nat. 114, 753-760.

Kleiman,DG (1981): Leontopithecus rosalia. Mammalian. Species. 148, 1-7.

Kleiman,DG (1981): Correlations among life history characteristics of mammalian species exhibiting two extreme forms of monogamy. In: Natural Selection and Social Behavior. (Eds: Alexander,RP; Tinkle,DW) Chiron Press, New York, NY, 332-344.

Kleiman,DG (1983): The behavior and conservation of the golden lion tamarin, Leontopithecus r. rosalia. In: A Primatologia No Brasil. (Ed: Mello,MT), Sociedade Brasileira de Primatologia, Brasília, DF, 35-53.

Kleiman,DG (1983): Social and parental behavior of a monogamous primate, the golden lion tamarin. J. of. Amer. Vet. Med. Assoc. 183(3), 363.

Kleiman,DG; Ballou,JD; Evans,RF (1982): An anlysis of recent reproductive trends in the captive golden lion tamarins with comments on their future demographic management. Inter. Zoo. Yearbook. 22, 99-101.

Kleiman,DG; Beck,B; Dietz,J; Dietz,LA; Ballou,J; Coimbra-Filho,A (1985): A conservation program for golden lion tamarins. Annual Meeting of the American Ass. Zoo. Parks and Aquariums. 1985, 60-62.

Kleiman,DG; Dietz,JM; Dietz,JM; Beck,BB; Ballou,J; Coimbra Filho, AF (1986): Reintroduction of golden lion tamarin: A model for the conservation of an endangered species. Prim. Rep. 14, 159.

Kleiman,DG; Evans,RF (1981): 1980 International Studbook, Golden Lion Tamarin, L. rosalia rosalia. National Zool. Park, Washington, D.C.

Kleiman,DG; Gracey,DW; Hodgen,GD (1978): Urinary chorionic gonadotropin levels in pregnant golden lion tamarins: Preliminary observations. J. Med. Primat. 7, 333-338.

Kleiman,DG; Hoage,RJ; Green,KM (): The lion tamarin, Leontopithecus rosalia rosalia. In: Ecology and Behavior of Neotropical Primates. Vol. II. (Eds: Coimbra-Filho,AF; Mittermeier,RA), World Wildlife Fund, Washington,DC, 299-347.

Kleiman,DG; Jones,M (1977): The current status of Leontopithecus rosalia in captivity with comments on breeding success at the National Zoological Park. In: The Biology and Conservation of the Callitrichidae. (Ed: Kleiman,DG) Smithsonian Institution Press, Washington, DC, 215-218.

Kleiman,DG; Mack,DS (1977): A peak in sexual activity during mid- pregnancy in the golden lion tamarin, Leontopithecus rosalia, Primates: Callitrichidae. J. Mammal. 58, 657-660.

Kleiman,DG; Mack,DS (1980): The effects of age, sex, and reproductive status on scent marking frequencies in the golden lion tamarin Leontopithecus rosalia. Folia. Primat. 33, 1-14.

Konstant,WR; Mittermeier,RA (1982): Introduction, reintroduction and translocation of neotropical primates: past experiences and future possibilities. International Zoo Yearbook. 22, 69-77.

Lacher,TE; Fonseca,GAB; Alves,C; Magalhães-Castro,B (1981): Exudate- eating, scent-marking, and territoriality in wild populations of marmosets. Animal. Behaviour. 29, 306.

Laufs,R; Steinke,H (1975): Passive immunization of marmoset monkeys against neoplasia induced by a herpesvirus. Nature. 255, 226-228.

Leutenegger,W (1980): Monogamy in Callitrichids: a consequence of phyletic dwarfism? Inter. J. Prim. Primatology. 1(1), 95-98.

Lorini,ML; Persson,VG (1990): Nova espécie de Leontopithecus Lesson, 1840, do sul do Brasil (Primates, Callitrichidae). Boletim do M. Nacional (338), 1-14.

Magnanini,A (1975): Uma espécie ameacada de extinção no Brasil (Problemas e soluções no caso dos micos leões, L. rosalia. FBCN Inf. (8), 21-23.

Magnanini,A (1977): Progress in the development of Poço das Antas Biological Reserve for Leontopithecus rosalia rosalia in Brazil. In: The Biology and Conservation of the Callitrichidae. (Ed: Kleiman,DG) Smithsonian Institution Press, Washington, DC, 131-136.

Magnanini,A; Coimbra-Filho,AF (1972): The establishment of a captive breeding p rogram and a wildlife research center for the lion marmoset, Leontopithecus, in Brasil. In: Saving the Lion Marmoset. (Ed: Bridgwater,DD) The Wild Animal Propagation Trust, Wheeling, WV, 110-119.

Magnanini,A; Coimbra-Filho,AF; Mittermeier,RA; Aldrighi,A (1975): The Tijuca bank of lion marmosets L. rosalia: a progress report. International Zoo Yearbook. 15, 284-287.

Mallinson,JJC (1975): Breeding marmosets in captivity. In: Breeding Endangered Species in Captivity. (Ed: Martin,RD) Academic Press, New York, NY, 203-212.

Mallinson,JJC (1977): Maintenance of marmosets and tamarins at Jersey Zoological Park with special reference to the design of the new marmoset complex. In: The Biology and Conservation of the Callitrichidae. (Ed: Kleiman,DG) Smithsonian Institution Press, Washington, D.C., 323-329.

Mallinson,JJC (1978): Acclimatisation of tropical mammals in the northern hemisphere with special reference to the family Callitrichidae. In: Biology and Behavior of Marmosets. (Eds: Rothe,H; Wolters,HJ; Hearn,JP), Eigenverlag H. Rothe, Gottingen, 49-55.

Mallinson,J (1984): Lion tamarins survival hangs in balance. Oryx. 18(2), 72-78.

Mallinson,J (1985): Plunder of the golden lions, Brazil's endangered primates. Country Life 2, 368-369.

Mallinson,JJC (1986): A note on the successful breeding and reintroduction of Leontopithecus rosalia with special reference to an nternational recovery programme and management committee for Leontopithecus chrysomelas. Current Issues in Primate Conservation, 48-52.

McLanahan,EB; Green,KM (1977): The vocal repertoire and an analysis of the contexts of vocalizations in Leontopithecus rosalia. In: The Biology and Conservation of the Callitrichidae. (Ed: Kleiman,DG) Smithsonian Institution Press, Washington, DC, 251-269.

Mikan,JC (1820): Delectus florae et faunae Brasiliensis. 1st ed. Anthony Strauss, Vienna, Aust.

Mittermeier,RA (1973): The plight of the lion marmosets. Lab. Prim. Newsl. 12(3), 12-13.

Mittermeier,RA; Bailey,RC; Coimbra-Filho,AF (1977): Conservation status of the Callitrichidae in Brasilian Amazonia, Surinam and French Guiana. In: Biology and Conservation of the Callitrichidae. (Ed: Kleiman,DG) Smithsonian Institution Press, Washington, DC, 137-146.

Mittermeier,RA; Coimbra Filho,AF (1981): Systematics: Species and subspecies. In: Ecology and Behavior of Neotropical Primates. 1st ed. Vol. 1. (Eds: Coimbra Filho,AF; Mittermeier,RA) Academia Brasileira de Ciencias, Rio de Janeiro, RJ, 29-110.

Mittermeier,RA; Coimbra-Filho,AF; Constable,ID (1980): Range extension for an endangered marmoset. Oryx. 15(4), 380-389.

Mittermeier,RA; Coimbra-Filho,AF; Constable,ID; Rylands,AB; Valle,C (1982): Conservation of primates in the Atlantic forest region of eastern Brasil. International Zoo Yearbook. 22, 2-17.

Mittermeier,RA; Coimbra Filho,AF; van Roosmalen,MGM (1977): Conservation status of the wild callitrichids. In: Biology and Behavior of the Marmosets. 1st ed. Vol. 1. (Eds: Rothe,H; Wolters,HJ; Hearn,JP) Mecke-Druck, Goettingen, WG, 17-40.

Mittermeier,RA; Coimbra-Filho,AI; Valle,C (1982): Brazil: primates in peril. I.U.C.N. Bulletin. 13(7-9), 56.

Mittermeier,RA; Rylands, AB; Coimbra-Filho, AF (1988): Systematics: Species and subspecies - an update. In: Ecology and Behavior of Neotropical Primates, 2, (Eds: Mittermeier,RA Rylands,AB; Coimbra-Filho,AF; da Fonseca,GAB. World Wildlife Fund, Wash., D.C. 13-75.

Mittermeier,RA; Valladares-Padua,C; Valle,C; Coimbra Filho,AF (1985): Major program underway to save the black lion tamarin. Prim. Conserv. (6), 19-21.

Molzen,EM; French,JA (1989): The problem of foraging in captive Callitrichid primates: behavioral time budgets and foraging skills. In: Psychological Well-Being of Nonhuman Primates. (Ed: Segal,E) Noyes, Publ, Park Ridge, New Jersey,89-101.

Montali,RJ; Bush,M (1981): Rictulariasis in Callitrichidae at the National Zoological Park. Erkrankungen der Zootiere. Verhandlugsbericht. des. XXIII. Int. Symposiums. uber. die. Erkrankungen. der. Zootiere. 23, 202.

Montali,RJ; Bush,M; Kleiman,DG; Evans,R (1980): Familial diaphragmatic defects in golden lion tamarins (Leontopithecus rosalia rosalia). Verhandlungsbericht. des. XXII. Internationalen. Symposiums. uber. die. Erkrankungen. der. Zootiere. 28, 173-179.

Montali,RJ; Gardiner,CH; Evans,RE; Bush,M (1983): Pterygodermatites nycticebi, Nematoda: spirurida in golden lion tamarins. Lab. Anim. Sci. 33, 194-197.

Montali,RJ; Ramsay,EC; Stephensen,CB; Worley,M; Davis,JA; Holmes,KV (1989): A new transmissible viral Hepatitis of marmosets and tamarins. Journal of infectious diseases. 160, 759-765.

Moynihan,M (1970): Some behavior patterns of Platyrrhine monkeys, ii. Saguinus geoffroyi and some other tamarins. Smithsonian. Contrib. Zool. 28, 1-77.

O'Donnell,K (1974): Female reproductive cycles in primates and experimental methods to determine estrus and menstrual cycle length in the golden lion marmoset Leontopithecus rosalia. M.A. Thesis. University of Illinois.

Omedes,A; Carroll,JB (1980): A comparative study of pair behavior of four Callitrichid species and the goeldi's monkey. The Dodo. 17, 51-62. lion marmoset L. rosalia from Brazil. Anthropologia. Contemporanea. 3, 254.

Peres,C (1986): Ranging patterns and habitat selection in the golden lion tamarin Leontopithecus rosalia. In: A Primatologia no Brasil. Vol. 2. (Ed: Thiago de Mello,M) Sociedade Brasileira de Primatologia, Brasilia, DF.

Peres,CA (1986): Costs and benefits of territorial defense in golden lion tamarins, Leontopithecus rosalia. MS.Thesis. University of Florida, Gainesville,FL.

Perry,J (1971): The golden lion marmoset. Oryx. 11(1), 22-24.

Pinder,L (1986): Translocação como técnica de conservação em Leontopithecus rosalia. MS. Thesis. Instituto de Biologia, Rio de Janeiro.

Pinder,L (1986): Projeto mico-leão III. Avaliação técnica de translocação em L. rosalia (Linnaeus, 1766)(Callitrichidae, Primates). In: A Primatologia no Brasil. 1st ed. Vol. 2. (Ed: Thiago de Mello,M) Sociedade Brasileira de Primatologia, Brasilia, DF, 235-241.

Pissinatti,A; da Cruz,JB; do Nascimento,MD; e Silva,RR; Coimbra-Filho,AF (1987): Spontaneous cholelitiasis in species of Callitrichidae. (Callitrichidae, Primates). Abstract. Int. J. Primatology. 8(5), 514.

Pissinatti,A; Tortelly,R; Coimbra Filho,AF; da Cruz,JB (1985): Alterações causadas por Trichospirura leptostoma em pâncreas de Leontopithecus chrysopygus (Mikan, 1823) Callitrichidae, Primates. Rev. Bras. Med. Vet. 7(6), 184-185.

Pook,AG (1977): Some notes on the development of hand-reared infants of four species of marmoset Callitrichidae. Jersey Wildlife Preservation. Trust. Thirteenth Annual Report, 38-46.

Price,EC; Hannah,AC (1983): A preliminary comparison of group structure in the golden lion tamarin Leontopithecus r. rosalia and the cotton-topped tamarin Saguinus o. oedipus. Dodo, 36-48.

Rabb,GB; Rowell,JE (1960): Notes on reproduction in captive marmosets. J. Mamm. 41, 401.

Ramsay,EC; Montali,RJ; Worley,M; Stephensen,CB; Holmes,KV (1989): Callitrichid hepatitis: epizootiology of a fatal hepatitis in zoo tamarins and marmosets. J. Zoo. &. Wildlife. Medicine. 20, 178-183.

Randolph,J; Bush,M; Abramowitz,M; Kleiman,D; Montali,RJ (1981): Surgical correction of familial diaphragmatic hernia of morgagni in the golden lion tamarin Leontopithecus rosalia. Pediatr. Surg. 16, 396-401.

Rathbun,CD (1979): Description and analysis of the arch display in the golden lion tamarin, Leontopithecus rosalia rosalia. Folia. Primat. 32, 125-148.

Rettberg-Beck,B; Ballou,JD (1987): Survival and reproduction of hand- reared golden lion tamarins. In: 1986 International Studbook for the Golden Lion Tamarin, L. rosalia rosalia. (Ed: Ballou,JD) National Zoological Park, Washington, D.C., 10-14.

Richter,CB; Humason,GL; Godbold,JH (1978): Endemic Pneumocystis carinii in a marmoset colony. J. Comp. Path. 88, 171-180.

Rohrer,MA (1979): Hand-rearing golden lion marmosets, Leontopithecus rosalia, at the Oklahoma City Zoo. Anim. Keeper's. Forum. 6, 33-39.

Rosenberger,AL; Coimbra-Filho,AF (1984): Morphology, taxonomic status and affinities of lion tamarins. Folia. Primat. 42, 149-179.

Rothe,H; Wolters,HJ; Hearn,JP (1978): Biology and behavior of marmosets. Proceedings of the marmoset workshop in Gottingen, W. Germany, September 2-5, 1977. Eigenverlag Rothe, Gottingen, W.Germany.

Rylands,AB (1982): The behaviour and ecology of three species of marmosets and tamarins (Callitrichidae, Primates) in Brazil. PhD Thesis, University of Cambridge.

Rylands,AB (1984): Ecologia do mico-leão, Leontopithecus chrysomelas, e o sagui, Callithrix kuhlii, na Bahia. In: Resumos do VI Congresso Brasilerio de Zoologia, Belém, Pará, 12th-17th February 1984., (Abstract).

Rylands,AB (1984): Marmosets and tamarins. In: The Mammal Encyclopaedia. (Ed: Macdonald,DW). George Allen and Unwin, London, 341-347.

Rylands,AB (1989): Sympatric Brazilian callitrichids: the black-tufted-ear marmoset, Callithrix kuhlii and the golden-headed lion tamarin, Leontopithecus chrysomelas. J. Human Evol. 18(7), 679-697.

Rylands,AB; Santos,IB; Mittermeier,RA (In Press): Distribution and status of Leontopithecus chrysomelas in the wild and captivity. In: A Case Study in Conservation Biology: The Golden Lion Tamarin. (Ed: Kleiman,DG). Smithsonian Institution Press, Wash., D.C.

Rylands,AB; Valle, C (1987): Esperança para o mico-leão preto. Ciência Hoje, 5(28),74-75.

Santos, IB; Mittermeier, RA; Rylands, AB; Valle, CM de C (1987): The distribution and conservation status of primates in southern Bahia, Brazil. Primate Conserv. 8,126-142.

Seuanez,HN; Forman,L; Alves,G (1988): Comparative chromosome morphology in three callitrichid genera: Cebuella, Callithrix, and Leontopithecus. J. Heredity. 79, 418-424.

Shadle,AR; Mirand,EA; Grace,JT (1965): Breeding responses in tamarins. Lab. Anim. Care. 15, 1-10.

Shimwell,M; Warrington,BF; Fowler,JSL (1979): Dietary habits relating to 'wasting marmoset syndrome' (wms). Lab. Animals. 13, 139-142.

Snowdon,CT; Hodun,A; Rosenberger,AL; Coimbra-Filho,AF (1986): Long-call structure and its relation to taxonomy in lion tamarins. Am. J. Primatol. 11, 253-262.

Snyder,PA (1972): Behavior of Leontopithecus rosalia and related species: A review. In: Saving the Lion Marmoset. (Ed: Bridgwater,DD) WV: Wild Animal Propagation Trust, Wheeling, 23-49.

Snyder,PA (1974): Behavior of Leontopithecus rosalia, golden lion marmoset and related species: a review. J. Human. Evol. 3, 109-122.

Soares,VMFC; Pissinatti,A; Coimbra-Filho,AF; Alvares,JN; Seuanez,HN (1982): Chromosome studies in Callitrichidae (Platyrrhini) a comparison between Callithrix and Leontopithecus. J. Med. Primat. 11(4), 221-234.

Stout,LC; Whorton,EB; Vaghela,M (1983): Pathogenesis of diffuse intimal thickening in nonhuman primate thoracic aortas. Atherosclerosis. 47, 1-6.

Stribley,JA; French,JA; Inglett,BJ (1987): Mating patterns in golden lion tamarin (Leontopithecus rosalia) : Continuous receptivity and concealed estrus. Folia. Primatologica. 49, 137-150.

Thiessen,D; Rice,M (1976): Mammalian scent gland marking and social behavior. Psychol. Bull. 83(4), 505-539.

Thorington,RW (1976): The systematics of New World monkeys. PAHO. Scient. Publ. 317, 8-18.

Ulmer,FA (1961): Gestation period of the lion marmoset. J. Mammal. 42, 253-254.

Valladares-Padua,C (1987): The black-lion tamarin (Leontopithecus chrysopygus): status and conservation. MA. Thesis. University of Florida.

Valle, C; Rylands, AB (1986): Lion tamarins rescued. Oryx 20, 71-72.

Vogt,P (1977): Tropical house for apes at Krefeld Zoo. International Zoo. Yearbook. 17, 225-228.

Wagner,D (1978): Anaesthesia and treatment of marmosets. In: Biology and Behavior of Marmosets. (Eds: Rothe,H; Wolters,HJ; Hearn,JP) Eigenverlag H. Rothe, Gottingen, W.Germany, 291-293.

Williams,JB (1981): Behavioral observations of feral and free-ranging new world monkeys Cebidae and Callitrichidae: a bibliography. Primate Information Center, Seattle, WA.

Wilson,CG (1976): Food sharing behavior in primates: another species added. Ark. Acad. Sci. Proc. 30, 95-96.

Wilson,CG (1977): Gestation and reproduction in golden lion tamarins. In: The Biology and Conservation of the Callitrichidae. (Ed: Kleiman,DG) Smithsonian Institution Press, Washington, D.C., 191-192.

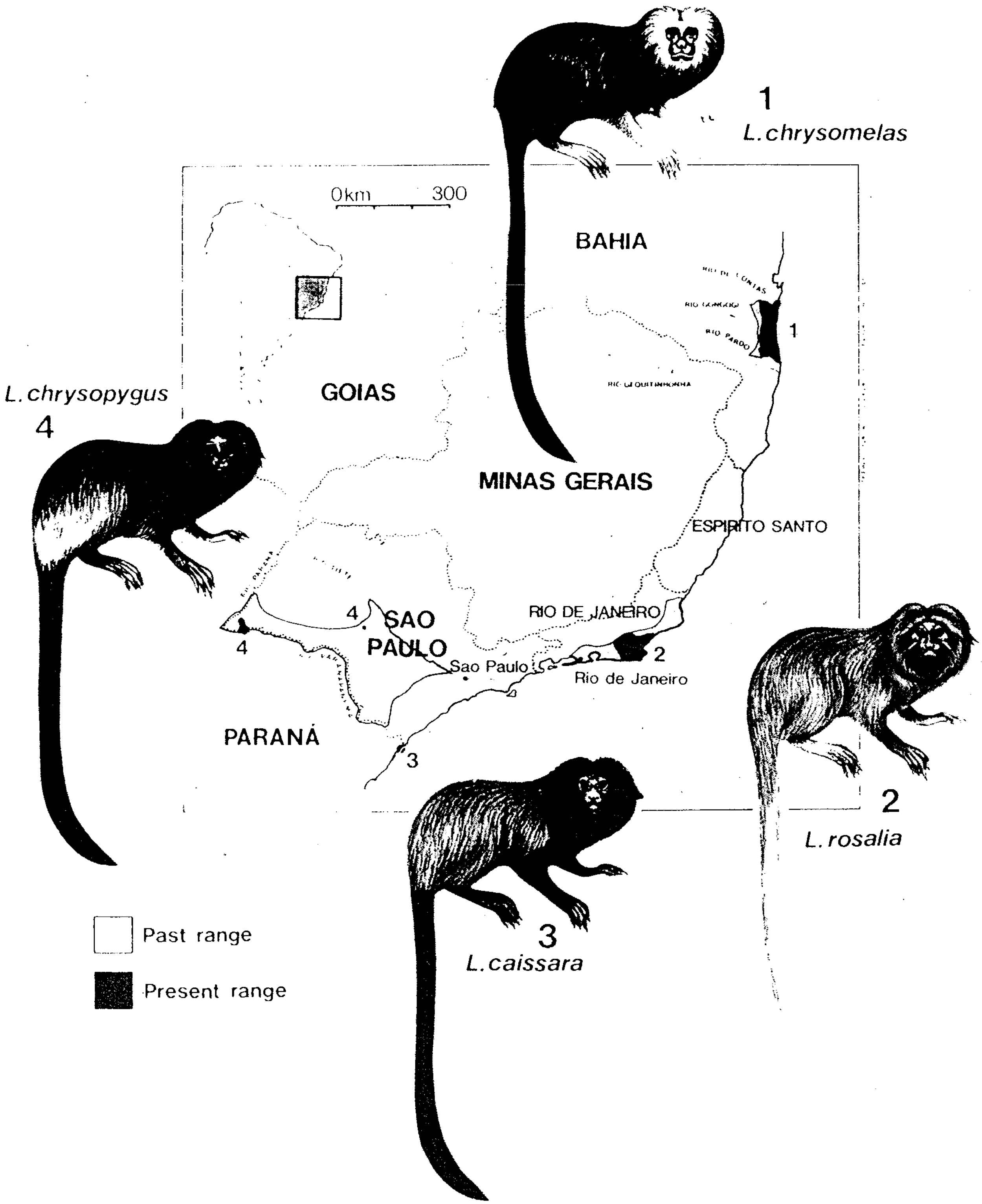
Wilson,GC (UNKNOWN YEAR): The social and reproductive behavior of golden lion tamarins, Leontopithecus rosalia in the Oklahoma Zoo. MS. Thesis. Oklahoma State University, .

