Lion Tamarin

PHVA Workshop

Final Report

Escola de Administração Fazendária (ESAF)

Brasília, Distrito Federal, Brazil
7-11 June 2005

Institutional Support

IBAMA - Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis
IPÊ - Instituto de Pesquisas Ecológicas
AMLD - Associação Mico-Leão-Dourado
IESB - Instituto de Estudos Sócio-Ambientais do Sul da Bahia

Planning Commitee

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Third Lion Tamarin
Population and Habitat Viability Assessment
(PHVA)

Escola de Administração Fazendária (ESAF)

Brasília, Distrito Federal, Brazil

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Contents

Executive Summary

The four endangered species of Lion Tamarins, the Golden Lion Tamarin (*Leontopithecus rosalia*), the Golden-headed Lion Tamarin (L. chrysomelas), the Black Lion Tamarin (L. chrysopygus) and the Black-faced Lion Tamarin (L. caissara) are endemic to the Atlantic Forest in eastern and southsouth-eastern Brazil. The Golden Lion Tamarin and the Golden-headed Lion Tamarin are both listed as “Endangered” in the IUCN Red List, and the Black Lion Tamarin and the Black-faced Lion Tamarin as Critically Endangered. Deforestation, hunting and commerce have caused their Lion Tamarin populations to decline drastically over the last half century, bringing at least the Golden Lion Tamarin close to extinction in the late 1960’s. National and international efforts, including captive breeding, turned this halted this decline and saved the species from going extinct in the wild. Current population estimates are ~1.400 Golden Lion Tamarins (GLTs), 6.000-15.000 Golden-headed Lion Tamarins (GHLTs), ~1.500 Black Lion Tamarins (BLTs) and ~350 Black-faced Lion Tamarins (BFLTs). Populations of the GLT and BLT are highly fragmented with a majority of animals in protected areas (Poço das Antas and União Biological Reserves in the state of Rio de Janeiro and Morro do Diabo State Park in the state of São Paulo, respectively). Both species have been supported by reintroduction and translocation programmes, and known populations are monitored closely. Less fragmented is the population of GHLTs, located in and around Una Biological Reserve in the state of Bahia. The distribution and status of the BFLTs are less well known due to the fact that they were only discovered in 1990. However, the majority obviously exist in the protected Superagüï National Park in Paraná State. Recently the species was also discovered on the mainland, and surveys have been initiated to identify the distribution of that population.

All four species are currently the subject of intensive conservation programmes that, depending on the species, have included scientific global management of captive populations (GLT, GHLT and BLT), studies on the ecology, behaviour and genetics of wild populations (all species), translocation of threatened wild groups (GLT, BLT), habitat restoration (GLT, GHLT and BLT), local conservation education programmes (all species) and reintroduction of captive born individuals to natural forest (GLT and BLT). Since 1991, all captive populations of Lion Tamarins belong are owned by the Brazilian Government (IBAMA). Since, 2000 a single International Committee for Conservation and Management (ICCM) covering all four species advices the Brazilian government (IBAMA) on the research and conservation activities for the four species. This committee was preceded by management committees for each species, initiated in the early 1990’s. The present captive population counts 450 GLTs, 524 GHLTs and 82 BLTs worldwide.

This is the third PHVA for Lion Tamarins. The first, held in 1990, was organised jointly by the Fundacão Biodiversitas, Belo Horizonte, and CBSG (Seal, U., Ballou, J.D. and Padua, C.V. 1990). The workshop served to focus the community of researchers, conservation biologists, reserve managers and administrators, and educators on the numerous conservation problems facing Lion Tamarins. The workshop resulted in the development of recovery plans and the establishment of the first formal Brazilian International Recovery and Management Committees (IRMC) for the 4 species of Lion Tamarins.

By 1996, most of the action items in the first action plan had been implemented, and a second PHVA workshop was conducted in 1997 upon the recommendations of the four IRMCs during their 1996 annual meetings in Brazil (Ballou, J.D., Lacy, R.C., Kleiman, D., Rylands, A & Ellis, S. 1998). The PHVA was preceded by a Lion Tamarin symposium which integrated and synthesized all of the current information on the 4 species’ biology and the history of their conservation (Kleiman, D.G. and Rylands, A.B., 2002). Once again, Fundacão Biodiversitas offered to host the workshop in Belo Horizonte, and CBSG volunteered to facilitate. The objectives of this second PHVA were to evaluate the current status and threats facing the Lion Tamarin species, and recommend and set priorities for conservation strategies to address existing problems. The workshop resulted in a new conservation action plan for the four species of Lion Tamarins. The recommendations from the workshop focused on three fundamental issues:

- Conservation of Lion Tamarins must proceed within a metapopulation context, including the captive populations where such are available, to maximize both the viability of Lion Tamarin populations and the conservation of habitat.
- Existing protected areas need to be maximally utilized, managed and safeguarded, with threats removed where they exist.
- Viable Lion Tamarin populations must be reconciled with the needs of the people sharing the Atlantic forests of Brazil and the resource limitations of those involved with the conservation of these species and habitat.