Yue,MY; Jensen,J; Jordan,H (1980): Spirurid infections Rictularia sp. in golden marmosets (a), Leontopithecus rosalia from the Oklahoma City Zoo. J. Zoo. Anim. Med. 11, 77-80.

LEONTOPITHECUS

MICO - LEÃO

ANÁLISE DE VIABILIDADE & PLANO DE SOBREVIVÊNCIA



1
L. chrysomelas
0km 300
BAHIA
1
GOIAS
L. chrysopygus
4
MINAS GERAIS
ESPIRITO SANTO
RIO DE JANEIRO
4
SAO PAULO
2
4
Sao Paulo
Rio de Janeiro
PARANÁ
3
2
L. rosalia
3
L. caissara
Past range
Present range

LEONTOPITHECUS

MICO - LEÃO

ANÁLISE DE VIABILIDADE & PLANO DE SOBREVIVÊNCIA

GRUPO DE TRABALHO

RECOMENDAÇÕES SOBRE *LEONTOPITHECUS*

Viabilidade das Populações

e

Plano de Conservação

20-23 de Junho de 1990

OBJETIVOS

Recomendações e esquema de atividades necessários para garantir a sobrevivência a longo prazo e evolução em vida silvestre de cada uma das espécies de *Leontopithecus*, com uma probabilidade maior do que 98% de sobrevivência durante os próximos 100 anos.

STATUS ATUAL E POTENCIAL DAS QUATRO ESPÉCIES

As quatro espécies (*Leontopithecus rosalia*, *L. chrysomelas*, *L. chrysopygus* e o recém descoberto *L. caissara*) de micos-leões estão ameaçadas em seu ambiente natural. Seu habitat histórico foi reduzido à apenas 2% da sua área original e está fragmentado a tal ponto que a espécie mais abundante (*L. chrysomelas*) possui menos de 600 indivíduos em áreas protegidas. Porções deste habitat remanescente e suas populações isoladas estão em perigo eminente de serem perdidas. Com isto, os riscos de extinção são aumentados e a viabilidade das populações restantes diminuida. A sobrevivência e conservação destas espécies em vida silvestre dependerão de:

1) Ações imediatas para garantir e proteger seu habitat;

2) Rescensear e proteger as populações silvestres.

3) Manter populações em cativeiro através de manejo científico;

4) Após cumprido o acima disposto, repovoar habitats apropriados nos quais as espécies não estejam mais presentes.

Baseando-se nas informações detalhadas colhidas, recebidas e condensadas durante a reunião, as seguintes recomendações foram feitas para a conservação das espécies de *Leontopithecus*.

RECOMENDAÇÕES

Para Todas As Espécies:

1. Estabelecer uma população em vida silvestre de no mínimo 2000 indivíduos para cada espécie até o ano 2025.

2. Cada espécie deverá ser constituída de pelo menos 3 sub-populações, cada uma com no mínimo 100 indivíduos em idade reprodutiva. As populações deverão estar suficientemente espaçadas para minimizar (<5%) a probabilidade de que catástrofes ambientais irão afetar as 3 populações durante o mesmo ano. Populações menores necessitarão de um monitoramento e manejo mais intensivos.

3. Identificar, garantir, e proteger suficiente habitat para cada espécie, o qual deverá suportar uma população de pelo menos 2000 indivíduos.

4. Caso o risco de extinção para o período de 100 anos seja maior do que 5%, então deve-se estabelecer uma população em cativeiro de modo a preservar 90% da heterozigosidade genética durante 100 anos. Não utilizar esta população para reintroduções até que esta esteja genetica e demograficamente segura.

5. Conduzir inventórios sobre os micos em todas as áreas que sejam passíveis de proteção e que possam conter os micos. Se as áreas contiverem *Leontopithecus*, censos e avaliações do habitat deverão ser conduzidas de modo a prover informações para o desenvolvimento de um protocolo de manejo.

6. Desenvolver um modelo populacional e um plano de manejo para cada uma das sub-populações e áreas protegidas assim como para cada população em cativeiro como parte de um plano de conservação para cada espécie de *Leontopithecus*.

7. Desenvolver um modelo metapopulacional e um plano para cada espécie de *Leontopithecus* que integre as estratégias de conservação para todas as sub-populações silvestres e as populações em cativeiro.

8. No evento de que os animais de cativeiro sejam utilizados para reinforçar as populações silvestres, deve-se prevenir a introdução de condições infecciosas, metabolicas ou de desenvolvimento, que possam ter se desenvolvido ou adaptado às condições em cativeiro.

Para As Espécies Em Particular

Leontopithecus rosalia:

Area total protegida é igual a 5.500 ha, dos quais 2900 ha em matas, contendo um número estimado de 290 micos-leões-dourados. Quatro blocos adicionais de habitat relativamente grandes, provavelmente contendo *L. rosalia* e potencialmente disponíveis para proteção totalizam aproximadamente 5150 ha. Além desses existem aproximadamente 20 áreas pequenas (50-100 ha) que podem ser viáveis para uma média de 1.5 grupos com 5 individuos cada. Assim, a área de florestas disponíveis para micos-leões-dourados e de 10650 ha, com uma capacidade de potential de sustentação de 844 micos. O número de micos confirmados na natureza é de 450 indivíduos atualmente. Esses valores excluem animais nascidos em cativeiro e reintroduzidos. A área total de habitat necessária para 2000 animais é de aproximadamente 25000 ha.

Riscos para as populações silvestres incluem fogo, doencas, pesticidas, acidentes com trens conduzindo produtos químicos, construção de barragens e perda de habitat por desmatamento. Estudos sobre a população silvestre têm fornecido dados sobre história vital e demografia da espécie que podem ser utilizados em modelos populacionais para avaliação dos riscos de extinção e os efeitos das diferentes estratégias de manejo na redução destes riscos.

Existem aproximadamente 560 animais em cativeiro, os quais estão sendo manejados demográfica e geneticamente de acordo com os princípios de biologia de populações.

RECOMENDAÇÕES EM ORDEM DE PRIORIDADE:

1. Identificar e recensear novas áreas com potencial de suportar populações de micos-leões-dourados;

2. Assegurar a proteção de areas que abrigam micos-leões-dourados atualmente bem como habitats em potencial, principalmente grandes áreas de mata próximas à Reserva Biológica de Poço das Antas. Desenvolver planos específicos para a Base Naval e Fazenda União;

3. Comprar terra, quando necessário, para assegurar a proteção de habitats atuais e potenciais de micos-leões-dourados;

4. Controlar e prevenir acidentes, especialmente na Reserva Biológica de Poco das Antas;

   a. Prevenir transmissão de doenças as populações silvestres,

b. Investigar alterações na bacia d'agua em áreas de turfa, para prevenir outros incendios e encorajar a rápida formação de florestas;

c. Prevenir fogo ou derramamentos de produtos tóxicos, transportados pela linha férrea através da Reserva;

5. Reflorestar e restaurar habitats degradados em áreas protegidas, incluindo um programa de pesquisa para desenvolver projetos de reflorestamento efetivos em termos de rapidez e baixo custo;

6. Aumentar a contribuição de indivíduos fundadores na população em cativeiro; um método pode ser a captura de grupos de em ilhas de habitat ameaçado para incorporá-los ao programa de criação em cativeiro;

7. Aumentar os programas de educação ambiental, a nível nacional e internacional para contribuir com a execução de todas as recomendações aqui porpostas e assegurar a continuação a longo-prazo de programas de educação ambiental atraves de um aumento no apoio financeiro por parte do IBAMA;

8. Expandir o programa de reintrodução;

9. Implementar programas para o manejo genetico de toda a populacao mundial (silvestre e em cativeiro);

ESTIMATIVA DE CUSTOS PARA IMPLEMENTAR O PROGRAMA (em U$1,000):

Distribiuido em ítens Recomendação Ano 1	Pessoal	Materiais	Equipamento	Próximos	5 anos
Identificação e censo de novas áreas	25	10	5	10	10
Proteção de áreas novas e existentes	150	20	10	120	75
Compra de terras	2570				
Prervenção contra fogo	175	30	10	135	50
Prevenção de doenças	15	5	5	5	10

Distribiuido em ítens Recomendação Ano 1	Pessoal	Materiais	Equipamento	Próximos	5 anos
Prevenção de desastre de trem	500				
Restauração Florestal					
Pesquisas	50	30	10	10	30
Implementação	100	40	60		80
Aumento no # de fundadores em cativeiro	10				10
Expanção em Edu. Ambiental	50	20	5	25	35
Expanção Prog. Reintrodução	45	15	5	25	30
Implementação Prog. Manejo	45	20	20	5	25
TOTAL	3735				355

O custo atual estimado para o program de conservação de *L. rosalia* é de $ 200,000/ano incluindo: educação; ecologia de comunidades; pesquisa em ecologia comportamental; reintrodução; restauração. Estes custos incluem os cordenadores estrangeiros, mas não os de manejo em cativeiro nem da Reserva Biológica de Poço das Antas.

Custo total estimado para o primeiro ano (incluindo o programa) $3,935,000

Custo dos anos subsequentes (5 anos) $555,000

Leontopithecus chrysomelas:

Área total protegida com habitat adequado é igual a 6200 ha. É estimado que 550-600 animais existam neste habitat com um potencial máximo de sustentação de aproximadamente 1000 indivíduos. Um adicional de 1000 ha de habitat em potencial podem existir na reserva de Una e talvez até 9000 ha em áreas particulares (mais vulneráveis ao desaparecimento). Assim, no total existem entre 7000 e 18000 ha de habitat protegido e potencial, os quais podem abrigar de 850 a 3100 animais sob condições ótimas de manejo. Atuais riscos para as populações incluem: desmatamento, incêndios e captura ilegal. A população de cativeiro, agora com 285 animais, possui animais distribuidos em 22 instituições.

RECOMENDAÇÕES:

1. Em áreas protegidas existentes:

   a. Implementação efetiva da reserva de Una.

   b. Relocação dos posseiros vivendo em Una.

   c. Adquirir urgentemente um corredor de 1000 ha ligando dois blocos de mata na Reserva (sendo considerado no presente).

   d. Prover infraestrutura e proteção adequadas para a reserva de Una.

   e. Inventoriar os micos-leões de cara dourada e conduzir pesquisas ecologicas adicionais na reservas de Una, ESCAN e Lemos Maia.

   f. Garantir que a CEPLAC mantenha a floresta restante em Lemos Maia.

   g. Garantir a transferência da ESCAN das mãos da CEPLAC para o IBAMA; investigar a possibilidade de aumentar a área da ESCAN.

   h. Estudar a possibilidade de restaurar as áreas degradadas de Una.

2. Em áreas de potencial proteção:

   a. Conduzir levantamentos de vegetação na área de distribuição da espécie usando imagens de satélite e pesquisas terrestres nos locais indicados.

   b. Levantar a população restante através de toda a área de distribuição geográfica conhecida.

c. Identificar novas áreas para proteção, incluindo levantamento vegetacional e estimativa populacional dos micos nas áreas de maior significancia.

d. Conduzir estudos em regeneração de florestas secundárias e plantações de cacau abandonadas.

e. Verificar as taxas de desmatamento e suas causas na região.

3. Educação Ambiental:

a. Promover a criação de reservas particulares nas terras de fazendeiros locais.

b. Enfocar esforços sobre a população local para diminuir o tráfico de animais.

c. Envolver estudantes Baianos (Universidade de Santa Cruz) nas pesquisas de conservação da região.

4. Reprodução em Cativeiro:

a. Expandir a rede de instituições envolvidas na reprodução dos micos de cara-dourada.

b. Facilitar a transferência de animais reproduzidos em cativeiro entre as instituições, ambas nacionais e internacionais.

c. Tranferência urgente dos animais mantidos em cativeiro em Una para instituições no Brasil ou exterior.

d. Construir um centro na região (não em Una) onde animais confiscados ou em processo de translocação possam ser quarentenados ou mantidos temporariamente enquanto em trânsito.

5. Reintroduções:

a. Identificar áreas potenciais para um programa de reintrodução.

Leontopithecus chrysopygus:

Área total protegida igual a 36340 ha dos quais 29000 ha representam habitat adequado. Existem aproximadamente 450 animais conhecidos em vida silvestre. Caso o habitat protegido seja manejado a população pode atingir 1600 animais. Isto não é suficiente para atingir a cota dos 2000 indivíduos, o que é o objetivo para a espécie. A população de cativeiro consiste de 64 animais localizados em duas instituições e foi fundada por 22 indivíduos. Este numero de animais e sua atual distribuição em cativeiro não é suficiente para assegurar sua sobrevivência. Riscos para a população silvestre incluem: incêndios, desmatamento e caça.

RECOMENDAÇÕES:

1. Inventoriar os animais fora da reserva ($50000).

2. Conduzir um censo na reserva de Caitetus ($10000).

3. Aumentar o financiamento para o Centro de Primatologia do Rio de Janeiro ($100000/ano).

4. Prevenção e controle efetivo contra incêndios ($150000).

5. Desenvolver um plano de manejo científico para a população de cativeiro ($2000).

6. Intensificar o programa de educação ambiental na reserva de Morro do Diabo (ano 1: $40000; ano 2: $40000) e iniciar um programa semelhante em Caitetus (ano 1: $75000; ano 2: $40000).

7. Iniciar programa de restauração ambiental para aumentar a capacidade de sustentação em Morro do Diabo e Caitetus.

8. Aumentar financiamento para vigilância e patrulhamento.

9. Definir os limites legais do parque.

10. Desenvolver um plano de manejo para Morro do Diabo e Caitetus ($50000).

11. Criar áreas tampões ao redor das áreas de proteção.

12. Continuar trabalhos de campo sobre a biologia dos micos em Morro do Diabo ($30000/ano).

13. Identificar novos habitats para repovoamento.

Leontopithecus caissara:

A área em potencial (Ilha Superagui) é de aproximadamente 5000 ha. Habitat adequado pode existir também em áreas adjacentes no continente. O tamanho da população é desconhecido, mas uma estimativa aproximada indica entre 125 e 625 animais, baseando-se nos requerimento de habitat das outras espécies. Muito pouco é sabido a respeito desta espécie recém-descoberta. O principal risco imediato é o tráfico de animais e desenvolvimento econômico local. Não existe nehuma população em cativeiro. Informações das outras espécies serão utilizadas para efetuar recomendações para esta espécie.

RECOMENDAÇÕES:

1. Conduzir pesquisa básica sobre a espécie, sua distribuição e seu habitat.

2. Incluir a espécie na Lista Brasileira de Espécies Ameaçadas e CITES.

3. Aumentar a fiscalização e prover o IBAMA com informações para a redefinição dos limites do parque.

4. Implementar um programa de educação ambiental enfocando a população local.

5. Tão logo quanto as pesquisas básicas permitirem, iniciar um programa de reprodução em cativeiro.

6. Prover fundos de acordo com o seguinte orçamento preliminar, para um período de 3 anos:

a. Pesquisa sobre ecologia geral, população e distribuição	$70.000
b. Pesquisa sobre ecologia e comportamento	$85.000
c. Programa de proteção ambiental	$50.000
d. Educação ambiental	$50.000

7. Criar um comitê especial equivalente ao das outras 3 espécies, para lidar com a conservação do novo mico em vida silvestre e eventualmente em cativeiro.

LEONTOPITHECUS

MICO - LEÃO

ANÁLISE DE VIABILIDADE & PLANO DE SOBREVIVÊNCIA

PLANO DE CONSERVAÇÃO

RELATORIO - MICO-LEÃO DOURADO

I. População Silvestre

A. Identificação de Habitats Protegidos

Locações	Área Total	Área Florestada	Proprietario
Poço das Antas	5,500	2900	IBAMA

B. Ameaças a População Protegida

Origem	Frequência	Projeções
Doenças	1 a cada 100 anos	50% redução sobrevivência
Trem	2 a cada 100 anos	10% " " "
Pesticidas	5 a cada 100 anos	10% " " "
Fogo	50 a cada 100 anos	30% redução da capacidade projetada

Descrição das estimativas de frequência e efeitos na população.

Doenças: Não existem sinais de epidemias, como por exemplo varias mortes no mesmo grupo, na Reserva Biológica Poço das Antas desde quando comecaram as observações, em 1983. Por isso, nos consideramos improvável a ocorrência de epídemia. A nossa estimativa de redução na sobrevivência, caso ocorra epídemia, e baseada na pior das hipoteses segundo R. Montali.

Trem: Ocorreram dois descarrilhamentos na Reserva desde 1983, nenhum dos dois com consequências na população de MLD. Mas, derramamento de combustivel resultando em fogo, e derramamento de produtos quimicos podem causar a eliminação de grupos vizinhos (estimados em três) ou de habitat.

Pesticidas: Estes produtos sao usados em fazendas vizinhas a Reserva. Erros no seu uso podem resultar em contaminação nas bordas da Reserva. A eliminação de populações de insetos ou intoxicação de micos poderia resultar em perdas de grupos nestas áreas.

C. Capacidade Estimada de Sustentação

290 indivíduos na área atualmente florestada; potencial total da Reserva se totalmente reflorestada = 508.

Este número é baseado na densidade de 1 animal/ 8 hectares na área de estudo (900 hectares), e uma densidade 33% menor (uma animal/ 12 hectares) para o resto do habitat em uso na Reserva (2000 hectares). Foi usada a menor densidade por dois motivos: para se ter uma estimativa cautelosa e porque é provavel que a área de estudo seja de melhor qualidade dentro da Reserva.

D. Habitat potencial

Local	Área Florestada		
	Hectares	MLDs?	Proprietario
Base Naval S.Pedro Aldeia	500	Sim	Marinha
Fazenda União	1000	?	RFFSA
Rio Vermelho-P. Abreu	1650	?	Particular
Morro de Sao Joao	2000	?	Particulares

Total	5150		

Alem destas, existem aproximadamente 20 pequenas áreas,com 50 a 100 ha cada, que podem ser consideradas como habitat adequado para uma media de 1.5 grupos com 5 individuos cada.

Ameaça as áreas potenciais:

Local	Probabilidade de ocorrência de desmate total ate 2025
Base Naval São Pedro Aldeia	5%
Fazenda União	10%
Rio Vermelho	50%
Morro de São João	50%
Áreas pequenas	75%

E. Projeções e estimativas sobre as áreas protegidas no ano 2025.

A estimativa total de áreas de habitat aceitável para o MLD no ano 2025, excluindo as pequenas áreas e se nenhuma outra área for identificada, e de 10,650 hectares. Esta projeção requer (1) preservação integral das áreas potenciais e (2) reflorestamento de todas as áreas de habitat degradado na Reserva.

Esta área potencial poderia suportar um contingente de 937 individuos, 47% do total desejado de uma população silvestre de 2000 individuos. Caso pequenos remanescentes florestais ou áreas isoladas sejam incluidas, a projeção da área total disponivel para a espécie passará para 12.150 ha, que poderiam suportar uma população de 1062 individuos, 53% da população selvagem desejada.

Projeções para o ano 2025

Área necessaria para 2000 animais:	23404 ha	(100%)
	-5500 ha em Poço das Antas	(24%)
	-5150 ha áreas não protegidas	(22%)

	12754 ha necessários no ano de 2025	(54%)

Entao, para atingir a meta de 2000 individuos, será necessario a identificação ou regeneração de uma área maior que aquela identificada atualmente. Análises sugerem que as metas imediatas devem ser a identificação e proteção de áreas florestadas que representem duas vezes o tamanho da Reserva.

II. Perfil da População Silvestre

A. Sobrevivência:

Filhotes	87% (N=60 filhotes)
Juvenil ate 2 anos ou até a saida do grupo familiar	90% (N=20 indivíduos)

Primeiro ano após saída do grupo:

Macho 67% (N=15 indivíduos)

Femea 50% (dados insuficientes, mas a expectativa é menor do que nos machos pois existem menos espacos disponíveis para fêmeas imigrantes).

*Porcentagem total desde o nascimento ate estagio reprodutivo:

Macho 52%

Fêmea---------- 39%

*Sobrevivência de adultos (anual):

Machos--------- 86% (N=42.6)

Fêmeas--------- 85% (N=27.2)

B. Idade na primeira reprodução: 3 anos

C. Número de filhotes/fêmea/ano

Número de filhotes	% fêmeas
0	19
1	6
2	52
3	6
4	17

Média: 1.94 filhote/fêmea/ano (N=31)

D. 71% dos machos adultos em grupos territoriais contribuem para reprodução: cerca de 40% dos grupos tem dois machos adultos não aparentados com a fêmea reprodutora, mas provavelmente apenas um macho por grupo contribuirá geneticamente em determinado ano.

E. Tamanho de população efetiva = 94.

Isso foi calculado baseado numa estimativa de 45 grupos na Reserva, com um macho reprodutor em cada grupo (total=45), mas com duas fêmeas reprodutoras em 10% dos grupos (total=49).

F. Número total de indivíduos reintroduzidos

Adultos sobrevivêntes + filhotes

III. Perfil da população reintroduzida (ate 1 maio, 1990).

A. Indivíduos nascidos em cativeiro e reintroduzidos.

No. reintroduzido	73
No. sobrevivêndo	28 (38%)

B. Indivíduos silvestres e reintroduzido.

No. reintroduzido	6
No. sobrevivêndo	3 (50%)

C. Performance reprodutiva dos indivíduos reintroduzidos.

No. de nascimentos apoś reintrodução	34
No. de filhotes sobrevivendo	21 (62%)

D. No. total de indivíduos resultantes da reintrodução (adultos + filhotes)	52

IV. Perfil das populações em cativeiro.

A. Demografia (agosto 1989)

1. No. total de indivíduos vivos	541
2. % pop. adulta reprod.	29%
3. % pop. adulta não reprod.	31%
4. % pop. ainda no grupo familiar	40%

B. Resumo Genético

1. No. de fundadores	46
2. Fundadores equivalentes	14.7

RECOMENDAÇÕES por ordem de prioridade:

1. Identificar novas áreas potenciais.

2. Assegurar a preservação das áreas potenciais identificadas como habitat apropriado, principalmente aquelas extensas ou próximas a Reserva de Poço das Antas, e desenvolver planos específicos para a Base Naval e a Fazenda Uniao.

3. Inventariar as populações de micos-leões-dourados em todas as áreas potenciais.

4. Prevenir e controlar acidentes que possam causar danos a Reserva Biologica de Poco das Antas tais como incêndios florestais e derramamento de combustível ou produtos tóxicos pela RFFSA. Investigar a alteração do nível hídrico nas áreas de turfa para prevenir fogo e incentivar a formação de floresta.

5. Estabelecer um programa para desenvolver manevias compativeis e viaveis tecnico-economicamente de reflorestamento e restauração dos habitats.

6. Aumentar o numero de fundadores na população em cativeiro; um metodo seria resgatar grupos de animais om ilhas de habitats ameacadas incorporando-os ao programa de criação em cativeiro.

7. Implementar um programa para o manejo genetico de toda a população mundial de micos-leões-dourados (selvageni e em cativeiro).

8. Expandir o programa de reintrodução.

9. Incrementar o programa de educação ambiental no sentido de contribuir para a efetivação das recomendações propostas.

10. Aumentar o conhecimento em ecologia de comunidades para os micos-leões-dourados.

11. Assegurar a continuidade de programas de educação ambiental a longo prazo atraves de um crescente apôio financeiro do IBAMA.

12. Avaliar o Programa de Conservação do Mico-Leão-Dourado visando a melhoria de sua capacidade em contribuir para a execução das recomendações acima mencionadas.

RELATORIO - MICO-LEÃO-DA-CARA-DOURADA

Membros do Grupo: Anthony Rylands (líder), Jeremy Mallinson, Adelmar Coimbra Filho, Cristina Alves, Max de Menezes, Saturnino de Souza, Ilmar Santos, Iolita Bampi, Jo Gipps.

I. POPULAÇÃO NO HABITAT NATURAL

nota: dados ainda não completamente coletados e analizados

A. Áreas Protegidas:

Três áreas identificadas dentro da área de distribuicão conhecida (entre os Rios Contas e Jequitinhonha).

1. Reserva Biológica de Una (IBAMA) (REBIO de Una)
   - criada em dezembro de 1980, com 11400 ha
   - somente 5342 ha foram adquiridos pelo IBDF (agora IBAMA) em dois blocos: Zona da Piedade (2607 ha) com 80 famílias de posseiros e Zona do Maruim, com nenhum posseiro. O número de posseiros na Zona da Piedade está agora reduzido a 30, com nenhum posseiro na Zona do Maruim (2735 ha).
   - 243 ha foram comprados em 1989/90 para aumentar o corredor entre as duas zonas.
   - área total atualmente de propriedade do IBAMA = 5585 ha.

2. Estação Experimental de Lemos Maia (CEPLAC)
   - área aproximada de 495 ha, dos quais aproximadamente 100 ha são de mata.
   - Três km ao sul da REBIO de Una

3. Estação Experimental de Canavieiras (ESCAN) (CEPLAC)
   - área aproximada de 500 ha
   - aproximadamente 40 km ao sul da REBIO de Una
   - quase completamente coberta por mata de boa qualidade
   - atualmente sendo considerada sua transferência da CEPLAC para o IBAMA

B. Potencial Para Proteção de Habitat no Futuro

1. Una:
   - mais terras estão sendo adquiridas (1000 ha) para fazer a Reserva mais arredondada (para a redução de pontas). Esse processo pode continuar, incorporando terras já adquiridas na época da criação da Reserva.
   - isso fará da área total da Reserva 6585 ha (alta probabilidade)
   - mais 1000 ha devem ser incluídos no futuro (baixa probabilidade)

2. Lemos Maia:
   - sugere-se a aquisicão de um corredor unindo a Rebio de Una a Lemos Maia (uma área de aproximadamente 600 ha)

3. ESCAN:
   - existe uma baixa possibilidade de que mais terras possam ser compradas (não mais que 350 ha). Há uma alta probabilidade de que haja uma transferência de título da CEPLAC para o IBAMA e uma baixa possibilidade que terra vizinhas (aproximadamente 500 ha) sejam transferidas do Instituto Nacional de Colonizacão e Reforma Agrária (INCRA) para o IBAMA.

4. Fazendas com MLCD na região da Rebio de Una que têm bom habitat e que podem se tornar áreas protegidas (baixa probabilidade)
   * Fazenda Dendévea (2,500 ha: a melhor área de mata na região da REBIO de UNA)
   * Fazenda Piedade (1,100 ha de mata, a maioria em plantacões de caçãu e borracha abandonadas), mas com alguma mata de boa qualidade)
   * Fazenda Pindorama (dois blocos: um de aproximadamente 1,000 ha de boa qualidade e outro de 300 ha).

5. Existem ainda outras fazendas na área, algumas das quais devem ser avaliáveis como habitat protegido para o MLCD (baixa probabilidade). Uma simples estimativa seriam 10 fazendas, cada uma com uma área de 150 ha, dando um total de 1500 ha.

6. Existem outras 13 localidades onde MLCDs foram registrados (observacões ou peles) e outras 36 localidades indicadas por pessoas do local (ainda não confirmadas; área total de habitat adequado ainda não determinada, mas digamos, 49 áreas com tamanho de 50 ha cada, dando um total possível de 2450 ha).

C. Resumo das Áreas Existentes e Potenciais de Habitat Protegidos. (Figuras em ha)

	Existentes (a)	Alta prob. (b)	Total (a+b)
a. Una	5585	1000	6585
b. Lemos Maia	100	600	700
c. ESCAN	500	-	500
d. Propriedades listadas	-	-	-
e. Outras propriedades	-	-	-
f. Observações visuais	-	-	-
TOTAL	6185	1600	7785

	Baixa prob (c)	Total (a+b+c)
a. Una	1000	7585
b. Lemos Maia	-	700
c. ESCAN	850	1350
d. Propriedades listadas	4900	4900
e. Outras propriedades	1500	1500
f. Observações visuais	2450	2450
TOTAL	10700	18485

Assim, em resumo:

* Existem 6185 ha de habitat protegidos.
* Existe uma alta possibilidade dessa área aumentar para 7785 ha.
* Existe além disso, a possibilidade (muito baixa) dessa área aumentar para 18485 ha.

D. Número de Animais Protegidos no Presente:

Esses números são baseados nos seguintes métodos e premissas:

Método 1: . Número medio de indivíduos por grupo= 6.6. Tamanho da área de uso por grupo (sem sobreposicão) = 42 ha

Método 2: . Distribuicão das densidades estimadas por levantamentos por transectos em Lemos Maia, 1980. Baixa: 0.046 ind./ha; alta: 0.167 ind./ha.

1. Una:

-Se a Reserva na sua totalidade consistisse de um habitat ideal, a população seria de:

Método 1: 972 indivíduos (50% = 466 - esse número, considerado mais realístico é usado para os cálculos a seguir)

Método 2: 257 - 933 indivíduos

2. Lemos Maia:

Método 1: 20 indivíduos

Método 2: 5 - 17 indivíduos
Obeservados: 3 grupos vistos, 20 indivíduos

3. ESCAN:

Método 1: 79 indivíduos

Método 2: 23:84 indivíduos
2 grupos avistados; não mais que 10 grupos

Áreas e animais protegidos: resumo

	Área(ha)	População (método 1)	Populacão (método 2)
Una	5585	466	257 - 933
Lemos Maia	100	20	5 - 17
ESCAN	500	78	23 - 17
Total	6185	564	285 -1033

E. O Número de Animais Que Poderiam Ser Apreendidos (se novas terras fossem obtidas).

	A	B	C	D	E
Método 1	564	251	815	1680	2495
Método 2 (baixa)	285	74	358	492	850
Método 2 (alta)	1033	267	1300	1787	3087

A = Número total de animais em áreas existentes
B = Número total de animais em áreas de alta probabidade
C = A + B
D = Número total de animais em áreas de baixa probabidade
E = C + D

F. Ameaças à População Selvagem

a. Deflorestamento é muito rápido em toda a área. Em 1980, por exemplo, haviam 7 serrarias na cidade de Una; in 1989, haviam 23. O medo da reforma agrária tem levado os proprietários de terra locais a destruírem as manchas de mata existentes para evitar a desapropriação para assentamentos de "sem terra". A estimativa de deflorestamento anual seria entre 1 e 5%

b. A piora da "vassoura de bruxa" (uma doenca importante e incurável que ataca pés de cacau), atualmente ainda em focos localizados, deve resultar na substituição das plantações, de cacau para dendê, ou talvez numa pior alternativa, que é pastagens. Plantações de cacau (especialmente "cabruca" - prática de plantar cacau sob a sombra de árvores nativas) pode aumentar a capacidade de suporte para o MLCD nas pequenas ilhas de matas e também pode agir como corredores de dispersão entre manchas de matas. Possível perda anual de habitat do MLCD poderia ser 1%/ano'; possibilidade de catástrofe: 1%/ano, resultando em 50% de perda de habitat marginal para o MLCD.

c. O contrabando internacional de espécimens vivos, que foi uma ameaça muito forte até os anos 80, foi reduzido, pelas atividades do Comitê Internacional de Recuperação e Manejo do MLCD. Entretanto, o comércio ilegal interno é ainda comum em toda a região. A perda potencial de animais devido à captura é estimada entre 50 e 100 animais.

d. Incêndios são infrequentes (quando comparados à Reserva de Poço das Antas) desde que o clima é muito menos sazonal e geralmente mais úmido, mas em certas regiões (especialmente ao redor de Canavieiras) a queima de pastos e o alastramento de fogo em áreas de matas adjacentes é uma possibilidade. Freqüência: 5% Severidade: 1% ou Freqüência: 1% Severidade: 5%

G. Reintroduções e Translocações:

1. Há um potencial limitado para reintroduções no presennte momento. Embora a população cativa terá brevemente indivíduos em excesso, há insuficiente informação sobre disponibilidade e proteção de habitat (ver Documento de Análise Geral de Devra Kleiman, com o qual nós concordamos; entretanto, a situação deveria ser mantida sob revisão constante, de acordo com a acumulação de dados sobre disponibilidade de habitat e aumento na concientização local sobre o status de conservação do MLCD.
2. Existe uma recomendação no Documento de Análise Geral do MLCD (4d) para que um centro para absorção/triagem seja criado na região para manter animais doados ou confiscados até uma destinação final e talvez para manter animais translocados de habitats destruídos para aqueles seguros e disponíveis. A mesma recomendação sobre essa possibilidade se aplica aquí, como no ítem 6a. acima.

H. Informações Demográficas

Existem poucas informações publicadas sobre os hábitos ou características demográficas dessa espécie na vida silvestre. Provavelmente deverá ser necessário se fazer uso de informações sobre o MLD como modelo para o MLCD, já que informações sobre essa última espécie são inexistentes.

Reprodução: três grupos em Lemos Maia (1980) se reproduziram apenas uma vez no ano (um grupo em agosto e 2 em setembro).

Densidade: 0.9 - 3.0 grupos por km^2
4.6 - 16.7 indivíduos por km^2

Estrutura de grupo: pode existir mais que um macho ou fêmea adultos em cada grupo; apenas uma fêmea se reproduz.

Tamanho da ninhada: 2

II. POPULAÇÃO EM CATIVEIRO

A população em cativeiro em 31 de agosto de 1989 consistia de 285 indivíduos (130.116.39), mantidos em 22 coleções. Essa população tinha 83 fundadores, dos quais 75 estão vivos. Assim, de um pponto de vista demográfico, a população em cativeiro está segura.

Baseando-se no número de fundadores atualmente representados nesta população, a diversidade genética da população selvagem está adequadamente protegida. Entretanto, a representação de fundadores é marcadamente desigual, com 21 fundadores vivos que ainda não têm filhotes. Assim, tudo deveria ser feito para maximizar a retenção da diversidade alélica da população.

Devido ao sucesso do programa de criação em cativeiro, a população cativa estará no futuro próximo, numa posição de fornecer animais para reintrodução. Contudo, no momento, reintrodução não pode ser considerada uma opção viável, por causa da pobreza de informações sobre a situação atual da população selvagem. É assim portanto, muito importante e urgente realização de levantamentos populacionais.

À respeito dos 21 animais presentemente mantidos na Reserva Biológica de Una, o Comitê de Manejo indica a importância da remoção desses animais da Reserva para evitar a transmissão de doenças ou ruptura social na população nativa. O Comitê de Manejo já identificou outros 20-23 locais fora do Brasil que dariam para acomodar 37-40 pares e para onde esses animais poderiam ser levados. Estes zoológicos já assinaram acordos e memoranda de entendimento com o Comitê Internacional de Manejo e todos eles tem experiência na reprodução de Calitriquídeos. Entretanto, devido ao sucesso geral do programa de criação em cativeiro, a absorção de mais animais de Una deve se tornar difícil na situação atual.

RELATORIO MICO-LEÃO-PRETO

(Claudio Padua, Faical Simon, Suzana Padua, Alexine Keuroghlian, Helder Faria, Jose Max, Francisco Serio)

I. POPULACAO SELVAGEM-HABITAT

A. Áreas Protegidas

1. Parque Estadual do Morro do Diabo	34.156 ha
2. Estação Ecologica de Caitetus	2.178 ha
Total	36.334 ha

Habitat disponível = 29.503 ha

Parque Estadual do Morro do Diabo e Estação Ecológica de Caitetus estão sob a administração do Instituto Florestal de Sao Paulo - Secretaria do Meio Ambiente (Governo do Estado).

B. Ameaças ao Habitat

1. Morro do Diabo: incendio, invasão e Ramal de Dourados (Estrada de Ferro)

2. Estação Ecologica de Caitetus:
   - incêndio.
   - caça (não é uma ameaca maior ao mico, pois os cacadores estão a procura de outros animais). Ha urgente necessidade de maior número de vigilantes.
   - água - qualidade e quantidade (uma vez que as nascentes estao fora da unidade).
   - invasão antropica (fazendeiros vizinhos procuram aumentar aos poucos a área de suas fazendas).

C. Ameaças a população

- caça
- frequencia e intensidade não avaliadas
- % de sobrevivencia ??
- % de reprodução ??

D. Outros Possiveis Habitats

Propriedade Privada:

- cerca de 2.500 ha.
- apropriado - levantamento a ser iniciado em 08/90
- status destas áreas - propriedades privadas

Ameaças a população:

- desmatamento;
- fogo;
- caça;
- frequencia e intensidade desconhecida
- % de sobrevivencia ??
- % de reprodução ??

Interação entre populações: impossível

II. BIOLOGIA DAS POPULAÇÕES

A. Os membros do grupo concordaram usar dados de MLD e MLCD, quando não dispõe-se de dados específicos.

B. Variação Ambiental:

São animais que parecem ter uma certa resistencia como se pode observar pela localização em áreas de baixa capacidade de suporte. A região do Morro do Diabo ja apresenta um gradiente variável de habitat.

III. OUTRAS CONSIDERAÇÕES PARA O MOMENTO

A. Populações em Vida-Selvagem

1. Necessidade de inventário;

2. Necessidade de monitoramento contínuo;

3. Proteção maior em Caitetus;

4. Restauração de áreas degradadas em Morro do Diabo.

B. Populações em Cativeiro

Pelos graficos anexos, considerando o pequeno tamanho da população, as colônias existentes, parecem ir bem;

Ficou claro a necessidade de se dividir a população em cativeiro em um maior número de colônias;

Ficou estabelecido a necessidade urgente de produzir-se um Plano de Ação para a especie em cativeiro.

RELATORIO ***Leontopithecus caissara***

A) POPULAÇÕES SELVAGENS

Informação sobre o Habitat

1. Áreas protegidas: Desconhecidas. A espécie foi observada em 3 localidades da ilha de Superagui.

2. Tamanho de habitat disponível: Desconhecido. Uma estimativa conservadora indica algo como 5000ha na ilha de Superagui.

3. Situação: Propriedade privada.

4. Ameaças ao habitat: Criação de gado (bufalos) e projetos de urbanização no futuro. Pescadores estimados na área; cerca 200 ou 300.

5. Ameaças a população: Comércio ilegal.

6. Outros habitats em potencial: Desconhecidos. Necessidade de pesquisa.

B) INFORMAÇÃO POPULACIONAL

1. Tendências Populacionais: Sem informação; Depende de levantamento.

2. Habitat potencial: Sem informação; Depende de levantamento.

3. Ameaças ao habitat: Comércio ilegal em virtude da publicidade gerada com a descoberta da espécie. Ameaça séria e imediata.

4. Interações entre populações. Sem informação.

C) INFORMAÇÃO BIOLÓGIUCA

Muito pouco se sabe. O tamanho populacional é desconhecido mas parece que uma estimativa conservadora baseada em informações de outros micos-leões seria algo entre 125 e 625. Não existe informações sobre sobrevivência, fertilidade etc.

D) POPULAÇÕES EM CATIVEIRO
Nenhuma.

PLANO DE AÇÃO PARA A CONSERVAÇÃO DOS MICOS-LEÕES-DA-CARA-PRETA, *Leontopithecus caissara*, UMA NOVA ESPÉCIE DO SUL DA FLORESTA ATLANTICA BRASILEIRA.

1) Levantamento da área de distribuição dos micos-leões-da-cara-dourada.

Descritos no ano de 1990, micos-leões-da-cara-preta, *Leontopithecus caissara*, são conhecidos somente em uma pequena parte da ilha de Superagui, em Guaraquecetuba, na região costeira do norte do Paraná, sul do Brasil (25 18'S, 48 11'W). Todavia, não é de todo impossível que a nova espécie ocorra tambem em outras partes de Superagui, bem como em outras ilhas na região e em partes adjacentes do continente. É imperativo um levantamento preliminar na região o mais rápido possível, para determinar a distribuição total da espécie, e avaliar sua população. Enfase especial deve ser posta na região do Parque Nacional de Superagui. Vez que os micos-leões-da-cara-preta são provavelmente os mais raros e mais ameaçados primatas neotropicais, este projeto deve merecer alta prioridade.

Custo estimativo para 3 anos....U$ 75,000

2) Ecologia e comportamento dos micos-leões-da-cara-preta.

Outra prioridade é conhecer-se melhor a biologia da espécie tanto para deteminar-se as necessidades deste primata de maneira a desenvolver-se plano para sua sobrevivência bem como pelo interesse científico em si, em virtude da controvérsia zoológica que existe no grupo *Leontopithecus*. Existem já dois modelos excelentes para este estudo de campo: o programa de pesquisas dos micos-leões-dourados Leontopithecus rosalia na Reserva Biológica de Poço das Antas, Rio de Janeiro e o do mico-leão-preto, no Parque Estadual do Morro do Diabo em São Paulo. As necessidades para desenvolver-se tal projeto são de alojamento e alguns materiais com armadilhas, equipamento de rádio etc.

Custo estimativo para 3 anos....U$ 75,000

3) Proteção de habitat para os micos-leões-da-cara-preta

Toda a área de ocorrência conhecida da espécie está compreendida dentro da Área de Proteção Ambiental de Guaraqueçaba (APA) e existe a possibilidade de que outras populações sejam encontradas tambem na fronteira do Parque Nacional de Superagui. De qualquer maneira vai haver necessidade de aumentar-se a proteção em toda área, talvez seja necessário aumentar-se a área do do Parque Nacional de Superagui para incluir toda a área de distribuição da espécie. Grande parte da estratégia a ser adotada vai depender do resultado do levantemento, mas proteção adicional (guardas e logistítca) parece desde já, será uma necessidade. Isso talvez possa ser obtido junto ao IBAMA, mas seria altamente recomendável o envolvimento da população local (os caiçaras que deram nome a espécie). Isto certamente aumentará a nível local o entusiasmo pela conservação da espécie e assegurará que os habitantes da região que conhecem bem o micos-leões-da-cara-preta envolvam-se imediatamente em sua proteção.

Custo estimativo para 3 anos....U$ 75,000

4) Educação ambiental e consciência pública: Os micos-leões-da-cara-preta como espécie símbolo da Mata Atlântica costeira do Estado do Paraná.

Um componente crítico para o programa de conservação dos micos-leões-da-cara-preta, vai ser programa de educação ambiental e consciência publica na região. Programas bem sucedidos já existem para os micos-leões-dourados, *L. rosalia*, e micos-leões-pretos, *L. chrysopygus*, e podem ser tomados como modelo para essa espécie tmabem embora em menor escala tendo em vista que a população humana na área dos micos-leões-da-cara-preta é muito pequena. Entre as medidas necessárias encontram-se levantemento preliminar para determinar atitudes locais, produção de material educativo (e.g. posters, camisetas), e eventualmente uma unidade móvel se a mesma apos testada mostrar-se eficaz.

Custo estimativo para 3 anos....U$ 25,000

5) Programa de criação em cativeiro

Técnicas para criação em cativeiro estão bem desenvolvidas e se mostraram úteis para as outras espécies de micos-leões. Após a conclusão do primeiro levantamento seria sensato iniciar-se um programa de criação em cativeiro para essa espécie também. O Centro de Primatologia do Rio de Janeiro é obviamente a Instituição para dar início a tal programa mas outras instituições envolvidas com o gênero *Leontopithecus* deveriam fazer parte também.

Custo estimativo para 3 anos U$ 50,000

Custo total estimativo para 3 anos U$ 300,000

LEONTOPITHECUS

MICO - LEÃO

ANÁLISE DE VIABILIDADE & PLANO DE SOBREVIVÊNCIA

ESTUDO DE PEQUENAS POPULAÇÕES

PANORAMA DE PEQUENAS POPULAÇÕES

J. Ballou

O objetivo principal de qualquer programa para a conservaçaõ de uma espécie deve ser a redução de seu risco de extinção. Para tal, o primeiro passo a ser dado é a identificação daqueles fatores que possam potencialmente causar a sua extinção. Entre estes o que naturalmente sobresai-se como de maior importãncia é o declínio de seu tamanho populacional. Declínio populacional sem ações que o revertam, levam a um iminente perigo de extinção. Todavia, se esse quadro é claro para populações em declínio, não o épara aquelas que não está em declínio. Seu destino eincerto assim como qualquer prognóstico sobre seu futuro.

Jã pequenas populações têm características ligeiramente diferentes. Elas são altamente vulnerãveis ã extinção mesmo quando mantem número estãvel ou crescente de indivíduos. O simples fato de serem pequenas, cria uma série de ameaças que aumentam consideravelmente sua probabilidade de extinção.

DESAFIO A PEQUENAS POPULAÇÕES

Desafios a pequenas populações podem ser categorizados como de natureza genética ou demogrãfica. Vamos em seguida descrever de maneira resumida cada um deles começando pelos desafios demográficos de natureza mais simples. Aqueles que atuam ao nível dos indivíduos. Nesse nível a maior ameaça por que passa uma população é o que chamamos de variação demogrãfica. Trata-se de variação que ocorre normalmente nas taxas de nascimento e morte da população como consequência de diferenças ao acaso entre indivíduos da mesma. A população pode sofrer flutuações de tamanho como simples consequência de diferenças individuais em reprodução ou sobrevivência. Dependendo da severidade das mesmas, essas flutuações ao acaso podem levar a população a se extinguir.