By 2004, most action steps from the first two workshops had been implemented, and Lion Tamarin recovery programs were considered some of the most progressive conservation programmes in the world. It was thus decided during the 2004 annual ICCM meeting to conduct a third PHVA workshop in 2005 to push conservation efforts even further. IBAMA offered to host the workshop in Brasília, Distrito Federal, Brazil, and CBSG Brasil and CBSG Europe volunteered to facilitate. The workshop was held from 7 to 11 June at Escola de Administração Fazendária (ESAF), Brasília, Distrito Federal, Brazil, and was followed on 13-14 June by the annual meeting of the ICCM. The objectives of this third PHVA were to evaluate the implementation status of the existing conservation action plans for the four species, the current status and threats facing the species and, based on that, to set new priorities for conservation strategies to address problems that may exist. Fortunately AMLD (The Golden Lion Tamarin Association) had developed new conservation action plans for the Golden Lion Tamarins through a strategic planning process, and IPE had developed new conservation actions plans for the Black and the Black-faced Lion Tamarins. New conservation priorities were underway for the Golden-headed Lion Tamarins as well, and there was thus a need for a cross-species prioritisation in order to avoid duplications and to make use of any synergy between the programmes for the four species. Additionally, it was possible to begin to develop a landscape approach to lion tamarin conservation through the incorporation of GIS technologies. Prior to the workshop a comprehensive briefing book was developed containing relevant background material such as scientific articles, maps, status documents and introduction to the workshop.

Fifty-one managers, scientists, governmental officials, educators and biologists from four different countries participated in the workshop. After opening welcomes, the participants were divided into six basic working groups, one for each species, one for population modelling (VORTEX) and one for the use of GIS (Geographical Information System). The species groups identified issues of importance for conservation of their specific species, and the issues were developed into problem statements. The modelling group started collecting necessary biological information for the simulations, and the GIS Group developed basic maps for the four species. During the first day it became obvious that there was a need for a number of topic-based working groups as well. Three topics were identified as important for the future conservation prioritisation, and working groups were formed for each of those. The topic-based working groups were: Inter-institutional Cooperation and Communication; Regional Landscape Planning, Socioeconomic Aspects and Education, Landscape Planning, Planning, Socioeconomic Aspects and Education, and Education; and Metapopulation Management. The topic-based working groups met on day 2 and developed objectives and action steps to counteract the identified problems. On day 3 the participants were re-grouped into species-based working groups to transform the problem statements into objectives and goals. Issues from the topic-based working groups were integrated into the species plans, and all groups interacted with the modelling group and the GIS group. On day 4 the working groups developed the necessary action steps to achieve the defined objectives, and on day 5 the final reports were presented, and the framework for the future work was set. At the 2006 annual meeting of the ICCM it was stated by IBAMA that the defined action steps regarding *ex situ* conservation activities was were not clear enough. Therefore, a working group clarified the identified actions and presented the ICCM with some additional action steps that could be included in the final PHVA report. Since not all participants of the PHVA workshop were present at the ICCM meeting, the additional report on the *ex situ* activities could not be included in the final report at the same level as the reports that were approved by the attendants at the end of the workshop. It was, however, decided to attach the identified *ex situ* action steps (2006) to the final report as an appendix in order to make the conservation action plan as complete as possible.

The problems addressed by the different working groups were as follows:

A. Species Working Groups

Golden Lion Tamarins:

- Lack of consolidation of the landscape: identification of suitable forest, protection of relevant forests and establishment of proper landscape management in order to have viable populations of GLTs.
- Lack of a comprehensive metapopulation management plan, including management strategies and techniques.
- Financial and infrastructure limitations, including inefficient integration and communication among all actors and lack of standardisations.
- Weak local/regional culture of conservation.
- Insufficient inter-institutional cooperation.

Golden-headed Lion Tamarins:

- Insufficiency of protected areas for the preservation of the species, principally Conservation Units of Complete Protection (CUCPs), their implementation and infrastructure.
- Loss (extent and quality) and isolation of primary forest, as a result of the activities of the logging industry and cattle ranching.
- Lack of information on the biology of the species and its habitat, including ecological interactions between primates, genetic variability, use of cabruca and areas essential for conservation.
- Low interactivity between the conservation agents, (*in situ* and *ex situ*): lack of involvement of foreign zoos, lack of communication between researchers/institutions of GHLTs, lack of coordinated action between institutions acting on conservation in the region, failure of researchers to return research results to IBAMA.
- Lack of information on the actual situation, changes in extent and distribution, threats, trends and economy of cabruca.
- Insufficiency of the law enforcement system for protection of areas, and to avoid the capture and commercialization of wild specimens.
- Lack of a metapopulation plan, including information on the spatio-demographic structure.
- Lack of guaranteed resources for research and monitoring.
- Insufficiency of activities in the entire distribution area of the species (with the exception of REBIO-Una) and principally in the western region, including research and conservation actions (environmental education, protection of areas, socio-economic programs).
- Lack of a Conservation Medicine Program for the species, focussing on parasitism, infectious agents, impact of domestic and production animals, interaction between area of use and parasites, interactions with other primates, training of people manipulating specimens, and health monitoring of populations, with better use of animals that die in nature.
- Low relevance of the environmental issues on policies that decide on land reform settlements and indigenous areas.
- Lack of knowledge of the dynamics of trade (areas of origin, destination, impact on natural populations) and mechanisms to determine the destiny of confiscated animals.
- Lack of agility in the process of obtaining research permits.