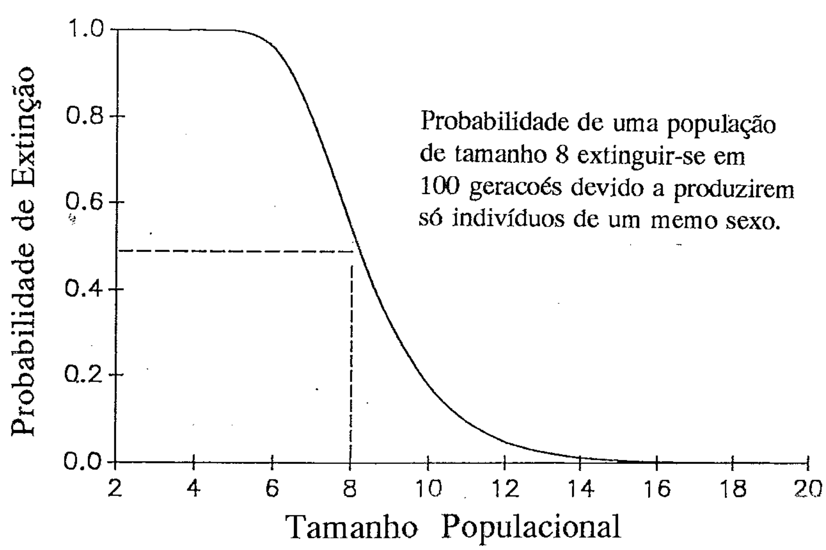


Figura 1. Exemplo de variação demogrãfica: Probabilidade de extinção em 100 gerações tendo como causa única a produção de filhotes de um só sexo em uma geração.

Um exemplo dessa ação é o caso de populações tão diminutas que todos os indivíduos nascidos numa mesma gearação sejam do mesmo sexo. Uma ocorrência como essa pode naturalmente resultar na sua extinção. A figura 1 ilustra a probabilidade dessa ocorrência em um período correspondente a 100 gerações em populações de diferentes tamanhos. Nesse mesmo perãodo de tempo, uma população de 8 indivíduos tem 50% de chance de estinção devido a uma razão sexual enviesada na mesma.

Resultados semelhantes poderiam ocorrer de maneira coincidente por uma elevação na taxa de mortalidade ou um decréscimo na taxa de natalidade. Esses riscos são todavia desprezíveis em populações de tamanho maior. Em geral o efeito de qualquer indivíduo na tendência geral da população é significantemente menor em populações pequenas do que em populações de maior tamanho. Como resultado, temos um desafio muito menor como consequência de variação demográfica em populações que não sejam muito pequenas (menos que 20 animais).

Outra ameaça a pequenas populações e essa ainda mais significativa que a primeira é Variação Ambiental. Émuito claro o impacto que variação nas condições ambientais, cria na habilidade de reprodução e sobrevivência de uma população. Populações mais suscetíveis a variação ambiental flutuam mais em tamanho do que aquelas menos suscetíveis, aumentando com isso o perigo de extinção. Por exemplo, o sucesso reprodutivo de uma espécie ameaçada como o Gavião-Caramujeiro-da-Flórida (Rostrhamus sociabilis) está diretamente relacionado aos níveis hídricos na sua área de ocorrência, que por sua vez determinam a densidade de suas presas principal, o caramujo: a taxa de sucesso no chocar diminui em cerca de 80% nos anos com baixos níveis hídricos, resultando em uma extrema instabilidade populacional na espécie (Bessinger 1986).

Um outro nível de ameaça a pequenas populações são epidemias e catastrofes. Essas duas, sendo similares a variação ambiental na sua ação pelo fato de tambem serem externas a população. No presente caso, entretanto, as mesmas serão consideradas separadamente pelo simples fato de que somente agora estamos começando a entender que as mesmas embora, sejam pressões ambientais que periodicamente atuem sobre as populações sã todavia de difícil predição. Elas podem ser entendidas como eventos relativamente raros mas que podem ter consequências devastadoras na sobrevivência de uma gande proporção da população. Um outro aspecto do mesmo problema são doenças menos devastadoras ou parasitismos que estão presentes em todas as populações de qualquer espécie e que podem criar uma redução nas taxas de reprodução e um incremento na mortalidade.

Epidemias podem ter efeitos diretos e indiretos. Por exemplo, em 1985, a praga da selva (sylvatic plague) teve um efeito indireto devastador sobre as últimas populações remanescentes de furão de pés pretos (black footed ferret) ao afetar o cã0 da pradarias (prarie dog) sua presa principal. Algum tempo depois ainda no mesmo ano, (distemper) afetou diretamente as populações desses raros furões eliminando quase que inteiramente sua população selvagem assim como, seis indivíduos que haviam sido trazidos para o cativeiro (Thorne e Belitsky 1989).

Catãstrofes por sua vez, são desastres de uma sõ ocorrência capazes de dizimar totalmente uma população. Eventos catastróficos incluem os de ordem natural (enchentes, incêndios, furacões) e aqueles provocados por açao humana (derrubada florestal ou outras destruições de habitat). Tanto faz populações grandes ou pequenas são igualmente suscetíveis a catástrofes. Destruição florestal nos trópicos, por exemplo, está assumindo proporções catastróficas e consequentemente tornando-se a mais importante causa de devastação a afetar atualmente as taxas de extinção de espécies. Estimativas do número de espécies tropicais que estarão extintas na virada do próximo sécual oscila entre 20 e 50 % (Lugo 1988).

Pequenas populações por sua vez, são tambem suscetíveis a desvios de ordem genética. O mais importante desses problemas a serem considerados éo da perda de variabilidade genética. A cada nova geração os genes que são passados as proles são uma amostra ao acaso dos genes dos pais. Em pequenas populações, esta amostra ao acaso, por ser pequena pode não ser representativa da geração paterna. Uma parte da variabilidade genética contida na geração dos pais pode apenas por casualidade, não ser passada a geração dos filhos, ocorrendo consequentemente, uma perda dessa variabilidade genética na população. Esse processo é conhecido como deriva genética pelo fato de poder provocar com o passar dos tempos, uma derivação ou variação nas características genéticas da poulação. Em pequenas populações, deriva genética pode ocasionar uma rãpida perda na variabilidade genética das mesmas sendo que quanto menor a população mais rápida a perda.

Consanguinidade (acasalamento entre parentes) pode tambem causar perda de diversidade genética. Em pequenas populações, todos os animais rapidamente tornam-se relacionados, compartilhando os mesmos alelos. Crias resultantes de pais relacionados se tornam consanguíneos e como consequência, podem adquirir os mesmoas alelos de sua mãe e de seu pai. Indivíduos consanguineos, são portanto mais homozigóticos do que os não consanguíneos e possuem níveis de diversidade genética mais baixo do que animais nascidos de pais não relacionados.

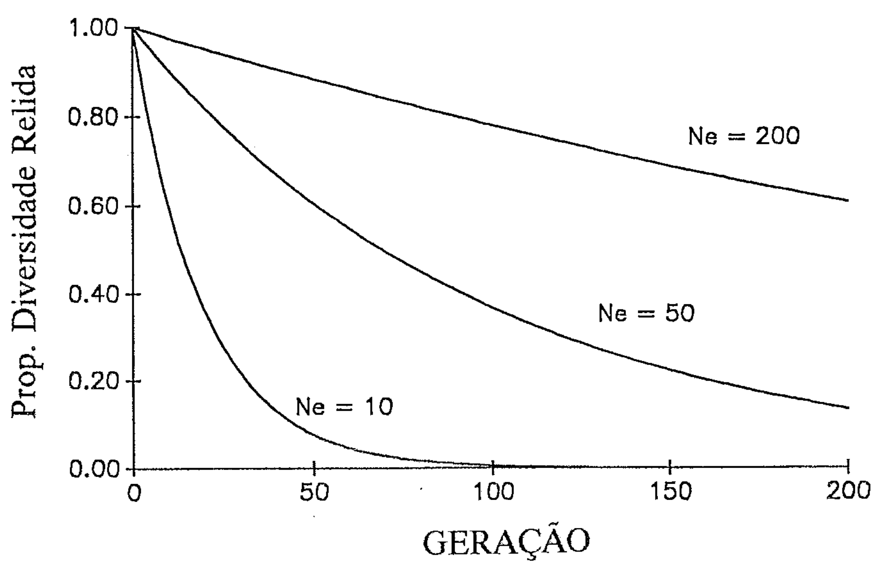


Figura 2. Perda de diversidade genetica para populações de diferentes tamanhos efetivos (Ne) em um período correspondente a 200 gerações.

A perda de variabilidade genética em populações de diferentes tamanhos pode ser observada na figura 2. O montante de perda é função do tamanho efetivo da população (Ne; a percentagem de diversidade perdida a cada geração é 1/2 Ne). Tecnicamente, tamanho efetivo de uma população, é o tamanho de uma população ideal que perde diversidade genética na mesma proporção da população verdadeira. A maneira de se calcular tamanho efetivo de população esta amplamente descrita na literatura (Lande e Barrowclough 1987) todavia, o número de indivíduos reprodutivos em cada geração pode ser usado como uma estimativa grosseira do tamanho efetivo. Fica claro com isso que o tamanho efetivo é um número bem menor do que o número atual de indivíduos presentes na população; de fato algumas estimativas sugerem que (Ne) corresponde normalmente a entre 10 e 30% da população total. Da mesma maneira, populações grandes vão tambem perder variabilidade genética se seu tamanho efetivo for pequeno.

Programas para a conservação de espécies em geral incluem a manutenção de diversidade genética como seu objetivo principal por inúmeras razões. Para uma espécie sobreviver ao tempo, ela tem que manter a capacidade de adaptar-se as mudanças ambientais (evoluir). Isto pode ser ainda mais enfatizado quando sabemos que o processo pelo qual seleção natural atua requer a presença de variabilidade genética para para ser efetivo. Não fosse por considerações evolutivas de longo prazo, tal ação se justificaria apenas pelo fato de jã ter sido demonstrado que a presença de diversidade genética é tremendamente importante para a manutenção do vigor populacional. Número crescente de publicações demonstra uma correlação geral mas não universal entre diversidade genética e varias características relacionadas a reprodução, a sobrevivência e a resistência a doenças (Allendorf e Leary 1986). Indivíduos com baixos níveis de variabilidade genética em geral tem taxas maiores de mortalidade e taxas menores de reprodução, quando comparados com indivíduos com maior diversidade.

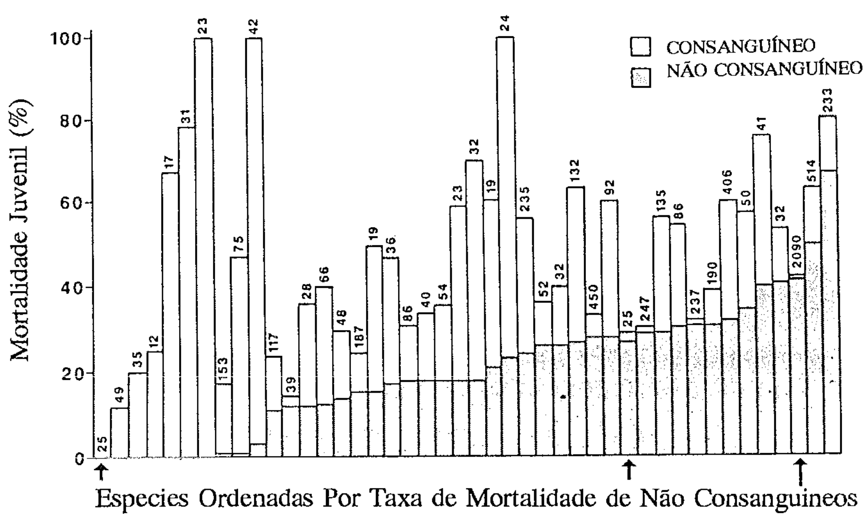


Figura 3. Efeitos da consanguinidade na mortalidade juvenil em 45 populações de mamíferos em cativeiro (fonte: Ralls e Ballou 1987).

Dados sobre o efeito de consanguinidade em espécies exoticas tambem mostram a importância de se manter diversidade genética. Inúmeros estudos mostram de forma bem clara que consanguinidade pode reduzir significantemente reprodução e sobrevivência em um número expressivo de espécies selvagens (Ralls e Ballou 1983; Wildt et al, 1987; Figura 3). Depressão por consanguinidade, por sua vez, resulta de dois efeitos: 1) um aumento na homozigose permite a expressão de aleleos deletérios presentes no genoma (o mesmo não ocorre em indivíduos não consanguíneos e portanto mais heterozigóticos); e 2) em casos onde heterozigóticos são mais aptos do que homozigóticos simplesmente porque, possuem dois alelos. Redução na heterozigose causada por consanguinidade reduz a aptidão dos indivíduos consanguíneos (sobredominância). Em ambos casos a perda de variabilidade genética devido a consanguinidade tem efeitos prejudiciais na sobrevivência da população.

Pequenas populações isoladas, sem migração de outras populações perde diversidade genética e torna-se crescentemente consanguínea com o tempo. Seu potêncial de sobrevivência a longo prazo esta comprometido uma vez que elas gradualmente perdem a diversidade genética necesãria a que evoluam. Está comprometida tambem sua sobrevivência a curto prazo pelo provável efeito deletério da consanguinidade na reprodução e sobrevivência.

Os desafios genéticos e demográficos discutidos acima, está claro, não agem independentemente em pequenas populações. A medida que uma população pequena torna-se mais consanguínea, aumenta a probabilidade de uma redução em sua sobrevivência e reprodução e a população diminui. Um circulo vicioso estabelece-se, com aumento nas taxas de consanguinidade. A população por tornar-se cada vez menor e mais consanguínea, torna-se mais suscetível a variações demogríficas, doenças e a severas variações ambientais. Cada fator exacerba os outros resultando numa espiral negativa conhecida como redemoinho da exinção (Extinction Vortex) (Gilpin e Soulé 1986).

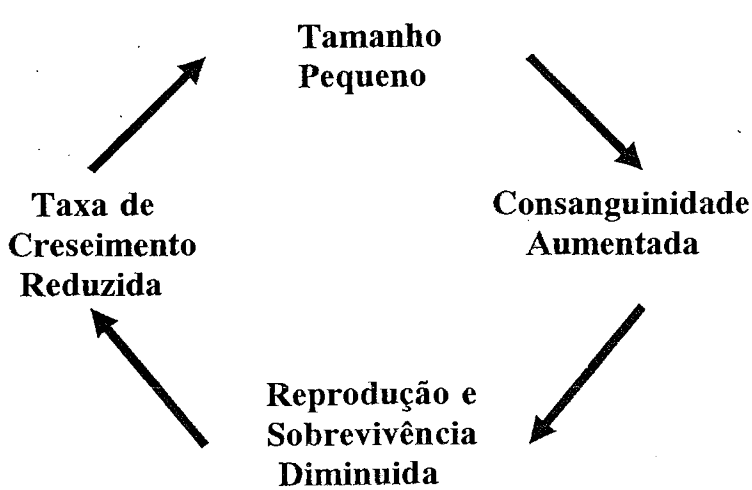


Figura 4. Redemoinho de Extinção causado por efeito negativo retroalimentado da consanguinidade.

ANÁLISE DE VIABILIDADE POPULACIONAL

Muitos dos desafios que enfrentam as populações pequenas são em realidade estocasticos e resultam de imprediziveis eventos ao acaso. Muitos desses permitem que se suponha um decréscimo na probabilidade de sobrevivência a longo prazo da população. Todavia em vista de sua natureza estocástica, não se pode prever de maneira totalmente acurada seus efeitos na retenção da diversidade genética bem como na extinção da população. Por exemplo apesar de sabermos que depressão por consanguinidade é fenomeno de carater geral, seus efeitos variam enormemente para diferentes espécie e é impossível predizer-se com certeza, como cada populaçáo reagirá a consanguinidade.

Apesar disso, estratégias orientadas para esses aspectos imprediziveis da extinção e da perda de diversidade genética devem ser desenvolvidos e implementados. O processo desenvolvido nos últimos anos para estimar probabilidade de extinção e perda de variabilidade genética chama-se Análise de Viabilidade Populacional (AVP; Soule 1987). Define-se AVP como uma avaliação sitemática, da importância relativa de fatores que coloquem em risco uma população. É portanto uma tentativa de identificar os fatores que são importantes para a sobrevivência de uma população. Em alguns casos essa é uma tarefa fácil, como no caso de destruição de habitat que é sempre um fator crítico para a maior parte das espécies em extinção. Em outros todavia, os efeitos de fatores únicos e a interação entre diversos fatores são de difícil predição.

Numa tentativa de uma compreenção de carãter mais quantitativo dos efeitos causados por esses fatores,foram desenvolvidos alguns modelos computadorizados. Eles tomam como base uma combinação de técnicas analíticas e de simulação que modelem a população no correr do tempo e estimem a probabilidade de extinção e de perda de variabilidade genética da população. O modelo é primeiro alimentado com informações descrevendo as caracterisiticas

ANÁLISE DE VIABILIDADE DE POPULAÇÕES (AVP)

Processo de Avaliação de Factor Interativos
Efetando o Risco de Extinção

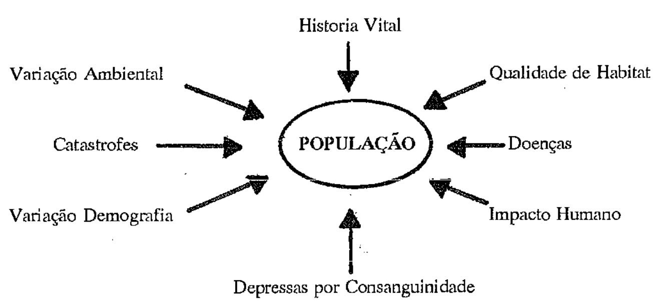


Figura 5. Modelo de Análise de Viabilidade da População (AVP), mostrando os efeitos de diferentes histõrias vitais, fatores ambientais e ameaças, na extinção e retenção de variabilidade genética de uma só população.

da histãria vital (life history) da populaçáo. Dependendo de que modelo esteja sendo usando, essas informaçóes querem dizer; dados em idade da primeira reprodução, distribuição de tamanho de ninhada, taxas de sobrevivência, estrutura de acasalamento e distribuição etária sem falar em estimativas variação associadas a cada um desses fatores. Alem desses, podem ser considerados alguns fatores externos como níveis de variação ambiental, mudanças na capacidade de suporte e severidade da depressão por consanguinidade. Modelos permitem tambem que leve-se em consideração ameaças a população: probabilidade de catastrofes e sua severidade, perdas de habitat e epidemias (Figura 5). Os modelos utilizam-se de variáveis da história vital, dos fatores externos e das ameaças potenciais para desenvolver uma projeção do futuro da população. Alem disso obtem-se o nível de variabilidade genética retido no correr do tempo e informação sobre se e quando a população desaparece (tamanho populacional igual a zero). Essas simulações são por seu turno, repetidas quase sempre milhares de vezes até fornecerem estimativas confiáveis da variação estatística associada aos resultados. Calcula-se a probabilidade de extinção em qualquer momento como o número de simulações

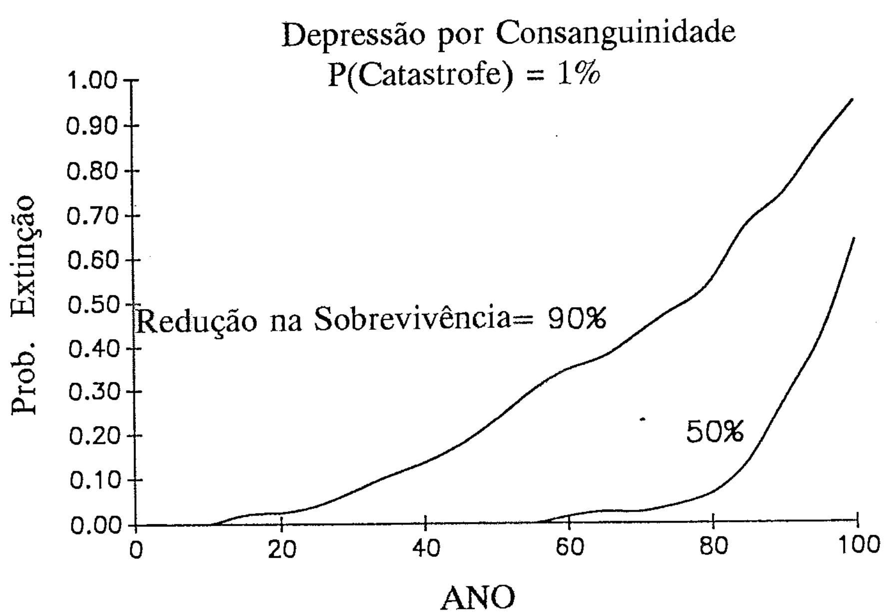


Figura 6. Resultado hipotético do modelo Vortex para AVP mostrando um exemplo de extinção de uma população. O modelo inclui os efeitos negativos da consanguinidade e uma probabilidade de catastrofe da ordem de 1%. A probabilidade de extinção é mostrada com o passar do tempo e para dois níveis diferentes de severidade de catástrofe: 90% e 50% de redução na sobrevivência.

nas quais a população se extinguiu no momento estudado dividido pelo número total de simulaçóes rodadas (Figura 6). Os níveis de variabilidade genética são obtidos como a percentagem da heterozigose original bem como o número de alelos originais retidos na população num dado momento.

Nos ultimos anos foram desenvolvidos um certo número de modelos de viabilidade populacional. Vortex é o modelo usado pelo grupo de especialistas em criação em cativeiro da União Internacional para a Conservação da Natureza e dos Recursos Naturais-IUCN, sendo seu autor, Robert Lacy da Sociedade Zoológica de Chicago. Este modelo tem sido amplamente usado na elaboração de estratégias de conservação para inúmeras espécies como o furão de pés pretos, a Pantera da Flórida, o Papagaio de Porto Rico, o Rinoceronte de Java e as quatro espécies de Micos-Leões.

O verdadeiro valor do modelo não está em tentar examinar os efeitos de todas as variáveis simultaneamente. As interações entre os diversos fatores que o compõem, são complexas demais para se tentar interpretar os resultados de projeções populacionais baseados em apenas algumas poucas dessas considerações. Pode-se obter um número muito maior de informações ao examinar-se somente um ou dois fatores de cada vez. Isso claro procurando-se concentrar naqueles fatores que parecem ter um verdadeiro impacto sobre a população e ignorando-se aqueles que parecem irrelevantes.

O ponto alto do modelo no desenvolvimento de estratégias conservacionistas, é a possibilidade que o mesmo oferece no desenvolvimento de análises do tipo "o que acontece se". Por exemplo, o que acontece se a taxa de sobrevivência da população selvagem diminui como consequencia da eclosão de uma epidemia? Como é que isso afetaria a extinção da população ou a retenção da diversidade genética na mesma? As análises do tipo "o que acontece se" podem tambem ser usadas para avaliar-se diferentes práticas de manejo. Por exemplo, que mudanças ocorreriam na probabilidade de extinção da população se fosse aumentada em 10% a capacidade de suporte de uma das reservas onde vivem os animais?

É preciso todavia salientarmos que em virtude do modelo não levar em consideração todos os fatores que potencialmente contribuem para a extinção, seus resultados são em geral uma versão subestimada da probabilidade se extinção da população. Nesse ponto é importante salientar que o objetivo da AVP não éa obtenção de uma estimativa exata da probabilidade de extinção mas sim identificar a importância relativa dos varios fatores que estão sendo considerados e avaliar o efeito de uma gama de recomendações de manjo na sobrevivência da população.

IMPORTANCIA DA AVP NOS OBJETIVOS DE MANEJO

Como já vimos os conceitos, extinção de população e perda de variabilidade genética são baseados muito mais em probabilidades do que em certezas. O que os resultados dos modelos que compõem a AVP, nos fornecem são informações sobre a probabilidade de extinção de uma ou mais populações, a luz de certas suposições sobre a biologia e a situação atual das mesmas. É preciso que fique bem claro pois, que não é possível predizer-se ou garantir-se com nenhuma certeza o que vai acontecer a essas populações.

Há algumas implicações de grande importância nesses fatos. Principalmente quando o que estamos querendo atingir são estratégias de conservação que reduzam os riscos de extinção das populações. É preciso que reconheçamos que não seremos capazes de formular ou implementar recomendações que garantam a sobrevivência de qualquer população. Só o que podemos fazer, éformular e implementar recomendações capazes de diminuir a probabilidade de extinção dessa população num dado período de tempo.

Uma aproximação usual, é desenvolver-se estratégias de manejo que assegurem 95% de chance de sobrevivência da população num período de de 100 anos, mantendo 90% de sua variabilidade genética no mesmo período (Shaffer 1987; Soule et al, 1986). Obtido isso, estariam asseguradas, uma alta probabilidade de sobrevivência acrescida da retenção de uma alta proporção da habilidade que a população tem de geneticamente adaptar-se e evoluir diante de mudanças ambientais. E esta aproximação, quem define o tamanho de uma população mínima viãvel para atingir-se esses objetivos de manejo. Estratégias de manejo por sua vez só podem ser completamente avaliadas se forem bem especificados os graus de certeza e período em que o manejo quer ser aplicado.

METAPOPULAÇÕES

Até o presente momento este trabalho enfocou apenas aspectos da dinâmica genética e da extinção de uma única população. Ocorre que muitas vezes as pessoas encarregadas do manejo conservacionista, se veem as voltas com o problema de uma espécie distribuida em diferentes populações que interagem. Chamamos de Metapopulação, a população geral de uma espécie distribuida em diferentes isolados onde a migração entre as mesmas ocorra em níveis tão altos que a dinâmica (extinção ou genética) de qualquer uma dos isolados seja afetada pela dinâmica de algum de seus vizinhos (Figura 7). Recentemente ficou claro que a compreenção da dinâmica das metapopulações tem importância crescente no desenvolvimento de estratégias de conservação.

METAPOPULAÇÕES

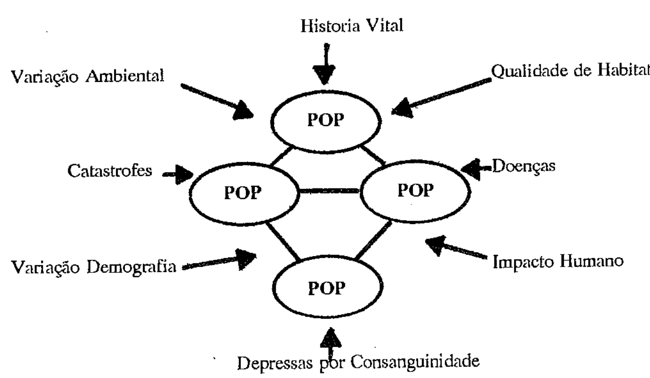


Figura 7. Uma metapopulação nada mais é do que o resultado da interação de diferentes isolados de população. Estratégias de conservação, devem levar em consideração a distribuição espacial dos isolados e seus efeitos em extinções correlacionadas bem como na recolonização entre isolados.

Manejo de Metapopulações enfoca a distribuição espacial das populações e como isso influencia a dinâ genética e demográfica do sistema. Para melhor entendermos Metapopulações, podemos imaginar as mesmas como um grupo de populações (isolados) de diferentes tamanhos e com diferentes distâcias entre si, em que periodicamente alguns isolados se extinguem e são recolonizados por migrantes de outros isolados. Do ponto de vista de conservação a consideração mais importante a se fazer aqui são as taxas de extinção para cada isolado e as taxas de re-colonização entre isolados (Gilpin 1987).

Como vimos anteriormente, a dinâmica de extinção de cada isolado, sofre influência de diversos fatores como tamanho da população, taxa de recuperação após um declínio populacional, etc. Do ponto de vista de uma Metapopulação, o nível de ocorrência mais simples é quando as taxas de extinção dos isolados, não são correlacionadas entre si. Neste caso a probabilidade de extinção de um isolado é totalmente independente de qualquer um dos outros. Outro ponto a ser abordado ainda dentro do mesmo tema é que tanto variação ambiental quanto catastrofes, aumentam a correlação de extinção entre isolados e isso a probabilidade de extinção da metapopulação como um todo. Por causa disso, considerações sobre a distribuição espacial entre isolados, e o seu significado em termos da semelhança com que reagem a variação ambiental e catastrofe, são aspectos importante no desenvolvimento de estratégias de manejo.

Por outro lado temos que levar em consideração o efeito da distribuição espacial nas taxas de recolonização entre isolados. Quanto mais prõximos estão os isolados entre si, maior e a chance de em caso de extinção de sua população, o mesmo ser recolonizado por migrantes vindo do isolado vizinho. Em outras palavras, distância entre isolados tem correlação positiva com recolonização e sobrevivência a longo prazo da metapopulação.

Da mesma maneira, extinção de isolado e recolonização, afetam a retenção de diversidade genética na população. Populações pequenas, fragmentadas e isoladas rapidamente perdem diversidade genética. Por outro lado, se houver migração entre isolados, o fluxo genético entre os mesmos pode ser aumentado com um consequente aumento bastante significativo da metapopulação total. ã preciso abrir parenteses aqui, para explicar que se extinção seguida de recolonização ocorre repetidamente mas envolve um número muito pequeno de animais (um casal, ou uma fêmea gravida) podemos ter o caso de isolados sem possibilidade de variar geneticamente como resultado de efeito fundador reincidente.

Entender a dinâmica das metapopulações tanto a nível genético quanto demogrãfico, torna-se um pouco complicado em virtude da interação existente entre os aspectos positivos da recolonização e os aspectos negativos da extinção de isolados correlacinados. Infelizmente ainda não estão disponíveis os programas de computador com modelos necessãrios ao desenvolvimento de estratégias de manejo conservacionista que levem em consideração a combinação de aspectos genéticos discutidos anteriormente e aspectos da extinção de uma população única com considerações da teoria de metapopulações.

Apesar do anteriormente exposto, as pessoas encarregadas de manejo conservacionista devem estar cientes das complexidades dos sistemas de metapopulações. De uma maneira geral, a longo prazo, populações distribuidas em diversas populações menores estão mais seguras do que aquelas que encotram-se em uma só localidade. Isto é especialmente verdadeiro se houver fluxo genético entre os isolados (seja ele natural ou por intervenção para manejo) e os mesmos não sejam suscetíveis as mesmas ameaças de catastrofe. Em alguns casos tambem as populações em cativeiro podem servir como isolados de segurança que nos forneçam um reservatório de diversidade genética que permita recolonização de outros isolados através do processo de reintrodução.

MANEJO INTERATIVO DE PEQUENAS POPULAÇÕES SELVAGENS E EM CATIVEIRO

T. J. Foose

Introdução

Estratégias para conservação de espécies ameaçadas de extinção devem ser baseadas em populações viáveis. Apesar de ainda necessária, a proteção de espécies ameaçadas de extinção *in situ* não é mais suficiente. Essas espécies precisam ser manejadas.

O manejo é necessário porque o tamanho das populações capazes de serem mantidas deverá ser pequeno para várias espécies sofrendo degradação e exploração irracional de seus habitats, por exemplo, algumas dezenas ou centenas (em alguns casos, até mesmo alguns milhares) de indivíduos, dependendo da espécie. Essas populações estão ameaçadas por diversos problemas ambientais, demográficos e genéticos, que ocorrem ao acaso na natureza e que podem causar extinção.

Pequenas populações podem ser devastadas por catástrofes (disatres ambientais, epidemias, exploração), como exmplificado pelo caso de certa espécie de furões nos Estados Unidos e dos papagaios de Porto Rico, ou podem ser dizimadas por flutuações ambientais menos drásticas. Demograficamente, pequenas populações podem ser afetadas por alterações na sobrevivência e fertilidade de seus indivíduos. Geneticamente, pequnas populações perdem a diversidade necessária para adaptabilidade e sobrevivência.

Mínimas Populações Viáveis (MPV)

Por causa de todos esses problemas, quanto menor for a população e quanto mais tempo ela permanecer pequena, maiores serão os riscos acima mencionados e maior será a possibilidade de extinção. Como consequência, estratégias de conservação para espécies com números reduzidos, e que provavelmente permanecerão assim por algum tempo, devem ser baseadas na manutenção de uma **mínima população viável** (MPV), isto é, populações com número suficiente de indivíduos para garantir sua persistência a longo prazo, apesar dos problemas genéticos, demográficos e ambientais.

Não existe um número mágico que constitua uma MPV para todas as espécies, ou mesmo para uma só espécie durante todos os momentos. Ao contrário, uma MPV depende de ambos os objetivos, genéticos e demográficos, do programa de manejo e das caracteristicas biológicas da população ou taxon em questão. Um outro problema é que, para se determinar uma MPV, fatores genéticos e demográficos atuais devem ser considerados separadamente, apesar de interações entre esses dois fatores existirem com certeza. Além disso, os modelos científicos para se estimar os riscos em relação ao tamanho da população estão ainda em rápido desenvolvimento. Apesar de tudo, considerando-se ambos objetivos, genéticos e demográficos, e as características biológicas da população, análizes científicas podem sugerir limites para os tamanhos de populações que proporcionem proteção contra problemas estocásticos, isto é, que ocorrem ao acaso.

Objetivos genéticos e demográficos de importância para MPV

Probabilidade de sobrevivência (ex., 50% ou 95%) desejada para a população;

Porcentagem de diversidade genética a ser preservada (90%, 95%, etc.);

Período de tempo durante o qual estabilidade demográfica e diversidade genética deverão ser mantidas (ex., 50 anos, 200 anos, etc.).

Em termos de problemas demográficos e ambientais, por exemplo, o objetivo pode ser 95% de probabilidade de sobrevivência durante 200 anos. Modelos estão sendo criados para se prever o tempo de persistência de populações de diversos tamanhos enfrentando esses problemas. Em termos de problemas genéticos, o objetivo pode ser preservar 95% da heterozigosidade média durante 200 anos. Também aqui, modelos para previsões estão disponíveis. Entertanto, é essencial que se compreenda que termos como **viabilidade**, **recuperação**, **auto-manutenção**, e **persistência** só podem ser definidos quando os objetivos demográficos e genéticos tiverem sido estabelecidos, incluindo o período de tempo esperado para o programa (e a população) continuar.

Características biológicas de importância para MPV

Tempo de Geração: Diversidade genética é perdida de geração para geração, e não de ano para ano. Portanto, espécies com tempo de geração mais longo terão menos oportunidades de perder diversidade genética em um dado período de tempo selecionado para o programa. Consequentemente, para atingir os mesmos objetivos genéticos, MPV podem ser menores para espécies com tempo de geração mais longo. Tempo de geração é quantitativamente a idade média na qual indivíduos reproduzem; quantitativamente, é uma função da idade-específica de sobrevivência e fertilidade da população, a qual varia naturalmente e que pode ser modificada por manejo, por exemplo, extendendo-se o tempo de geração.

Número de Fundadores: Fundador é um indivíduo de uma população original (a população selvagem, por exemplo) que estabelece uma outra população (em cativeiro, por translocação para um novo local, ou a partir da implantação de um programa de manejo intensivo). Para ser efetivo, um fundador deve se reproduzir e ser representado por descendentes na população existente. Tecnicamente, um indivíduo deve ainda ser não-consanguíneo e não relacionado a nenhum outro representante da população original.

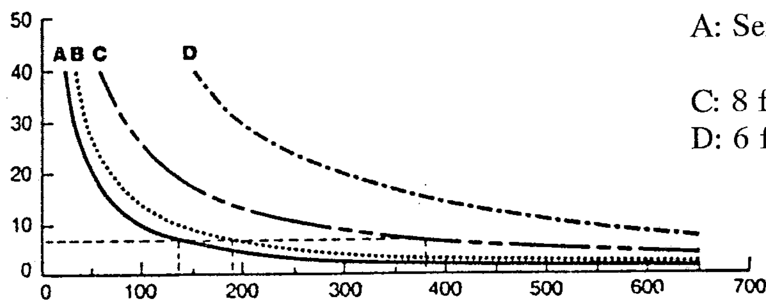
Basicamente, quanto mais fundadores, melhor, ou seja, mais bem representada estará a amostra do pool genético original e menor será a MPV necessária em termos dos objetivos genéticos. Existe ainda um fenômeno demográfico chamado efeito fundador; quanto maior o número de fundadores, menos provável será a extinção devido a oscilações genéticas ao acaso da população. Entretanto, para os grandes vertebrados, existe um ponto de saturação (Figura 1), onde o crescente número de fundadores não tem mais esse efeito, pelo menos em termos genéticos. Portanto, um objetivo comum é obter de 20 a 30 fundadores efetivos para se estabelecer uma população. Caso esse objetivo não possa ser atingido, então o programa deverá fazer o melhor possível com o número de fundadores disponíveis. Se uma fêmea grávida de mamute fosse descoberta pelas tundras do Alasca, certamente valeria a pena tentar desenvolver um plano de recuperação para a espécie, mesmo que a probabilidade de sucesso seja baixa. Ao objetivar o ideal, um programa está na ralidade melhorando suas chances de sucesso.

Preservação de 90% da Diversidade
Genética Original por 200 anos

Efeito Fundador

A: Sem efeito fundador
B: 20 fundadores
C: 8 fundadores
D: 6 fundadores

Tempo de Geração



Tamanho da População Efetiva

Figura 1. Interação do número de fundadores, tempo de geração da espécie e tamanho da população efetiva necessários para preservar 90% da diversidade genética inicial por 200 anos.

Tamanho da População Efetiva: Outra consideração importante é o tamanho efetivo da população, designado N_e. N_e nao é o mesmo que o número total de indivíduos em uma população, N. Ao contrário, N_e reflete o modo como membros da população estão se acasalando com outros indivíduos a fim de transmitir genes para a próxima geração. N_e é normalmente muito menor que N. Por exemplo, para o urso-pardo americano, proporções de até 0.25 para N_e/N têm sido estimadas (Harris e Allendorf 1989). Como consequência, se os modelos genéticos recomendam uma população efetiva de 500 indivíduos (N_e = 500) para atingir certos objetivos genéticos, a MPV deverá ser formada de 2000 indivíduos (N = 2000).

Taxa de Crescimento: Quanto mais alta a taxa de crescimento, mais rapidamente a população pode se recuperar de seu tamanho pequeno, superando assim muitos dos riscos demográficos e limitando a quantidade de diversidade genética perdida durante a fase chamada "bottleneck" ou afunilamento genético. E' importante diferenciar **tamanho do afunilamento genético** de **MPV**.

Análise da viabilidade de populações

O processo pelo qual a MPV é estimada considerando-se diversos fatores, como o conjunto de objetivos e características, é conhecido como Análise da Viabilidade (as vezes, Vulnerabilidade) de Populações (AVP). A fim de se obter resultados de AVP que sejam aplicáveis, é necessário um processo de interação entre biólogos especialistas em estudo de populações, manejadores e pesquisadores. AVP tem sido utilizada em um grande número de espécies (ex., Parker e Smith 1988, Seal et alli. 1989, Ballou et alli. 1989, Lacy et alli. 1989, Lacy e Clark no prelo).

Como mencionado anteriormente, os modelos de AVP são frequentemente aplicados separadamente com respeito a eventos genéticos e demográficos. Modelos genéticos indicam ser necessário manter populações de centenas ou milhares de indivíduos para preservar uma alta porcentagem do pool genético por vários séculos. Modelos recentes permitem considerações simultâneas sobre a demografia e sobre variaçoes no ambiente e na genética das populações.

A fim de combater os efeitos de oscilações demográficas e ambientais, a MPV deve ser ainda maior do que deveria ser para somente preservar a diversidade genética, especialmente se uma alta probabilidade de sobrevivência durante um período apreciável de tempo for desejada. Por exemplo, uma probabilidade de sobrevivência de 95% pode requerer a manutenção de uma população muito maior, cujo tempo de persistência é 20 vezes mais alto do que o requerido para uma probabilidade de sobrevivência de 50% (em media); 90%, 10 vezes mais alto. Por outro lado, pode ser esperado que mais de 50% das populações existentes sejam extintas antes de terminar seu tempo médio de persistência.

Espécies de grandes vertebrados irão certamente nessecitar de populações com centenas ou talvez milhares de indivíduos para serem viáveis. Em termos dos problemas e oscilações ao acaso que as populações têm que enfrentar, quanto maior a população, melhor.

Metapopulações e Areas Mínimas

MPV implicam áreas mínimas críticas de habitat natural. Consequentemente, populações com as centenas ou milhares de indivíduos necessários para sua viabilidade serão difíceis ou impossíveis de serem mantidas contíguas, em unidade.

Entretanto, é possível que populações menores e refúgios sejam viáveis, se eles forem manejados como uma única população grande (uma metapopulação), cujo tamanho coletivo seja equivalente ao da MPV (Figura 2). Na realidade, a distribuição de animais em múltiplas "subpopulações" aumentará a população efetiva para o número total de indivíduos mantidos em termos da capacidade de tolerar problemas estocásticos. Uma subpopulação qualquer pode ser extinta ou quase extinta devido a esses problemas; porém através de recolonização ou reforço de outras subpopulações, a metapopulação pode sobreviver. Metapopulações são claramente frequentes na natureza, com ocorrência de muita extinção local e recolonização a partir de outras subpopulações.

METAPOPULAÇÃO

SUBPOPULAÇÕES **SUBPOPULAÇÕES**

Figura 2. Várias subpopulações servem como base para o manejo de uma metapopulação para sobrevivência da espécie na natureza.

Infelizmente, conforme populações selvagens tornam-se fragmentadas, a migração natural necessária para recolonização pode se tornar impossível. Portanto, o manejo de metapopulações necessitará o transporte planejado, ou translocaçao, de animais para corrigir problemas genéticos e demográficos (Figura 3). Para a migraçao ser efetiva, os emigrantes devem se reproduzir na nova área. Portanto, no caso de migraçao manejada, é importante que a performance genética e demográfica dos emigrantes seja monitorada.

Migraçao manejada é simplesmente um exemplo dos vários tipos de proteçao e manejo intensivos que são desejáveis e necessários para a viabilidade de populações na natureza. E' possível reduzir a MPV necessária para certo conjunto de objetivos ou, por outro lado, extender o tempo de persistência de uma população de certo tamanho, através de manejo interventivo, para corrigir problemas genéticos e demográficos, quando detectados. Na realidade, muitas dessas medidas simplesmente aumentarão o N_e para o número de animais mantidos em uma população.

MIGRAÇÃO MANEJADA ENTRE POPULAÇÕES SELVAGENS

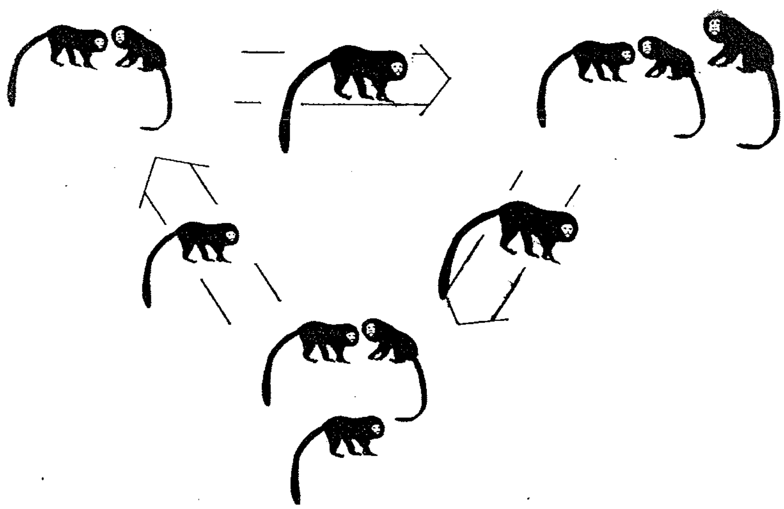


Figura 3. Migração manejada entre subpopulações para manter o fluxo genético em uma metapopulação.

Conforme refúgios naturais e suas populações vão se tornando menores, eles efetivamente transformam-se em "megazoológicos", que necessitarão certas formas de manejo genético e demográfico intensivo, assim como as espécies em cativeiro.

Propagação em Cativeiro

Um outro modo de melhorar a viabilidade de populações selvagens é reforçá-las com propagação em cativeiro. Mais especificamente, propagação em cativeiro oferece um número de vantagens: a) proteção contra exploração excessiva, ex., caçadores ilegais; b) controle das alterações ambientais, pelo menos para uma parte da população; c) melhor manejo genético e, consequentemente, melhor preservação do pool de genes; d) expansão acelerada da população, movendo-se em direção da MPV desejada e fornecendo animais mais rapidamente para introdução em novas áreas; e) aumentando o número total de animais mantidos.

Deve ser enfatizado que o propósito da criação em cativeiro é reforçar populações selvagens, e não substituí-las. Colônias em cativeiro e zoológicos devem servir como reservatórios de material genético e demográfico, cuja transfusão periódica para habitats naturais pode ajudar a restabelecer espécies que tenham sido extirpadas ou revitalizar populações debilitadas por problemas genéticos ou demográficos.