Black Lion Tamarin:

- The known Black Lion Tamarin populations occur in low density in isolated areas, and this situation promotes genetic and demographic problems that affect the species survival. As a factor increasing the problem, there is a lack of strategic knowledge to help the species conservation.
- The greater the habitat fragmentation, the higher the anthropic pressure on Black Lion Tamarin occurrence areas.
- Lack of public policies for Black Lion Tamarin conservation.
- Lack of information on the availability and quality of potential habitats to be managed (lack of areas admittedly viable for species conservation and habitat quality).
- Lack of qualified personnel in several fields limits Black Lion Tamarin management and conservation actions.
- Lack of organized and easily accessible information is impairing integrated research and management actions.
- Bureaucracy is an obstacle to research and management actions.

Black-faced Lion Tamarin:

- The genetic status of the Black-Faced Lion Tamarin's (BFLT) is unknown. This knowledge is necessary for better conservation management decision-making. Observation: being a priority, this research is dissociated from the others.
- Lack of information on: 1) phenology (BFLT x vegetation relationship), 2) ecological patterns in the mainland distribution area, 3) impact of invasive fauna and flora species (giant African snail, *Achatina fulica* and "bambuzinho"), 4) predation pressure on the continent, and 5) detailed distribution of the species in the foothills and other areas on the continent to help design management actions.
- The isolation of island and continental populations of BFLT, which hampers the genetic flow and

associated ecological processes.

- Lack of coordination of governmental actions affect the protection of the species and its habitat (e.g.: relationship between IBAMA and FUNAI; IBAMA and Tourism Agency; IBAMA and INCRA), as well as internal relationships within IBAMA´s different administrative levels.
- The growth of villages, the lack and decline of alternative incomes and the loss of cultural identity can drive habitat loss and increase the pressure on natural resources.
- Insufficient enforcement hampers the protection of the species.
- Lack of a consolidation of the Conservation Medicine program for the species. Lack of information on: 1) phenology (BFLT x Vegetation relationship), 2) ecological patterns on the mainland distribution area, 3) impact of invasive fauna and flora species, 4) predation pressure in the continent, and 5) fine scale distribution of the species in the foothills and other areas on the continent to help design management actions.
- Lack of engagement of the community, government and non-government agencies, and the private sector with socio-environmental issues, which hampers the implementation of the program for the conservation of the species and its habitat.

B. Topic-Based Working Groups

Regional landscape planning, socioeconomic aspects and education:

- Lack of landscape consolidation
- Habitat reduction
- Inefficient fiscalization/ control
- Geographic isolation of species
- Anthropogenic pressure
- Information and methods not integrated into a single GIS system
- Lack of effective protected areas (UC, RL, APP)
- Lack of alternative sources of income
- Public policies aren't directed to sustainable development
- Conventional (modern) agriculture is incompatible with conservation
- Lack of formal technical capacity for conservation
- Loss of cultural characteristics of communities
- Economic instruments are not used to give value to environmental services
- Emphasis is on assistance (subsidies, money) vs. sustainability in the long term
- There is much pressure on natural resources (hunting, animal traffic, and other forms of exploitation)
- Lack of environmental knowledge by local actors.
- Communities generally don't recognize the importance of conservation
- Lack of sensitization to improve attitudes
- Lack of involvement of teachers in educational activities

Metapopulation management:

- Lack of a Metapopulation Management Planning Process

Interinstitutional cooperation and communication:

- Slowness of the research permit process
- Insufficient coordinated inter- and intra-institutional actions