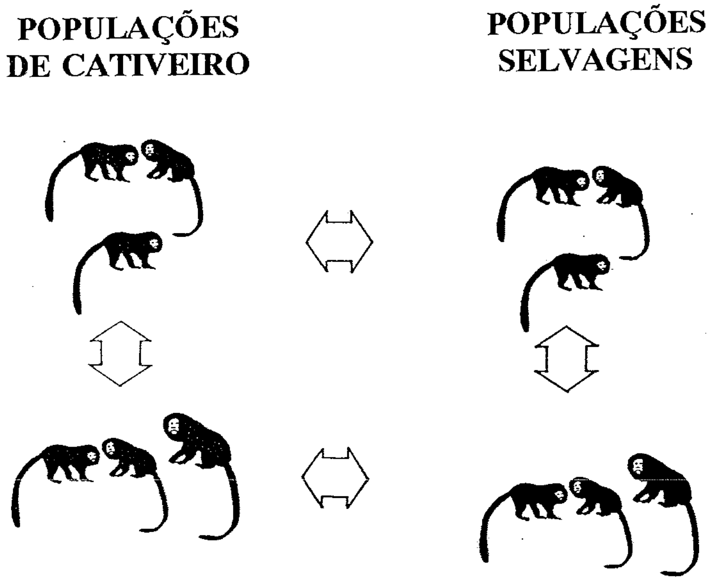


Figura 4. Uso de populações de cativeiro como parte da metapopulação a fim de expandir e proteger o pool genético de uma espécie.

A sobrevivência de um grande e crescente número de espécies ameaçadas irá depender do auxílio da propagação em cativeiro. Na realidade, o que emerge como ideal e inevitável são estratégias para conservação de espécies ameaçadas, incorporando o manejo interativo de ambas as populações, selvagem e de cativeiro, para suporte e sobrevivência mútua (Figura 4). A populaçãoo de cativeiro pode servir como reservatório vital de material genético e demográfico; a população selvagem, se grande o bastante, pode continuar a submeter a espécie à seleção natural. Essa estratégia geral tem sido adotada pela IUCN (organização mundial de conservação), a qual recomenda que criação em cativeiro seja utilizada sempre que a população selvagem de uma espécie ou taxon caia para menos de 1000 indivíduos (IUCN 1988).

Planos de Sobrevivência de Espécies

Zoológicos em muitas regiões do mundo estão organizando programas cientificamente manejados e coordenados para reforçar populações naturais com propagação em cativeiro. Na América do Norte, esses esforços estão sendo desenvolvidos sob os auspícios da Associação Americana de Parques Zoologicos e Aquários (American Association of Zoological Parks and Aquariums - AAZPA), em coordenação com o Grupo Especialista em Criação em Cativeiro (Captive Breeding Specialist Group - CBSG) da IUCN SSC. Esse plano é conhecido como Plano de Sobrevivência das Espécies (Species Survival Plan - SSP).

Criação em cativeiro pode ser útil, mas somente se as próprias populações de cativeiro forem baseadas nos conceitos de populações viáveis. Para isso será necessário o maior número de fundadores possível, rapidamente expandindo a população até várias centenas de indivíduos, além do manejo cuidadoso da população, genética e demograficamente. Esse é o propósito dos Planos-mestres do SSP. Programas em cativeiros podem também conduzir pesquisas para facilitar o manejo da espécie na natureza e em cativeiro, assim como para melhor compreeder as interações entre os dois.

Um excelente exemplo de tal estratégia é a combinação do Plano de Recuperação do Serviço de Pesca e Vida Selvagem do Estados Unidos (United States Fish and Wildlife Service - USFWS) com o Plano-mestre do SSP para o lobo vermelho americano. A maior parte da criação em cativeiro do lobo vermelho tem sido feita em instalações especiais no estado de Washington, Estados Unidos, mas existe ainda um número crescente de zoológicos que oferecem em cativeiro o ambiente dessa espécie, principalmente intituições dentro dos limites históricos de ocorrência do lobo vermelho.

LEONTOPITHECUS

MICO - LEÃO

ANÁLISE DE VIABILIDADE & PLANO DE SOBREVIVÊNCIA

MODELO SIMULADO DO PROCESSO DE EXTINÇÃO

J. D. Ballou and C. V. Padua

MODELO SIMULADO DO PROCESSO DE EXTINÇÃO EM POPULACÕES DE MICOS-LEÕES QUE HABITAM AREAS ATUALMENTE PROTEGIDAS

INTRODUÇÃO

Modelos computadorizados para a avaliação da probabilidade de extinção e de perda de variabilidade genética compõem parte importante da Análise de Viabilidade de População (AVP). Eles proporcionam um resumo quantitativo da situação da população em termos de conservação e permitem a avaliação das consequências a longo prazo dos efeitos de diferentes práticas de manejo (ver Panorama de Pequenas Populações).

Neste trabalho, foi utilizado o modelo Vortex criado por Robert Lacy (Sociedade Zoológica de Chicago) para modelar a situação conservacionista atual das populações de micos-leões em suas áreas protegidas. Para o mico-leão-dourado (MLD), foi utilizada a população de aproximadamente 290 indivíduos que vivem atualmente na Reserva Biológica de Poço das Antas. O modelo para o mico-leão-da-cara-dourada (MLCD) foi desenvolvido com as populações da Reserva Biológica de Una (est. mínima 466 animais), da Estação Ecológica de Canavieiras (ESCAN; est. 79 animais) e da Estação Experimental de Lemos de Maia (est. 20 animais). Quanto aos micos-leões-pretos (MLP), foram usadas no modelo, as populações do Parque Estadual do Morro do Diabo (est. mínima 80 animais) e da Reserva Ecológica de Caitetus (est. mínima 8 animais). A população de micos-leões-da-cara-preta (MLCP), recentemente descoberta no Parque Nacional de Superagui tambem foi modelada, mas não deve-se esperar resultados conclusivos imediatos pela quase completa falta de informações sobre a mesma. Cada uma dessas populações consideradas de maneira isolada, foi modelada levando-se em consideração um período de 100 anos. Cada bloco de simulações de 100 anos foi repetido entre 200 e 1000 vezes (dependendo dos resultados obtidos e do tempo requerido de computador). Tanto probabilidade de extinção quanto heterozigose esperada foram acompanhados todo o tempo. Cada vez que o tamanho populacional chegava a zero considerava-se como um evento de extinção para aquele ano. A probabilidade final de extinção foi determinada a partir da média das taxas de extinção de todas as simulações. Heterozigose esperada foi obtida monitorando-se a frequência de alelos da população no passar do tempo.

Para que se pudesse avaliar a sensibilidade dos resultados as premissas basicas feitas quando do desenvolvimento do modelo e explorar o efeito em potencial de várias opções de manejo na sobrevivência da população, modelou-se cada população diversas vezes usando-se diferentes parâmetros iniciais.
A contribuição potencial de uma população para a sobrevivência a longo prazo da espécie, é avaliada tomando-se como base sua probabilidade de extinção e sua capaciadade de reter uma proporção significativa de sua

diversidade genética original por um dado período de tempo. Um objetivo conservacionista consagrado, é o de que a população tenha tamanho e demais condições necessárias a que possua menos de 2% de probabilidade de extinguir-se e que seja capaz de reter pelo menos 90% de heterozigose por um período de 100 anos.

Estes e outros critérios como a sensibilidade da população a mudanças de carater biológico, ecológico, ambiental e de manejo, foram os critérios utilizados nessa avaliação da situação atual para fins conservacionistas das diversas populações de micos-leões enfocadas nesse trabalho.

FONTES DE DADOS

Os modelos AVP foram baseados em dados apresentados na Oficina (Workshop) AVP e sumariados no panorama das espécies apresentados neste volume. Entres os dados apresentados sobre a ecologia dos 3 micos-leões, os de Dietz e Baker para os Dourados, foram os mais completos, e a não ser que especificado de outra maneira, foram os utilizados nessa análise. Deve-se outrossim levar em consideração o fato do mico-leão-de-cara-preta (L. caissara) ser espécie recém descoberta, com dados praticamente inexistentes.

SOBREVIVENCIA

MLD:	Idade 0-1	13%±.14	13%±.14
	Idade 1-2	10%±.12	10%±.12
	Idade 2-3	33%±.21	50%±.21
	Adultos*	19%±.11	19%±.11

* Dados da população selvagem, mostram uma taxa de mortalidade anual para adultos de 15%. O modelo para extinção de populações todavia supõe uma mortalidade constante para os adultos e permite truncagem na idade máxima de longevidade (15 anos). Se aplica-se uma taxa de mortalidade constante, vamos dizer 15% sem truncagem, criamos uma situação artificial em que mais de 5% da população sobrevive a mais de 15 anos de idade. Alem disso teremos uma geração com quase 9 anos. Todos esses números seriam muito acima dos esperados para MLDs. Para corrigir essas distorções, calculamos uma taxa anual de mortalidade para adultos que coincidisse com a taxa reprodutiva líquida observada para as populações selvagens (1.95). Os resultados mostram que para uma taxa de mortalidade de adultos de 19%, a taxa reprodutiva líquida obtida com o programa, é a mesma da população. Dessa maneira, foi usado 19% de taxa de mortalidade para adultos nas diversas rodadas do modelo.

MLP, MLCD E MLCP: As mesmas médias que MLD; Variação utilizada igual a 2/3 daquela usada para MLDS (ver Variação Ambiental abaixo).

REPRODUÇÃO

MLD: Fêmeas podem produzir até no máximo duas ninhadas por ano. Dados de 1986 a 1989 mostram que:

19% das fêmeas produzem 0 crias/ano
06% das fêmeas produzem 1 cria/ano
52% das fêmeas produzem 3 crias/ano
06% das fêmeas produzem 4 crias/ano
17% das fêmeas produzem 4 crias/ano

O desvio padrão da percentagem de fêmeas procriando a cada ano é 0.23 (ver Variação Ambiental abaixo).

% de machos procriando=71%

MLP: Dados resultantes do trabalho de campo desenvolvido por Padua (não publicado) no Parque Estadual Morro do Diabo, sugerem que as fêmeas da espécie produzem menos ninhadas por ano do que MLDs. São os seguintes os dados para 4 grupos estudados por dois anos:

25% produziram 0 filhotes por ano
25% produziram 1 filhote por ano
50% produziram 2 filhotes por ano

Para todos os outros valores associados à reprodução (MLP, MLCD e MLCP) presumiu-se que seriam similares aos de MLD.

CAPACIDADE DE SUPORTE ATUAL

Presumiu-se que todas as populações estariam em áreas no limite ou quase de sua capacidade de suporte.

MLD: Poço das Antas=290

MLP: Morro do Diabo=80 a 350
Caitetus=8 a 30

MLCD: Una=466 a 972
Lemos Maia=20
ESCAN=79

MLCP: Superagui=125 a 625

A não ser quando assim observado, a população mínima estimada foi a usada nos modelos.

DISTRIBUIÇÃO ETÁRIA

MLDs:

Idade em	Percentual	
Meses	Machos	Fêmeas
< 9	16	19
9-18	18	21
18-30	18	19
> 30	48	41

MLP, MLCD e MLCP: Faltam Dados. Dessa maneira presumiu-se o mesmo que MLD

VARIAÇÃO AMBIENTAL

MLD

Tem-se observado que é baixo o efeito da variação ambiental sobre a mortalidade e reprodução na Reserva de Poço das Antas. Mesmo em anos relativamente secos, as taxas de reprodução e sobrevivência permaneceram altas. O que falta ainda, são estimativas diretas do efeito da variação ambiental sobre as populações.

Todavia, variação ambiental representa papel importante na variação das taxas de reprodução e mortalidade das populações naturais. O modelo Vortex, incorpora a variação binomial normalmente associada com os diversos parâmetros. Conceptualmente esta é a variação demográfica inerente a população. Uma maneira de incorporar variação ao modelo é através do incremento da variação demográfica por alguma constante multipla. As taxas reprodutiva e de sobrevivência ficam maiores que o esperado para o processo binomial "de per si".

No período de 5 anos em que os animais foram estudados, houve um ano de muita umidade durante a temporada seca quando a taxa reprodutiva elevou-se em 15% (Dietz e Baker, com. pess.). Esses dados foram usados para originar a variação ambiental na população. Presumiu-se que em temporadas como essa haja uma probabilidade de 80% de que a taxa de reprodução seja pelo menos 15% mais alta do que a média anual. Os dados acima foram os usados para definir a distribução da probabilidade para variação ambiental. Esta distribuição, nos dá para fêmeas reproduzindo na capacidade de suporte, um erro padrão de 3 a 4 vezes o esperado para uma distribuição binomial sozinha.

Usando esses parâmetros como um guia simplificado para variação ambiental, e levando em conta que este é provavelmente um valor sub-estimado da variação ambiental, estimamos que o efeito multiplicativo da variação ambiental seria 5 vezes aquele da variação demográfica. Chamamos tal valor de variação ambiental NORMAL. Para explorarmos as ramificações deste parametro no modelo procedermos corridas adicionais levando em consideração um efeito multiplicativo de 10 vezes a variação demográfica. Chamamos esse valor de ALTA variação ambiental. O desvio padrão para reprodução foi baseado na estimativa normal.

Um outro problema na obtenção de dados, é a falta de números disponíveis sobre os efeitos da variação ambiental na mortalidade. Nesse caso, admitimos que seria menor do que na reprodução e assim consideramos que o efeito da variação ambiental sobre a mortalidade seria 50% do da reprodução. Pelo mesmo raciocínio, o desvio padrão da sobrevivência foi baseado nesse mesmo valor.

MLP, MLCD e MLCP

A variação ambiental em áreas que contem tanto MLCD, MLCP como MLP, foi dada como menor do que a encontrada em Poço das Antas. Para essas espécies, a variação ambiental foi estimada em 2/3 da utilizada para os MLDs.

CATASTROFES

MLD

Probabilidade e severidade de catástrofes

Doenças: 1% de chance/ano com 50% de redução na sobrevivência
Desastre Ferroviário (uma vez que passa uma estrada de ferro na Reserva): 2% de chance/ano com 10% redução na sobrevivência
Desastre por Pesticida: 5% de chance/ano com 10% de redução na sobrevivência.

Como o modelo Vortex admite que somente duas catástrofes independentes ajam na população, juntamos as duas últimas em uma só com 7% de chance/ano e 10% de redução na sobrevivência.

MLP

Para a população do Morro do Diabo, foram usados catástrofes independentes como:

> Fogo com 5% de chance de ocorrência/ano e com uma redução de 50% na sobrevivência e doenças com 1% de ocorrência/ano e 50% de redução na sobrevivência.

Em Caitetus, existe a probabilidade de uma epidemia dizimar toda a população e por isso seu efeito foi modelado com uma chance de reduzir em100% a população.

MLCD

Identificou-se doença como a sua maior ameaça. Como probabilidade e severidade não foram estimadas, foram usados os mesmos valores usados para MLDs;

> 15% de chance/ano com uma redução de sobrevivência de 50%.

MLCP

Inexistem dados, foram usados os mesmos valores dos MLDs.

DEPRESSÃO POR CONSANGUINIDADE

MLD

Redução na sobrevivência e reprodução em consequência de consanguinidade é fenômeno comum entre as espécies de mamíferos. Nas populações de micos-leões-dourados em cativeiro, animais consanguíneos tem taxas de mortalidade significantemente maiores do que os não consanguíneos assim como suas ninhadas são de tamanho reduzido. O modelo de extinção de populações, pode levar em consideração, os efeitos da depressão por consanguinidade atraves de um modelo estocástico dos efeitos de genes letais na população. Em cativeiro, os valores médios para MLDs foram determinados como 4.3 eqivalentes letais (genes que são letais em homozigose). Utilizou-se esse mesmo valor de carga genética para as populações selvagens. Em alguns casos todavia esse valor foi reduzido em 50% para explorar-se os efeitos específicos desse parâmetro no resultado total.

MLP, MLCD e MLCP

Para essas espécies, as populações em cativeiro ou são pequenas demais ou não existem, o que levou a utilização dos mesmos valores que dos MLDs.

LIMITAÇÕES DO MODELO

O modelo VORTEX simula a sobrevivência e os eventos reprodutivos de cada indivíduo da população. Como consequência o modelo tem limitações no tamanho das populações que pode simular. A situação é particularmente difícil, quando leva-se em consideração depressão por consanguinidade (modelar os efeitos da consanguinidade requer memória adicional de computador para acompanhar a trajetória de alelos individuais na população). Enquanto na maior parte dos cenários trabalhados correu-se 1000 simulações, o número de simulações para alguns modelos de cenários foi limitado por esse mesmo motivo.

RESULTADOS DETERMINÍSTICOS

O modelo calculou estimativas do potencial determinístico das taxas de crescimento populacional e do tamanho de geração, sem levar em consideração efeitos estocásticos (ex: usando-se tabuas de mortalidade simples). Os resultados são apresentados na tabela 1 abaixo:

Tabela 1. Resultados do modelo determinístico

Espécie	Area	Taxa Potencial Anual de Crescimento	Tamanho de Geração (anos)
MLD	Poço das Antas	1.12	6.72
MLCD	Todas	1.12	6.85
MLP	Todas	1.02	6.26
MLCP	Superagui	1.12	6.72

Todas as populações apresentaram elevadas taxas de crescimento populacional com exceção dos micos-leões-pretos que mostraram uma taxa reprodutiva menor que das outras espécies modeladas.

RESULTADOS

1) MICO-LEÃO-DOURADO

A tabela 2 mostra a probabilidade de extinção em 100 anos com taxa normal e alta de variação ambiental (EV) para os vários modelos rodados para a população de Micos-leões-dourados na Reserva Biológica de Poço das Antas. Os diversos aspectos das diferentes rodadas são explicados abaixo.

Tabela 2

Rodada	Descrição do Modelo	Probabilidade de Extinção em 100 anos EV=Normal	 EV=Alta
1	K=290 Carga Genética=4.3	15%	17%
2	Redução Consanguinidade	<1%	3%
3	Sem Depressão/Consanguinidade	<1%	<1%
4	Aumento em K para 508	1%	2%
5	Redução nas Catastrofes	5%	7%
6	Com Reintrodução	13%	19%

Rodada	Descrição do Modelo	% Heterozigose Retida EV=Normal	 EV=Alta
1	K=290 Carga Genética=4.3	87%	86%
2	Redução Consanguinidade	91%	91%
3	Sem Depressão/Consanguinidade	92	92%
4	Aumento em K para 508	93%	93%
5	Redução nas Catastrofes	89%	88%
6	Com Reintrodução	87%	87%

EV= Variação ambiental com um fator multiplicativo de 5 para Normal e de 10 para Alta.

Situação Geral:

Rodada (1): Situação Atual

Esta rodada nos mostra o resultado correspondente a situação atual sem modificações para os próximos 100 anos e na premissa de que a carga genética é comparável àquela observada em cativeiro.

A capacidade de suporte (K) é constante em 290 animais. Da maneira como a população encontra-se no momento, ela é incapaz de atingir os critérios estabelecidos para sua conservação de menos de 2% de probabilidade de extinção e 90% de retenção de diversidade genética. Dobrar o efeito da variação ambiental tem efeito muito pequeno sobre esses reultados.

Rodadas (2) e (3): Redução na Consanguinidade

Tomou-se como premissas a redução em 50% em relação ao observado em cativeiro e a ausência total de efeito da consanguinidade. Em ambos os casos, há uma melhoria sensível na probabilidade de extinção e nos níveis de variação retidos na população. O que fica bem claro, é que diferentes premissas sobre os níveis de carga nas populações tem efeito significativo sobre os resultados do modelo.

Rodada (4): Aumento na Capacidade de Suporte

Somente 53% da área da Reserva Biológica de Poço das Antas, tem cobertura florestal. O fogo impede que grande parte da mesma regenere em habitat para símios. Se o fogo puder ser controlado, os pesquisadores na área estimam que a mesma tera um aumento considerável em sua capacidade de suporte indo de 290 para 508 em 35 anos (no ano 2025). Isto naturalmente requer um aumento de 1.6% anual na capacidade de suporte da mesma. Esta foi a taxa de mudança que incorporamos ao modelo para a corrida número 4. O resultado sugere que essa é uma pratica de manejo que pode aumentar consideravelmente a probabilidade de sobrevivência a longo prazo da população alem de melhorar sua capacidade de retenção de diversidade genética.

Rodada (5): Catastrofes

Foram identificados três tipos possíveis de catástrofes; pragas, descarrilhamento de trens com a possibilidade de problemas de cargas tóxicas e contaminação por pesticidas vindos das fazendas vizinhas. A rodada 5 mostra o que aconteceria se removessemos completamente a ameaça de descarrilhamento de trens ou em 50% a probabilidade de ocorrência de epidemias. Embora essas ações pudessem reduzir em 50% o risco de extinção da população elas por si só não são suficientes para assegurar o destino genético e demográfico da mesma.

Rodada (6): Programas de Reintrodução

Um programa de reintrodução que adicione a uma pequena população, animais sem laços de sangue, pode potencialmente, aumentar a situação genética e demográfica da população original. Em Poço das Antas todavia, a população presente está na sua capacidade de suporte e sua taxa natural de crescimeto (dependendo naturalmente do nível de depressão por consanguinidade) parece ser suficiente para produzir os indivíduos necessários para repor à reposição das perdas naturais. Reintrodução, não nos parece vá afetar a taxa geral de extinção da população, mas vai com certeza afetar a retenção de heterozigose. Nessa corrida examinamos os efeitos de reintroduzir-se 6 animais sem parentesco (dois adultos, dois jovens e dois sub-adultos) na Reserva a cada ano e por dez anos. A probabilidade de extinção no caso foi reduzida em 2% (em nada diferente estatisticamente a da corrida 1). Quanto ao nível de heteorzigose retida, permaneceu inalterado. Está clara a necessidade de explorar-se novos cenários, como mudanças na duração e intensidade de programas de reintrodução que afetam a sobrevivência a longo prazo e a situação genética da população.

Figuras 1 e 2 mostram a probabilidade de extinção e heterozigose retida no correr do tempo, com os diferententes cenários produzidos para Poço das Antas.

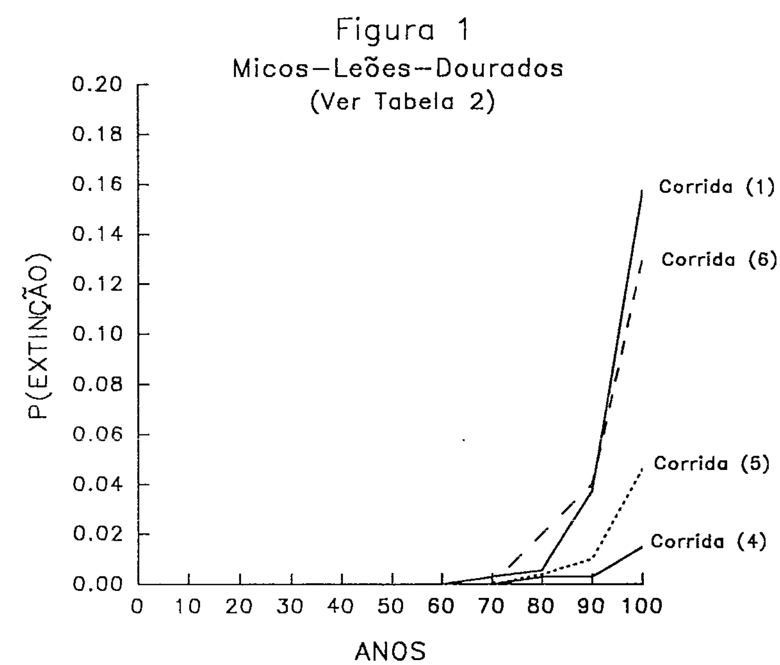
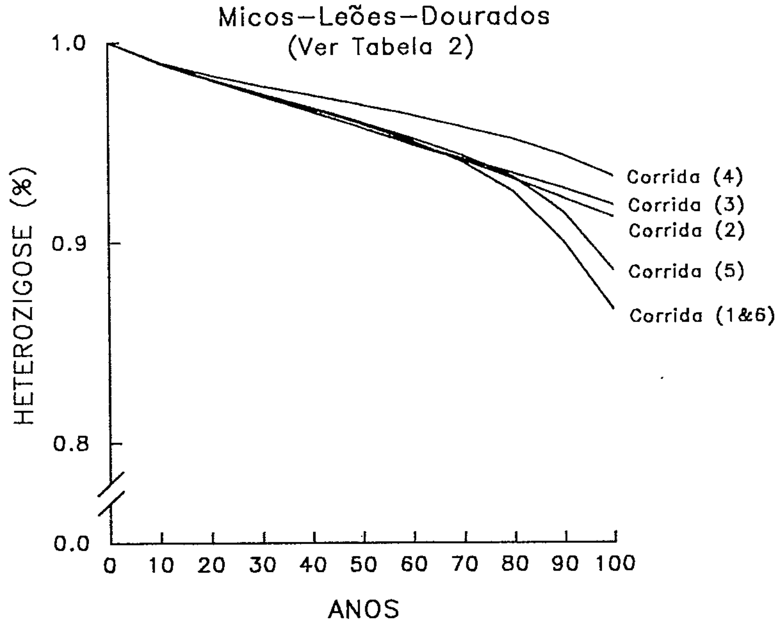


Figura 2
Micos-Leões-Dourados
(Ver Tabela 2)



2) MICO-LEÃO-DA-CARA-DOURADA

Tabela 3.

A tabela 3 mostra a probabilidade de extinção e retenção de variabilidade genética para os cenários desenvolvidos com as populações de Una, Lemos Maia e ESCAN.

Tabela 3

Rodada	Descrição do Modelo	Probabilidade de Extinção em 100 anos EV=Normal	EV=Alta
1	Una-K=466 Carga Genética=4.3	<1%	<1%
2	Una-Redução Consanguinidade	<1%	<1%
3	Lemos-K=20 Carga Genética=4.3	>99%	>99%
4	Lemos-Redução Consanguinidade	>99%	>99%
5	ESCAN-K=79 Carga Genética=4.3	>99%	>99%
6	ESCAN-Redução Consanguinidade	>99%	>99%

Rodada	Descrição do Modelo	% Heterozigose Retida EV=Normal	EV=Alta
1	Una-K=466 Carga Genética=4.3	95%	95%
2	Una-Redução Consanguinidade	95%	95%
3	Lemos-K=20 Carga Genética=4.3	--*--	--*--
4	Lemos-Redução Consanguinidade	--*--	--*--
5	ESCAN-K=79 Carga Genética=4.3	--*--	--*--
6	ESCAN-Redução Consanguinidade	--*--	--*--

--*-- = Todas as populações extintas.

Os resultados que apresentam >99%, são casos em que a extinção ocorreu em todas as simulações (Taxa de extinção de100%). Entretanto, em virtude de um erro estatístico associado ao número de simulações resta ainda uma chance ínfima de sobrevivência para a população. Por isso eles são apresentados com >99% e não 100%.

Rodada (1) (3) (5): Situação Atual

A Reserva de Una, com uma estimativa conservadora de 466 animais, apresenta-se como a única população que apresenta alta probabilidade de sobreviver 100 anos retendo suficiente diversidade genética. As outras duas populações trabalhadas, apresentam menos de 1% de chance de sobrevivência. A probabilidade de extinção e de perda de variabilidade genética é menor em Una do que em Poço das Antas (mesmo com uma capaciadade de suporte de 508) porque estimamos uma variação ambiental (VA) menor em Una. Alem disso a população de Poço das Antas tem que crescer dos 290 animais atuais até os 508 projetados. Nessa fase de crescimento, a mesma se torna mais suscetível à perda de de variabilidade genética e aumentam os ricos de extinção comparados a Una.

Rodada (2) (4) (6): Redução na Consanguinidade

A tabela 3 nos mostra os resultados de uma redução nos efeitos deletérios da consanguinidade. Ele não são tão severos como nas populações de MLDs por exemplo nem em alta nem em baixa Variação Ambiental. Essas são premissas que tem pouco efeito nos resultados gerais.

Não tentamos, diferentes opções de manejo para as populações de micos-leões-de-cara-dourada, porque as populações das Reservas menores, parecem estar na sua capacidade de suporte e as chances de crescimento das mesmas é pouca ou nenhuma. A população de 466 animais em Una, representa 50% de sua taxa de ocupação, mas de nada valeria trabalhar uma população maior pois isso apenas reduziria chance de extinção e perda de diversidade já que a mesma é a unica que atinge os objetivos propostos.

3)MICOS-LEÕES-PRETOS

A tabela 4 mostra a probabilidade de extinção e retenção de variabilidade genética para os cenários desenvolvidos com as populações de Micos-leões-pretos em Morro do Diabo e Caitetus.

Tabela 4

Rodada	Descrição do Modelo	Probabilidade de Extinção em 100 anos EV=Normal	EV=Alta
1	Morro do Diabo-K=80	>99%	>99%
2	Morro do Diabo-K=350	>99%	>99%
3	Morro do Diabo-Aumento de K=	>99%	>99%
4	M.do Diabo-Redução Consanguinidade	>97%	>97%
5	Caitetus-K=8	>99%	>99%
6	Caitetus-K=30	>99%	>99%

Rodada	Descrição do Modelo	% Heterozigose Retida EV=Normal	EV=Alta
1	Morro do Diabo-K=80	--*--	--*--
2	Morro do Diabo-K=350	72%	79%
3	Morro do Diabo-Aumento de K=	--*--	--*--
4	M.do Diabo-Redução Consanguinidade	79%	80%
5	Caitetus-K=8	--*-- -	-*--
6	Caitetus-K=30	--*--	--*--

--*-- = Todas as populações extintas nesse momento

Rodada (1) (2) (5) (6): Situação Atual

Estimativas no tamanho populacional em Morro do Diabo, vão de um mínimo de 80 a um máximo de 350 animais. Esses dois extremos foram modelados e os resultados nos mostram que mesmo com 350 animais a população tem uma probabilidade maior que 99% de de extinguir-se nos próximos 100 anos. As probabilidades de extinção tambem são maiores que 99% para a população de Caitetus tanto no mínimo de 8 quanto no máximo de 30 indivíduos. De uma maneira geral esses resultados nos mostram uma diferença em relação a MLDs e MLCDs em virtude principalmente da menor taxa de fecundidade estimada para MLPs (uma e não duas parições por ano).

Rodada (3): Aumento na Capacidade de Suporte

Uma das possibilidades de manejo examinadas nesse trabalho, foi um aumento na capacidade de suporte de Morro do Diabo. Atualmente 30% de Morro do Diabo não possui cobertura florestal adequada. Um programa de restauração florestal poderia aumentar a capacidade de suporte de Morro do Diabo elevando-a de 80 para 104 animais. Esse aumento estimativo de 30% foi usado como se ocorresse durante os próximos 35 anos. O resultado dessa rodada mostra que essa prática teria pouco impacto na sobrevivência a longo prazo da população.

Rodada (4) : Redução na Consanguinidade

Foram examinados tambem, os efeitos de uma redução nos níveis de depressão por consanguinidade em 50% para uma população em Morro do Diabo com 350 indivíduos. Essa redução embora diminua levemente a taxa de extinção da população, não é suficiente para eliminar o risco de extinção da população.

As probabilidades de extinção no correr do tempo tanto para Caitetus como para Morro do Diabo, estão postas de uma maneira comparativa e fácil de se entender nas figuras 3 e 4. Da mesma maneira perda de heterozigose para Morro do Diabo, pode ser observada na figura 5.

Figura 3
Micos-Leões-Pretos: Morro do Diabo
(Ver Tablela 4)

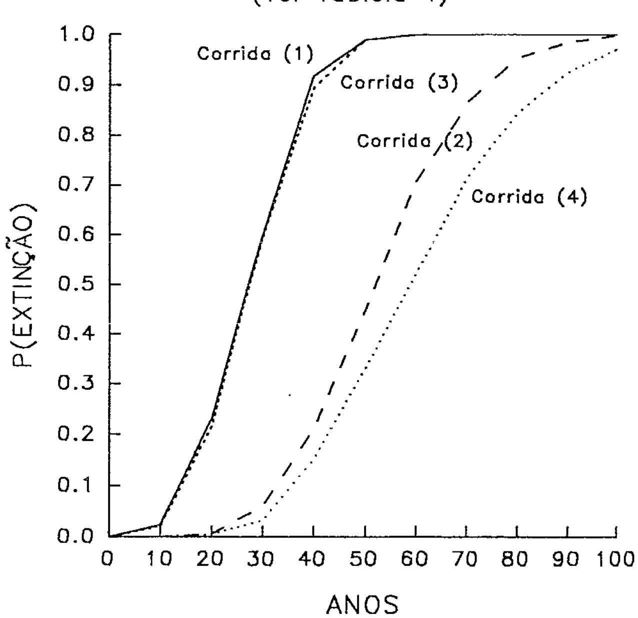


Figura 4
Micos-Leões-Pretos: Caitetus
(Ver Tabela)

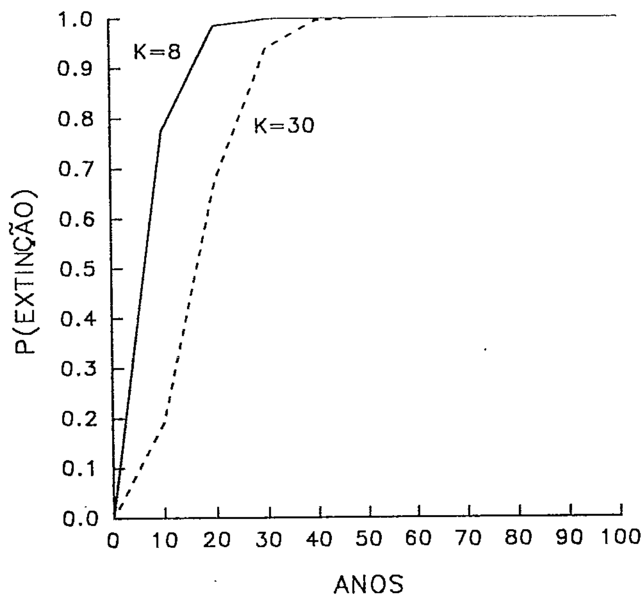
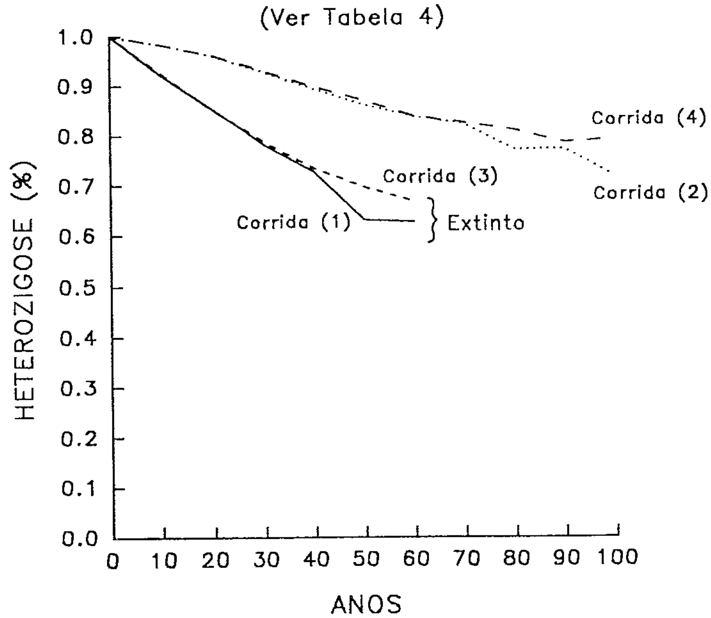


Figura 5
Micos-Leões-Pretos: Morro do Diabo
(Ver Tabela 4)



4)MICOS-LEÕES-DA-CARA-PRETA

A População de micos-leões-da-cara-preta, foi trabalhada em 165 animais, usando-se os mesmos parâmetros utilizados para micos-leões-pretos em Poço das Antas. A tabela 5 mostra essses resultados.

Tabela 4

Rodada	Descrição do Modelo	Probabilidade de Extinção em 100 anos EV=Normal	EV=Alta
1	Superagui-K=125	>99%	>99%

Rodada	Descrição do Modelo	% Heterozigose Retida EV=Normal	EV=Alta
1	Superagui-K=125	--*--	--*--

--*-- = Todas as populações extintas em 100 anos. Estimativas de heterozigose não disponíveis.

4) Rodada (1): Capacidade de Suporte

Levando-se em conta uma história vital e caracteristicas poulacionais iguais as de micos-leões-dourados, a probabilidade de extinção dessa população é de quase 100%.

CONCLUSÕES

As taxas de extinção para todas as populações modeladas, com exceção da de UNA, não alcançaram a tolerância mínima de 2% em 100 anos estabelecidas como as mais realísticas para os objetivos conservacionistas propostos.

A população de micos-leões-dourados em Poço das Antas tem 15% de probabilidade de extinção em 100 anos. O modelo sugere que a probabilidade de sobrevivência a longo prazo da população poderia ser aumentada em muito se a capacidade de suporte fosse aumentada para 500 animais. Ficou bem claro tambem, que um importante fator de conservação nessa população é a severidade na depressão por consanguinidade.

Estratégias conservacionistas devem basear-se em todo conhecimento disponível. Dados das populações em cativeiro sugerem que a consanguinidade está presente na espécie nos níveis utilizados nesse modelo e que a mesma tem o potencial de levar a população a extinção.

Entre as populações de micos-leões em geral a que parece mais segura é a de micos-leões-de-cara-dourada da Reserva Biológica de Una. Esses resultados todavia não devem, em hipótese alguma, ser considerados como se a população de Una estivesse segura para os parametros determinados. As Análises de Viabilidade de Populações (AVP), fique bem claro, não consideram todos os fatores que afetam a viabilidade de populações e portanto devem ser tomados como valores sub-estimados da mesma.

Quanto as populações de micos-leões-pretos: a de Caitetus está extremamente vulnerável a extinção (78% de chance de extinguir-se nos proximos 10 anos). A população de Morro do Diabo não alcança os critérios de tolerância estabelecidos para extinção num período de 20 anos (Figura 4). Está claro pois que aos níveis atuais, essas populações não são suficientes para a conservação da espécie.

Em resumo, os resultados obtidos nitidamente vão de encontro as recomendações formuladas pelos participantes da Oficina, que urgem por medidas imediatas para identificar e proteger habitat adicional para os micos-leões bem como a descoberta de novas populações desses símios.

LEONTOPITHECUS

MICO - LEÃO

ANÁLISE DE VIABILIDADE & PLANO DE SOBREVIVÊNCIA

RECOMENDAÇÕES PARA TRANSLOCAÇÕES

EDUCAÇÃO AMBIENTAL

ESTUDOS PATOLÕGICOS

MOCAO

GLOSSARIO

RECOMENDAÇÕES PARA TRANSLOCAÇÕES E REINTRODUÇÕES

Existem condições apropriadas para recomendar (ou desaprovar) a reintrodução de animais nascidos em cativeiro ou promover translocações de indivíduos ou grupos?

Abaixo estão listadas 10 condições necessárias para se efetuarem recomendações a respeito de programas de translocação/reintrodução. Em adição, avalia-se a posição de cada mico-leão com relação a cada critério. Finalmente, uma recomendação geral é apresentada com relação a se um programa de translocação/reintrodução é viável para cada forma de mico no presente momento, baseando-se no ponderamento de vários critérios.

1. Faz pouco sentido se promoverem reintroduções ou translocações se as causas de declíneo da população não foram eliminadas. Nós sugerimos que estas condições não foram ainda atingidas para *chrysopygus* e *chrysomelas*. Permanece questionável se as causas do declíneo de *rosalia* estão realmente sob controle.

2. Reintrodução não é recomendada caso não haja suficiente habitat protegido. Nós estimamos que exista habitat suficiente para *chrysopygus*, mas não para *chrysomelas*. É questionável se existe suficiente habitat para *rosalia*.

3. A reintrodução ou translocação para o interior de áreas saturadas não é recomendada devido a possíveis disturbios sociais na população nativa e introdução de doenças. Portanto, é preciso que hajam areas disponíveis com poucos ou nenhum animal para que animais adicionais possam ser introduzidos. Esta condição existe para *rosalia*. Também é possível que haja habitat não saturado para *chrysomelas*, porém com menos certeza. Entretanto, existem muitos *chrysomelas* confiscados os quais podem ser facilmente absorvidos no programa de cativeiro; translocação/reintrodução pode ser uma opção viável para aqueles dentre os confiscados que nasceram em vida silvestre. As condições atuais não favorecem a reintrodução de *chrysomelas*. A situação para *chrysopygus* é desconhecida.

4. Reintrodução deveria ser encorajada apenas quando existe alguma certeza de que a introdução de animais provenientes de regiões diferentes (cativos e silvestres) não colocará em risco a população nativa em consequência de distúrbios sociais ou transmissão de doenças. Nós não temos esta certeza para nenhuma das 3 formas de micos-leões.

5. A fim de avaliar o habitat disponível e potencial sucesso de um programa de reintrodução/translocação, precisam-se obter informações a respeito da ecologia comportamental/biologia das populações silvestres. Em uma escala de 1-5, sendo 5 o melhor dos cenários, nós sugerimos que existe suficiente informação para *rosalia* e total falta de informação para *chrysomelas*, com *chrysopygus* num estágio intermediário.

6. Um programa de educação conservacionista informará a população local de modo a oferecer suporte ao programa de reintrodução/translocação. Os programas de conservação para *rosalia* e *chrysopygus* possuem altos componentes de educação. O programa de educação para *chrysomelas* está apenas começando.

7. A introdução de animais atualmente em cativeiro (nascidos em cativeiro ou em vida silvestre) é imprópria a menos que a população em cativeiro esteja assegurada, exista um plano de manejo a longo prazo e existam excedentes de animais em cativeiro. Esta condição existe apenas para *rosalia*. Uma exceção são os especimens confiscados de *chrysomelas*, atualmente em Una, os quais não podem ser facilmente absorvidos pelo programa de cativeiro no presente momento.

8. Reintrodução/translocações não são recomendadas a menos que existam suficientes informações básicas ou conhecimento sobre a metodologia e técnicas de preparação, adaptação e soltura para que o processo tenha alguma chance de sucesso. No presente nós temos considerável informação a este respeito, entretanto existem muitas questões não respondidas que irão assegurar o sucesso a respeito de algumas técnicas como por exemplo, a introdução de indivíduos no interior de grupos sociais já estabelecidos.

9. Não há sentido em soltar animais em vida silvestre, sem os recursos necessários para monitorar as atividades e sobrevivência destes animais, especialmente uma vez que nós não temos ainda aperfeiçoado nossa técnicas de reintrodução/translocação. Os programas de conservação para *chrysomelas* e *chrysopygus* não estão suficientemente avançados com respeito ao suporte financeiro e uma infra-estrutura semi-permanente para garantir um esforço de reintrodução/translocação. O programa para *rosalia* tem uma infra-estrutura bem desenvolvida e recursos financeiros consideráveis.

10. Reintrodução/translocações são desnecessárias a menos que as populações silvestres necessitem reforços em números ou diversidade genética. Esta condição foi atingida para *rosalia*, mas não para *chrysomelas* e *chrysopygus*.

RECOMENDAÇÕES:

Levando-se em consideração as excessões apontadas nos ítens 3 e 7 e considerando-se as condições necessárias para reintrodução/translocação, conclui-se que estes esforços são apropriados para *rosalia*, mas não para *chrysomelas* ou *chrysopygus*.

Translocação/reintrodução de micos-leões:
[Existem condições necessárias? (escala 5 = melhor)]

	rosalia	*chrysomelas*	*chrysopygus*
1. As razões para redução da população foram eliminadas (caça, desmatamento, comércio).	?	não	não
2. Suficiente habitat já está garantido e protegido.	sim	não	sim
3. Existe habitat disponível com baixas densidades ou desabitados por micos silvestres.	sim	sim(?)	?
4. Certeza de que a soltura de animais não irá prejudicar a população nativa.	não	não	não
5. Existe suficiente informação sobre a biologia da espécie em vida silvestre (demografia, reprodução, alimentação).	5	1-5	3
6. Programa de educação ambiental	5	2	4
7. A população de cativeiro é bem manejada, está garantida e possui excedente de animais.	sim	não	não
8. Conhecimento sobre metodologia de reintrodução e translocação.	-------------3-----------		
9. Recursos e mecanismos para monitorar os resultados.	sim	não	não
10. Necessidade de aumentar o tamanho da população ou sua diversidade genética em vida silvestre.	sim	não	não
11. Reintrodução/translocação recomendadas.	**SIM**	**NÃO**	**NÃO**

Educação Ambiental e os Micos-Leões

Suzana Padua, Lou Ann Dietz, Elizabeth Nagagata, Cristina Alves

Com base nos estudos apresentados na Oficina (Workshop) e os resultados das diversas simulações rodadas (veja: Modelo de Extinção de Populações), ficou claro que a sobrevivência dos micos leões depende do esforço de diversas áreas. Educação Ambiental é um instrumento essencial para a conscientização da população em relação aos problemas ambientais. Também pode demonstrar a importância da conservação, e apresenta alternativas que possam contribuir para a preservação da vida silvestre. Em termos práticos, educação pode intervir de diversas maneiras: detendo desmatamento; conservando populações de micos-leões existentes e preservando seus habitats; protegendo florestas que sirvam como áreas de reintrodução; possibilitando a descoberta de novas populações de micos-leões, e expandindo áreas florestadas necessárias a futuros programas de reintrodução desses primatas. Além disso, educação pode ser efetiva no decréscimo de caça predatória, fogo que ameaça seus habitats florestais, tráfico e contrabando desses animais que podem atingir preços altos nos mercados ilegais, sejam eles nacionais ou internacionais. Embora proibido o comércio de espécies ameaçadas de extermínio, esses símios são procurados como animais de estimação para satisfazer caprichos de colecionadores inescrupulosos.