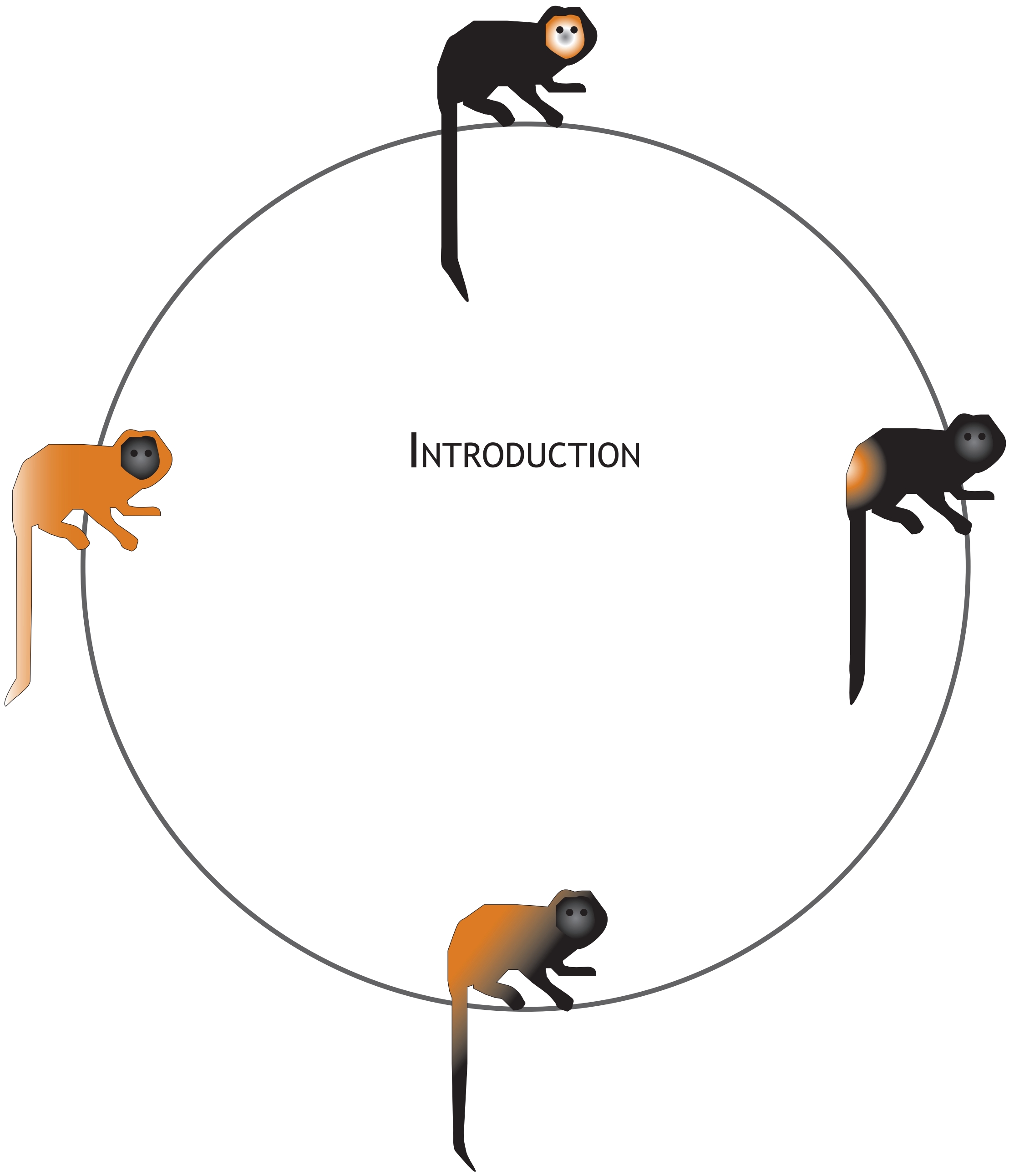
The resulting recommendations of the established working groups are listed in the following chapters and will not be dealt with in the summary. However, one thing needs to be mentioned. A noteworthy development during the workshop was a very active exchange of information between the species-based working groups and the modelling and the GIS groups. This current exchange of information, the questions asked both ways and the resulting modelling and mapping proved to be of great importance to the final prioritisation of action steps. Opportunities were identified that were not obvious before, and in some cases this led to a total change of recommendations. An integrated use of modelling, GIS mapping and general facilitation is thus highly recommended for future PHVA workshops.

Last, but not least, we want to thank all of the participants for all their efforts, both before, during and after the workshop. It was entirely due to their enthusiasm and dedication that it became possible to get the work done within the short time frame. Work was not limited to the normal working hours; late evenings and early mornings were just as important, and even the nights did not go free. Problems were discussed, reports were made, presentations were prepared, and drafts were adapted, not once but many times. The end result was that we ended up having a brand new, well argued and well documented conservation action plan for the four species of Lion Tamarins. It is now up to the participants and to the governmental and non-governmental bodies to make sure the recommendations are implemented in the spirit they were developed.

Good luck!

Bengt Holst & Patrícia Medici

Introduction



Introduction

The Third Lion Tamarin PHVA (Population and Habitat Viability Assessment) is the third in a row of Lion Tamarin Conservation Workshops starting with a PVA (Population Viability Assessment) workshop in 1990 and a PHVA in 1997. It builds upon the already existing conservation action plans for the four species of Lion Tamarins: Golden Lion Tamarin (*Leontopithecus rosalia*), Golden-Headed Lion Tamarin (*Leontopithecus chrysomelas*), Black Lion Tamarin (*Leontopithecus chrysopygus*) and Black-Faced Lion Tamarin (*Leontopithecus caissara*), and on the ongoing work in the ICCM (International Committee for Conservation and Management) for *Leontopithecus* Species under IBAMA (Brazilian Federal Environmental Agency).

The main organization behind the workshop is a partnership between IBAMA (Brazilian Federal Environmental Agency), IPÊ (Institute for Ecological Research), AMLD (Golden Lion Tamarin Association), IESB - Instituto de Estudos Sócio-Ambientais do Sul da Bahia and CBSG (IUCN/SSC Conservation Breeding Specialist Group) Brasil, supported by CBSG Europe. CBSG will be responsible for the design and facilitation of the workshop and will produce the workshop materials as well as the final workshop report.

IBAMA - Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis (Brazilian Institute for the Environment and Renewable Natural Resources – IBAMA) is the federal organ responsible for the execution of policies concerned to preservation, conservation and sustainable use of the environmental resources. Among its principal attributions, IBAMA develops, together with its Department of Fauna and Fishing Resources, the function of administration and management of the savage and exotic fauna. The protection of the fauna species is charged to a special Coordination, subordinated to the General Coordination of Fauna and, which main focus are the extinction threatened species. Charges to this unit the elaboration and implementation of conservation strategies and management of the threatened fauna.

IPÊ - Instituto de Pesquisas Ecológicas (Institute for Ecological Research) is a non-governmental organization founded in 1991, in São Paulo State, Brazil. The institution works for the conservation of biodiversity and develops conservation projects in several Brazilian ecosystems, especially the Atlantic Forest. Today, IPÊ works with a small core of 60 high level professionals, each with junior and senior assistants. IPÊ's conservation work is based on multidisciplinary research that defines planning and action. Field research on endangered species and ecosystems have been important focal points to trigger other conservation actions, and scientific findings are turned into tools for public involvement and participation. IPÊ's researchers are trained in an atmosphere where field studies should influence public policies that favor conservation.

AMLD - Associação Mico-Leão-Dourado (Golden Lion Tamarin Association) was created in 1992 to ensure a long term collaboration of scientists, educators, government people, conservationists and the local communities to understand the biology of Golden Lion Tamarins and ecology of their habitat, enhance captive well-being, and conduct environmental education programs within and outside of Brazil. The mission of AMLD is conservation of the Atlantic Forest biodiversity by focusing on the protection of the Golden Lion Tamarin in its natural habitat.

IESB - Instituto de Estudos Sócio-Ambientais do Sul da Bahia is a nongovernmental organization based in Ilheus, Bahia state, Brazil. Their main area of geographic focus is the Atlantic Forest of Southern Bahia. IESB's mission is to develop and support research and conceptual models concerning sustainable coexistence of humans and the natural environment, with the dual goals of conserving biodiversity and the sustainable use of natural resources, thereby promoting the social development of local communities. IESB's focus is divided into six thematic areas: Biodiversity, Sustainable Communities, Geoprocessing, Public Policy, Environmental Education, and Ecotourism and Protected Areas

CBSG – Conservation Breeding Specialist Group. With over 1000 volunteer members, the IUCN/SSC Conservation Breeding Specialist Group (CBSG) is one of the largest Specialist Groups comprising the Species Survival Commission (SSC). CBSG has over 10 years of experience developing, testing and applying scientifically based tools and processes for risk assessment and decision-making in the context of species management. These tools, based on small populations and conservation biology, human demography, and the dynamics of social learning are used in intensive, problem-solving workshops to produce realistic and achievable recommendations for both *in situ* and *ex situ* population management. CBSG's workshop processes provide an objective environment, expert knowledge, and neutral facilitation to support the exchange of information across diverse stakeholder groups in order to reach some agreement on the important issues facing both humans and wildlife. With this understanding, meaningful and practical management recommendations can be made.

The Population and Habitat Viability Assessment (PHVA) is a very efficient and systematic process for species action planning. Managing endangered species is an extremely complex conservation problem. It requires a coalescence of expertise from different professions and sectors, an exchange of knowledge and technology, a building of consensus around threats and solutions, and a mobilization of resources. The CBSG PHVA workshop process balances the need to integrate information necessary for evaluating alternative species conservation strategies with the need to integrate, or at least connect, individuals from different disciplines and backgrounds that are centrally concerned with the species of interest. This is done with the hope that some realignment of priorities among individual stakeholder groups will result to take into account the needs, views and initiatives of other groups. Central to this process is the use of Vortex, a computer software simulation model of wildlife population dynamics that performs a risk assessment, and provides a tangible focus for quantitative evaluation of conservation options for a species and a vehicle for integrating diverse species biological and human sociological data. Taken together, the risk assessment modelling and focused, stakeholder-driven deliberations are designed to directly address the issues affecting the species so that alternative strategies can be analyzed rationally and systematically. When this occurs, better conservation decisions and specific action steps with targeted responsibility result.

Objectives and Goals

The main goal of this workshop is to gather, systematize and discuss all available data and information on the four species of Lion Tamarins (status in the wild and in international breeding programs, distribution, threats, available habitat, ecological factors etc.), to refer this information to existing conservation action plans and use this information to establish research, management and conservation priorities for the four species.

Expected Outcome

The expected outcome of this workshop is an updated Conservation Action Plan for all four species of Lion Tamarins, including short- and long-term goals, as well as prioritized action steps for both *in situ* and *ex situ* conservation efforts.