Do ponto de vista humano, os micos-leões são espécies carismáticas de primatas. Programas de Educação Ambiental tem tido êxito ao eleger esses primatas como símbolos de conscientização e valorização de florestas nativas. Estratégias tem sido adotadas para envolver comunidades que habitam áreas proximas às desses primatas. Programas de Educação proporcionam aumento de conhecimento, e enfatizam a singularidade que essas espécies representam nas áreas onde ocorrem. Esses primatas são motivo de orgulho e ponto de referência em suas regiões. Consequentemente, o conceito da preservação de florestas pode ser introduzido, por ser indispensável à conservação dos micos. Ecossistemas inteiros tem sido preservados a partir de uma espécie utilizada como símbolo de educação (Fazendeiros na área de ocorrência do mico-leão-dourado, Rio de Janeiro, concordaram em preservar suas florestas para poderem receber micos reintroduzidos).

Devido aos acelerados índices de desmatamento, todos os segmentos das comunidades devem ser atingidos. Programas de educação tem sido utilizados para reforçar o envolvimento das comunidades locais e a conscientização para a importância da conservação. O mico-leão-dourado, o mico-leão preto e mais recentemente, o mico-leão-da-cara-dourada tem tido efetivos programas de educação em comunidades locais. Cada programa utilizou estratégias com o propósito de aumentar a efetividade.

Abaixo estão relacionadas algumas dessas estgratégias, descritas como recomendações, mesmo se já empregadas. Estas podem variar de acordo com o contexto regional e o empenho do grupo de educadores:

- cada população humana deve ser vista como única, e materiais apropriados devem ser elaborados e testados específicamente para cada grupo. Os instrumentos utilizados devem ser compartilhados e não impostos;
- funcionários de reservas e parques são participantes importantes para os planos de conservação dos micos-leões, pois seu envolvimento é essencial para a efetivação "in loco" de programas de Educação Ambiental;
- professores e estudantes representam instrumento efetivo para o alcance da comunidade como um todo. O educador poderá apresentar o Programa nas escolas com quaisquer materiais disponíveis. As escolas tem propiciado local efetivo para programas de treinamento de professores que representam elementos multiplicadores de transmissão de conhecimentos para outras pessoas;
- programas de extensão para estudantes podem ser organizados, assim como concursos de desenhos, poesias ou redações, visitas à áreas naturais sempre que possível. Os estudantes devem ter um contato direto com o meio ambiente natural para que desejem conservá-lo. Apresentação e discussão de filmes e vídeos sobre Natureza, e outras atividade correlatas poderão ser organizadas de acordo com as necessidades locais e criatividade do educador;
- famílias podem ser envolvidas através dos estudantes, mas programas especiais devem ser pensados para elas (apresentações de 'slides', concursos de comidas ou músicas típicas, exposição de arte ou artesanato, representações, etc.);
- visitas aos fazendeiros vizinhos devem ser priorizadas. Aqueles que tem florestas originais devem ser convidados a participar do "plano emergencial" para salvar os micos-leões, e aos que não as tem devem ser apresentados os benefícios do plantio de essências nativas. Os Programas Educativos devem compreender as necessidades dos fazendeiros e enfatizar como conservação relaciona-se com elas. A proprietários de terras devem ser mostrados incentivos fiscais que favorecem a preservação ou o plantio de florestas;
- líderes comunitários devem ser contactados e convidados a contribuir para planos globais para conservação da Natureza local;
- políticos devem ser capazes de reconhecer as vantagens de participar na preservação de áreas ou espécies protegidas. Uma vez que as populações locais estejam conscientes, políticos ficarão automaticamente interessados em assuntos que lhes tragam popularidade. Entretanto, o Programa deve ser apolítico, ou seja, não deverá estar envolvido ou tomar posição de parcialidade com qualquer partido ou indivíduo na esfera política;

- aos meios de comunicação devem ser fornecidas informações sobre as espécies e a região, bem como notícias sobre atividades educativas que enfatizem a importância dos valores locais;
- métodos de avaliação devem ser planejados para cada etapa de um programa educativo, para que sua efetividade e progresso possam ser medidos e modificados de acorde com as necessidades, e o resultado final seja efetivo;
- grupos de conservação nacionais ou internacionais, principalmente os respectivos comitês internacionais para a preservação de cada espécie de micos-leões, devem ser notificados e consultados em qualquer circunstância que possa ameaçar essas espécies ou seus habitats.

Através de Programas efetivos de Educação Ambiental, populações locais tornar-se-ão defensoras potenciais dos habitats naturais. Programas educativos contínuos propiciarão meios de obtenção de maiores conhecimentos, apreciação do mundo natural, compreensão de conceitos ecológicos. Desta forma solidificam-se as bases conservacionistas das comunidades. Em se tratando dos micos-leões, o maior objetivo é a proteção das espécies em si, através da preservação do restante de seus habitats e da criação de novos habitats que favoreçam o aumento do número de indivíduos e a formação populações viáveis.

NOTAS SOBRE A OBTENÇÃO DE AMOSTRAS PARA ESTUDOS PATOLÕGICOS DE SAGUIS NO CAMPO

Richard Montali, D.V.M.

I. Procedimentos e Materiais

1. Materiais e Equipamentos. Kit regular de dissecção com bisturi, pinças e tesouras; Vidros do tipo de comida de bebes com formol a 10%; Caderno de notas e lãpis; Culturettes para obtenção de culturas de bactérias (produto comercial).

2. Procedimentos. Se as carcaças de saguis estiverem em condições de serem enviadas refrigeradas ou em gelo (NÃO CONGELAR) a um laboratõrio de necrõpsia no periodo de 24 horas apos a morte, essa é a medida acertada. Se não, coletar material para patologia como se segue:

   A. Examinar as carcaças procurando sinais de trauma - mordidas, feridas, ectoparasitas etc. Feridas que antecedem a morte devem estar associadas a hemorragias. Feridas apos a morte (por co-especificos ou carniceiros) não apresentam hemorragia.

   B. Faça incisão longitudinal a meio ventre e por detras do sterno até a ãrea inguinal. Puxe a pele e examine o estado nutricional do animal (ausencia ou presença de gordura sub-cutânea ou da cavidade abdominal). Cuidadosamente examine o diafragma a procura de hérnias ou outros defeitos (ver livro de linhagens e protocolo de manejo dos micos-leões-dourados).

   C. Examine todos os orgãos abdominais. Fique atento para colorações anormais, pintas ou lesões. Colete material das lesões forçando uma mecha (swab) nas ãreas lesadas e guardando a mecha (swab) em receptãculo apropriado sem tocar nos arredores. Com bisturi e pinça, colete secção fina de TODOS os orgãos mas especificamente dos pulmões (3 ou 4 lobos), fígado (múltiplos lobos), baço, rins, pancreas, adrenais, gonadas e bexiga. Certifique-se de estar coletando lesões se elas existirem. As secções não podem ser mais grossas que 1 cm para uma fixação apropriada. Abra a cavidade dos orgãos vilosos (estômago, intestino, outros orgãos tubulares, vesícula biliar) e colete todos os parasitas e pedras. Obtenha cortes de 1 cm das paredes intestinais, alem de pequena quantidade de fezes e mergulhe em solução de formol. Tome notas de todas as observações. A quantidade de formol no recipiente deve ser de aproximadamente 10 vezes o volume da amostra.

II. Problemas Na Reintroducao

Previna a introdução de qualquer condição de doenças contagiosas, infecciosas ou parasitãrias, que possam ter adaptado-se a esses animais enquanto em cativeiro com as seguintes prãticas:

(1) Usos de procedimentos usuais de quarentena antes da reintrodução.

(2) Uso de exames de saóde antes do embarque para reintrodução que incluam; hemograma, perfis químicos do soro, exame para ecto e endo parasitas, teste de tuberculose, testes serolõgicos para certas doenças infecçiosas (incluindo, herpes, hepatite e outras) alem de todos os outros procedimentos de diagnósticos que identifiquem problemas pertinentes de infecção.

(3) Exame de saude do pessoal envolvido com os saguis antes ou durante a reintrodução ficando atento para possíveis zoonoses que possam ser transmitidas aos animais.

III. Prevenir qualquer anormalidade metabólica ou de desenvolvimento que possa ocorrer nas crias dos animais reintroduzidos com os seguintes procedimentos:

(1) Exame dos animais a serem reintroduzidos com os metodos apropriados que identifiquem anormalidades fenotípicas como;

A. Uso de herniograma invertido para identificação de saguis com defeito potencial no diafragma.

B. Uso de metodos de exame bioquímicos que detectem desordens metabõlicas.

WORKSHOP - CONSERVAÇÃO DOS MICOS-LEÕES

LION TAMARINS CONSERVATION WORKSHOP

Moção No. 06

Proposta por: Participantes do workshop - conservação dos micos-leões, representantes da Fundação Biodiversitas (Belo Horizonte), IBAMA (Diretoria de Ecossistemas e Superintendências), Centro de Primatologia do Rio de Janeiro, Instituto Florestal de São Paulo, Fundação Pau Brasil (Iabuna), Conservation International (USA), World Wildlife Fund (USA), National Zoological Park (USA), IUCN/SSC/Captive Breeding Specialist Group, Zoological Society of London (Inglaterra), Jersey Wildlife Preservation Trust (Inglaterra) e outros.

Assunto: Moção de agradecimento à CEPLAC (Comissão Executiva do Plano da Lavoura Cacaueira) pelo apoio dado a projetos de conservação ambiental na região sul do Estado da Bahia.

Destino: Secretaria Geral da CEPLAC

Texto: Os participantes do Workshop - **conservação dos micos-leões,** realizado em Belo Horizonte no período de 20 a 23 de junho de 1990, manifestam os seus mais sinceros agradecimentos a CEPLAC (Comissão Executiva do Plano da Lavoura Cacaueira) pelo importante apoio que tem dado aos pesquisadores que desenvolvem projetos de conservação ambiental na regão sul da Bahia e, em especial, ao "Projeto Mico-Leão Baiano", de educação ambiental. Ao mesmo tempo, manifestam a certeza de que esse importantíssimo órgão de desenvolvimento regional continuará somando esforcos no sentido de preservar a integridade das áreas de Mata Atlântica remanescentes naquela região, bem como dos outros ecossistemas ali representados.

cc:
1. Coordenadoria Regional da CEPLAC
2. Chefia do Centro de Pesquisas do Cacau- CEPEC
(Km 22, Rodovia Ilhéus/ Itabuna - Ilhéus, BA, 45660)

WORKSHOP - CONSERVACAO DOS MICOS-LEOES

LION TAMARINS CONSERVATION WORKSHOP

Moção No. 07

Proposta por: Participantes do workshop - **conservação dos micos-leões,** representantes da Fundação Biodiversitas (Belo Horizonte), IBAMA (Diretoria de Ecossistemas e Superintendências), Centro de Primatologia do Rio de Janeiro, Instituto Florestal de São Paulo, Fundação Pau Brasil (Iabuna), Conservation International (USA), World Wildlife Fund (USA), National Zoological Park (USA), IUCN/SSC/Captive Breeding Specialist Group, Zoological Society of London (Inglaterra), Jersey Wildlife Preservation Trust (Inglaterra) e outros.

Assunto: Moção de agradecimento à Fespi (Federação das Escolas Superiores de Ilhéus e Itabuna) pelo apoio dado a projetos de conservação ambiental na região sul do Estado da Bahia.

Destino: Ilmo Sr. Altamirano Marques
Diretor Geral da FESPI
Km 16, Rodovia Ilhéus/Itabuna
Ilhéus, BA 45660

Texto: Os participantes do Workshop - **conservação dos micos-leões,** realizado em Belo Horizonte no período de 20 a 23 de junho de 1990, manifestam os seus mais sinceros agradecimentos a Fespi (Federação das Escolas Superiores de Ilhéus e Itabuna) pelo grande apoio que tem dado ao "Projeto Mico-Leão Baiano". Ao mesmo tempo, manifestam a certeza de que esse importantíssimo estabelecimento de ensino da região sul da Bahia continuará somando esforcos no sentido de preservar a integridade das áreas de Mata Atlântica remanescentes naquela região, bem como dos outros ecossistemas ali representados.

cc: Reneé Albagli
Coordenadora Acadêmica

WORKSHOP - CONSERVACAO DOS MICOS-LEOES

LION TAMARINS CONSERVATION WORKSHOP

Moção No. 08

Proposta por: Participantes do workshop - **conservação dos micos-leões,** representantes da Fundação Biodiversitas (Belo Horizonte), IBAMA (Diretoria de Ecossistemas e Superintendências), Centro de Primatologia do Rio de Janeiro, Instituto Florestal de São Paulo, Fundação Pau Brasil (Iabuna), Conservation International (USA), World Wildlife Fund (USA), National Zoological Park (USA), IUCN/SSC/Captive Breeding Specialist Group, Zoological Society of London (Inglaterra), Jersey Wildlife Preservation Trust (Inglaterra) e outros.

Assunto: Moção de agradecimento à TV Cabrália, da Rede Manchete de Televisão, pelo apoio dado a projetos de conservação ambiental na região sul do Estado da Bahia.

Destino: Ilmo Sr. Ramiro Aquino
Diretor da TV Cabrália
Morro dos Canecos s/no.
Itabuna, BA, 45600

Texto: Os participantes do Workshop - **conservação dos micos-leões,** realizado em Belo Horizonte no período de 20 a 23 de junho de 1990, manifestam os seus mais sinceros agradecimentos a TV Cabrália, da Rede Manchete de Televisão, pelo contribuição que tem prestado ao "Projeto Mico-Leão Baiano", de educação ambiental. Ao mesmo tempo, manifestam a certeza de que essa importantíssimo órgão de comunicação continuará somando esforcos no sentido de concientizar a sociedade regional no sentido de preservar a integridade das áreas de Mata Atlântica remanescentes naquela região, bem como dos outros ecossistemas ali representados.

GLOSSÅRIO DE DEMOGRAFIA

Idade Classe etária em anos.

Px Idade específica de sobrevivência.

Probabilidade de que um animal de certa idade sobreviverá até a próxima classe etária.

Lx Idade específica de sobrevivência.

Probabilidade de que um recém-nascido sobreviverá até uma dada classe etária.

Mx Idade específica de fertilidade.

Número médio da progênie (do mesmo sexo do genitor) produzida por um animal em dada classe etária. Também pode ser interpretado como a porcentagem média de animais que irão reproduzir.

r Indice instantâneo de mudança.

Se:

$r < 0$ .... População em declínio

$r = 0$ .... População estacionária
(Não muda em número)

$r > 0$ .... População crescente

Lambda Porcentagem de mudança da população por ano.

Se:

lambda < 1 ... População em declíneo

lambda = 1 ... População estacionária
(Não muda em número)

lambda > 1 ... Populção crescente

R_o Indice reprodutivo líquido.

O índice de mudança por geração.

Se: $R_o < 1$ ... População em declíneo

$R_o = 1$ ... População estacionária

$R_o > 1$ ... População crescente

G ou T Tempo de geração.

Período médio de tempo entre o nascimento do indivíduo genitor e o nascimento de sua progênie. É equivalente à idade média na qual um animal produz sua progênie.

GLOSSÅRIO DE GENÉTICA

DNA

Åcido Desoxirribonucleico: uma cadeia de moléculas contém unidades chamadas nucleotídeos: o material que armazena e transmite informação herdada de uma célula ou organismo para o próximo. O DNA principal está localiado nos cromossomos, no núcleo das células. Nas mitocôndrias também existe DNA, menos importante, mas ainda muito significativo.

GENE

O segmento de DNA que constitui uma unidade funcional de herança.

LOCUS

A seção de DNA ocupada por um gene. Gene e locus (com plural "loci") são frequentemente usados com a mesma conotação.

ALELO

Formas alternativas de um gene. Mais especificamente, alelo refere-se a diferentes formas de um gene determinando características alternativas. Entretanto, alelo é mais amplamente usado para denotar diferentes cópias de um gene, isto é, as duas cópias de cada um gene que todo organismo diplóide carrega para cada locus.

FREQUÊNCIA GÊNICA OU ALÉLICA

A proporção na população de todas as cópias de um gene que representa um dado alelo.

GENÓTIPO

Os tipos de alelos que um indivíduo possui como suas duas cópias de um gene. Por exemplo, se existem dois alelos (A e **a**) possíveis em um locus, então existem três genótipos possíveis : **AA**, **Aa** e **aa**.

FREQUÊNCIA GENOTIPICA

A proporção de indivíduos em uma população que carregam um dado genótipo.

HETEROZIGOSIDADE

A proporção de indivíduos em uma população que são heterozigotos, isto é, que carregam alelos funcionalmente diferentes, em um locus.

EQUILIBRIO DE HARDY-WEINBERG

Um princípio em genética de população que prevê frequências de genótipos bseado nas frequências dos alelos, presumindo-se que a população esteja se reproduzindo ao acaso por pelo menos uma geração. No caso mais simples, quando existem dois alelos (A , a) em um locus e esse alelos ocorrem com frequência P_{a}, a lei de Hardy-Weinberg prevê que, após uma geração de panmixia, as frequências dos genótipos serão: **AA** = P_A^2; **Aa** = 2 $P_A P_a$; **aa** = P_a^2.

HETEROZIGOSIDADE ESPERADA = DIVERSIDADE DE ALELO FUNDADOR = DIVERSIDADE GENÉTICA

É a heterozigosidade esperada em uma população se a população estiver em equilíbrio de Hardy-Weinberg. A heterozigosidade esperada é calculada a partir de frequências de alelos, e é a heterozigosidade esperada na progênie produzida por crusamento ao acaso. 1 - Σ P_i, onde P_i = frequência do alelo i.

GENOMA

O conjunto completo de genes que um indivíduo carrega.

OSCILAÇÃO GENÉTICA

A mudança nas frequências gênicas de uma geração para a outra devido ao acaso pelo qual alelos são transmitidos dos pais para a progênie. Essa variação ao acaso torna-se maior conforme a população torna-se menor, assim como a amostra de genes transmitida de uma geração para a próxima.

AFUNILAMENTO GENÉTICO = BOTTLENECK

Uma geração na linhagem de um fundador quando apenas um ou poucos descendentes são produzidos, de modo que nem todos os alelos do fundador possam ser transmitidos para a próxima geração.

FUNDADOR

Um indivíduo de uma população fonte (ex., selvagem) que produz descendentes em uma nova população derivada (ex., cativeiro).

REPRESENTAÇÃO DO FUNDADOR

A porcentagem ou fração de todos os genes na população, a qualquer momento, que tenham derivado de um dado fundador.

REPRESENTAÇÃO EXISTENTE

A porcentagem existente da representação de fundadores na população.

REPRESENTAÇÃO ALVO

A porcentagem desejada de representação de fundadores. Os nalores dessa porcentagem alvo são proporcionais â fração de cada genoma fundador que sobreviveu na população. A obtenção desses valores de representação alvo irá maximizar a presevação da diversidade genética.

ALELOS FUNDADORES ORIGINAIS

O número total de alelos (cópias) de cada gene portado em cada locus pelos fundadores. O número de alelos fundadores originais é duas vezes o número de genomas fundadores originais.

GENOMAS FUNDADORES ORIGINAIS

O conjunto de todos os genes em um fundador. A soma de tais conjuntos é o genoma fundador. O número de genomas fundadores originais é metade do número de alelos fundadores originais.

ALELOS FUNDADORES SOBREVIVENTES

O número de alelos ainda sobreviventes em cada locus em uma população, presumindo-se que cada fundador levou dois alelos diferentes em cada locus para a população derivada (ex., população em cativeiro).

GENOMAS FUNDADORES SOBREVIVENTES

O número de genomas fundadores originais ainda sobreviventes na população. Representa a perda da diversidade original devido a afunilamento genético no pedigri da população.

EQUIVALENTES DE GENOMA FUNDADOR

O número de animais selvagens necessário para obter a diversidade genética na presente população em cativeiro. Essa medida reflete a perda devido a afunilamento genético e disparidades na representção de fundadores.

EQUIVALENTES DE FUNDADORES

O número de fundadores igualmente representados que produziriam a mesma diversidade genética observada na população sobrevivente, considerando-se os alelos fundadores que já se perderam devido a afunilamentos genéticos. Equivalentes de fundadores refletem a perda de diversidade genética devido a representação desigual de linhagens fundadoras na população sobrevivente.

TAMANHO DA POPULAÇÃO EFETIVA

Um conceito desenvolvido para refletir o fato de que nem todos os indivíduos de uma população contribuem igualmente, quando contribuem, para a transmissão de material genético para a próxima geração. Tamanho da população efetiva é normalmente denotado por N_e e é definido como o tamanho de uma população ideal que teria a mesma taxa de oscilação genética e de consanguinidade observada na população real de interesse. Uma população ideal é definida por: reprodução sexual; cruzamento ao acaso; iguais proporções de ambos os sexos; distribuição de Poisson para tamanho de famílias, isto é, período total de produção de descendentes; distribuição etária estável e tamanho constante, isto é, estabilidade demográfica.

COEFICIENTE DE PARENTESCO

A probabilidade de que um alelo selecionado ao acaso de um indivíduo na população esteja presente em um segundo indivíduo, devido a ambos terem herdado esse alelo de um ancestral comum. Equivalentemente, a proporção de genes em dois indivíduos que são os mesmos devido a descendência comum. O coeficiente de consanguinidade deum animal é igual a 1/2 do parentesco entre os pais.

PARENTESCO MÉDIO

É o coeficiente médio de parentesco entre um animal e todos os animais (incluindo ele mesmo) na população viva descendente (excluindo os fundadores). O parentesco médio é igual a duas vezes a perda proporcional de diversidade genética da população descendente em relação aos fundadores e é também igual a duas vezes o coeficiente médio de consanguinidade da progênie produzida por cruzamentos ao acaso.