Workshop Format

The first step of the Population and Habitat Viability Assessment (PHVA) Workshop is to compile all the available information and data about Lion Tamarins across their range. Participants will be requested to contribute scientific articles, data and knowledge of the species and its habitat, and list the major issues related to Lion Tamarin conservation. Based on this, participants will be divided into working groups to work on specific topics identified as major issues. Each group will have a series of tasks: 1.) Identify and define problems and rank them in order of priority; 2.) Develop goals to achieve the change in the conditions identified in the problem statement, specifying minimum and maximum goals to achieve in the next five years, developing goals for each problem and ranking the goals in order of priority; 3.) Develop actions to accomplish the goals identified under the problems or issues, taking into account the scientific information on the species, its habitat, and the threats identified. Additionally, the PHVA will develop a large set of alternative models that represent different hypotheses of Lion Tamarin biology/ecology and then, through comparison of model behaviors, identify those biological factors that most acutely influence Lion Tamarin population growth. With this knowledge, and with data on the specific threats that are known to impact Lion Tamarin populations now and in the future, we will by using computer simulations (VORTEX) design and test management strategies that minimize those specific threats which act on the most influential biological factors.

In order to be able to address species specific issues for all four species the working groups will from time to time split up in species specific groups in addition to the topic oriented division of participants. The following setup will be available:

Facilitator:	Bengt Holst (CBSG Europe)
Facilitator:	Patricia Medici (IPÊ, CBSG Brasil)
Facilitator/modeler:	Kathy Holzer (CBSG)
Modeler:	Jonathan Ballou (National Zoo, Washington, US)
Modeler:	Kristin Leus (CBSG Europe), also needed as content person, GHLT Studbook

Workshop Agenda

JUNE/JUNHO 6 - MONDAY - SEGUNDA-FEIRA

Arrival of Participants / Chegada dos Participantes: Escola de Administração Fazendária (ESAF)

18:30-20:30	Dinner / Jantar
20:30	Icebreaker

JUNE/JUNHO 7 - TUESDAY - TERÇA-FEIRA

07:30-08:30	**BREAKFAST / CAFÉ DA MANHÃ**
08:30-08:45	Opening Welcome: *Bengt Holst*
08:45-09:15	Plenary: Introduction of Participants
09:15-09:45	Plenary: Introduction to Workshop and to the PHVA Process: *Bengt Holst*
09:45-10:00	**Coffee Break**
10:00-10:30	Plenary: Introduction to VORTEX: *Jon Ballou*
10:30-11:00	Plenary: Introduction to GIS: *Maurício Schmidt*
11:00-13:00	Status and Conservation Report - Golden Lion Tamarin: *Devra Kleiman*
13:00-14:00	**LUNCH / ALMOÇO**
14:00-16:00	Status and Conservation Report - Black Lion Tamarin: *Alcides Pissinati*
16:00-16:30	Coffee Break
16:30-18:30	Status and Conservation Report – Black-faced Lion Tamarin: *Guadalupe Vivekananda*
18:30-19:30	Dinner / Jantar
19:30-21:30	Status and Conservation Report – Golden-headed Lion Tamarin: *Kristin Leus*

JUNE/JUNHO 8 - WEDNESDAY - QUARTA-FEIRA

07:30-08:30	**BREAKFAST / CAFÉ DA MANHÃ**
08:30-10:30	Plenary: Status of GHLT Programme
10:30-10:45	**Coffee Break**
10.45-11.00	Plenary: T. cruzi in GLTs and GHLTs (Rafael Monteiro)
11.00-11.30	Plenary: Introduction to working groups and task 1 (Problem statements)
11:30-12:30	PHVA Working Groups: Develop **Baseline VORTEX Model** Identify and Prioritize **PROBLEMS** species by species
12:30-14:00	**LUNCH / ALMOÇO**
14:00-17:00	PHVA Working Groups: Develop **Baseline VORTEX Model** Identify and Prioritize **PROBLEMS (contd.)**
17.00-18.30	Plenary: Working group reports (**Problem statements**)
18:30-20:30	**DINNER / JANTAR** Rooms available for working groups.

JUNE/JUNHO 9 - THURSDAY - QUINTA-FEIRA

07:30-08:30	**BREAKFAST / CAFÉ DA MANHÃ**
08:30-09:30	Plenary: Introduction to task 2 (Objectives)

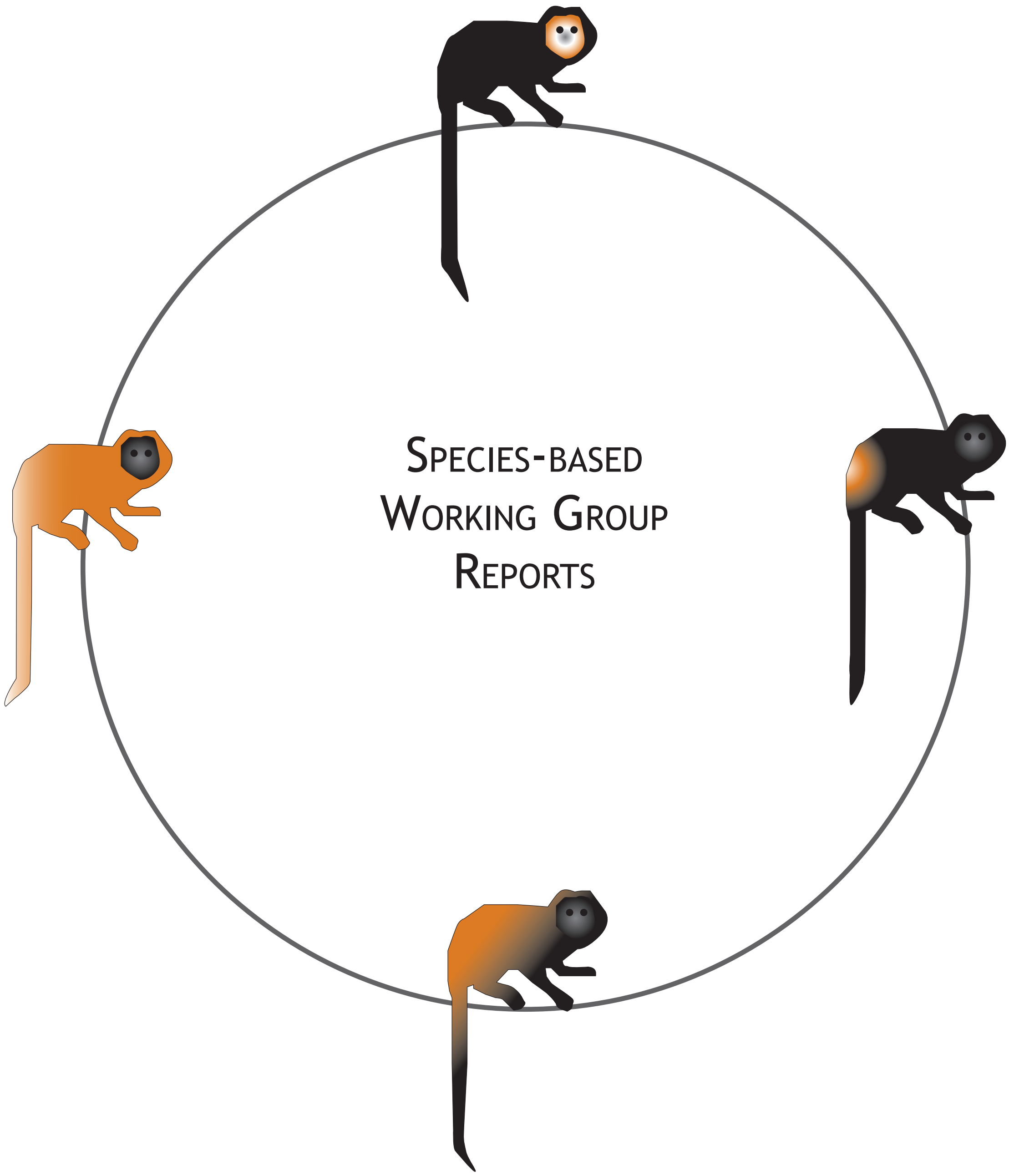
09:30-10:30	PHVA Working Groups: Develop **Baseline VORTEX Model** Develop **GOALS** to address **PROBLEMS/THREATS**
10:30-10:45	**Coffee Break**
10:45-12:30	PHVA Working Groups: Develop **Baseline VORTEX Model** Develop **GOALS** to address **PROBLEMS/THREATS**
12:30-14:00	**LUNCH / ALMOÇO**
14:00-14:30	Plenary: Presentation of Baseline VORTEX Model
14:30-18:00	PHVA Working Groups: Run **VORTEX Simulations** Develop **GOALS** to address **PROBLEMS/THREATS**
18:30-20:30	**DINNER / JANTAR** Rooms available for working groups.

JUNE/JUNHO 10 - FRIDAY - SEXTA-FEIRA

07:30-08:30	**BREAKFAST / CAFÉ DA MANHÃ**
08:30-09:30	Plenary: Working Group Reports
09:30-10:30	PHVA Working Groups / Action Plan: Run **VORTEX Simulations** Develop **MANAGEMENT ACTIONS** to accomplish **GOALS**
10:30-10:45	**Coffee Break**
10:45-12:30	PHVA Working Groups / Action Plan: Run **VORTEX Simulations** Develop **MANAGEMENT ACTIONS** to accomplish **GOALS**
12:30-14:00	**LUNCH / ALMOÇO**
14:00-18:00	PHVA Working Groups / Action Plan: Run **VORTEX Simulations on Different Scenarios** Develop **MANAGEMENT ACTIONS** to accomplish **GOALS**
18:30-20:30	**DINNER / JANTAR** Rooms available for working groups.

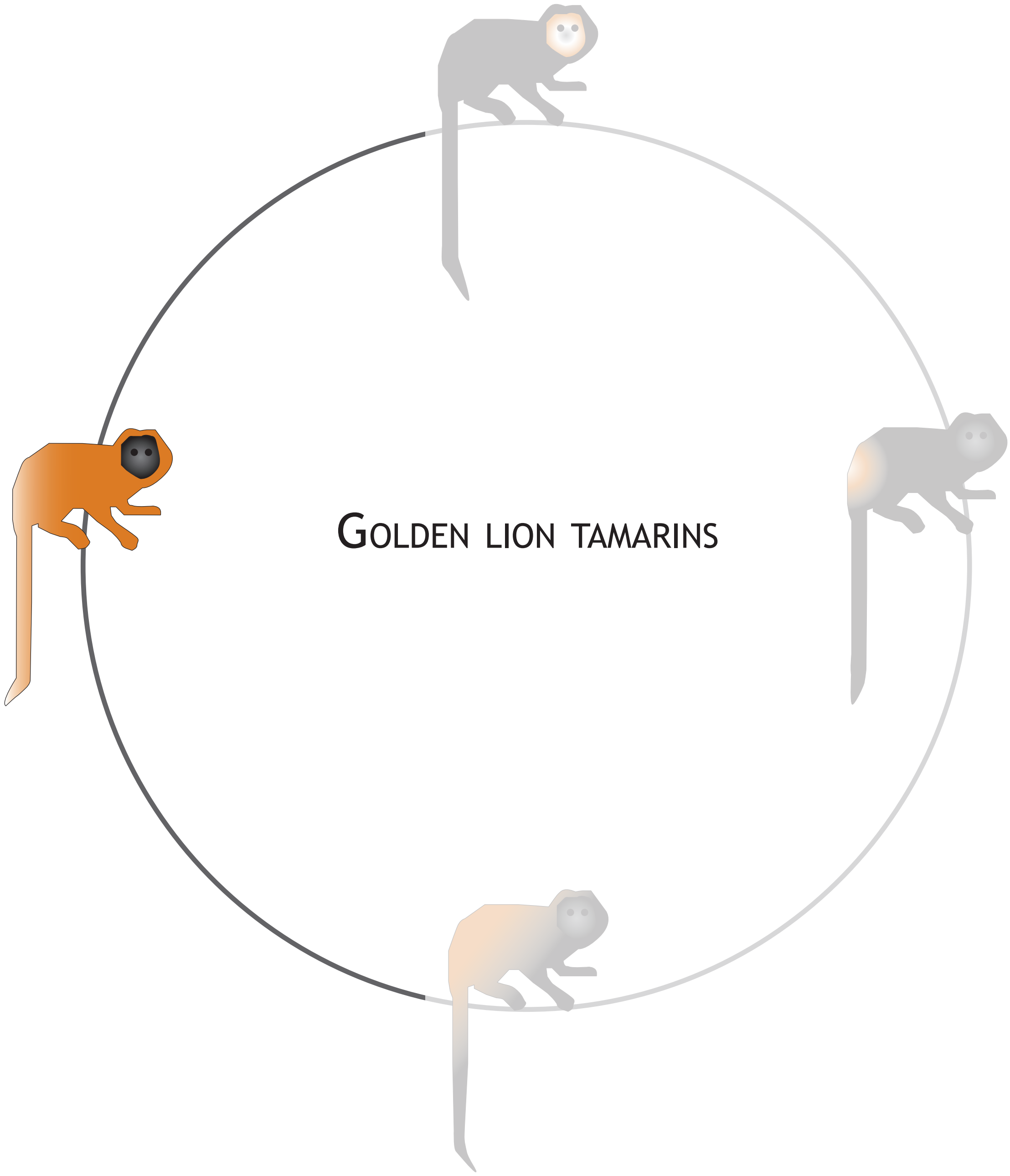
JUNE/JUNHO 11 - SATURDAY - SÁBADO

07:30-08:30	**BREAKFAST / CAFÉ DA MANHÃ**
08:30-09:30	Plenary: Working Group Reports
09:30-10:30	PHVA Working Groups / Action Plan: Run **VORTEX Simulations on Different Scenarios** Develop **MANAGEMENT RECOMMENDATIONS / ACTION PLAN**
10:30-10:45	**Coffee Break**
10:45-12:30	PHVA Working Groups / Action Plan: Develop **MANAGEMENT RECOMMENDATIONS / ACTION PLAN**
12:30-14:00	**LUNCH / ALMOÇO**
14:00-16:15	PHVA Working Groups / Action Plan: Develop **MANAGEMENT RECOMMENDATIONS / ACTION PLAN**
16:15-16:30	**Coffee Break**
16:30-17:30	Plenary: Working Group Reports
17:30-18:00	Closing Ceremony
18:30-20:30	**FAREWELL DINNER & SOCIAL EVENING / JANTAR & CONFRATERNIZAÇÃO**



Species-based Working Group Reports

Golden lion tamarins



Golden Lion Tamarins

Leontopithecus rosalia

Group members:
Rodrigo Bacelar, Benjamin B. Beck, Maria Inês Bento, Lou Ann Dietz, Rosan Fernandes, Adriana Grativol, Devra Kleiman, Andréia Martins, Patricia Mie Matsuo, Jennifer Mickelberg, Carlos Ruiz Miranda, Rafael Monteiro, Mônica Mafra Montenegro, Paula Procópio, Denise Rambaldi, Márcio Schmidt, Sinara Lopes Vilela

The Problems (in priority order):

1. Lack of consolidation of the landscape
2. Lack of a comprehensive meta population management plan (including techniques of management)
3. Financial and infrastructure limitations
4. Lack of a culture of conservation in the region
5. Problems of inter-institutional cooperation

Problem 1

Lack of consolidation of the landscape: identification, protection and management

In order to achieve the goal of 25,000 ha of protected forest to accommodate 2,000 tamarins by the year 2025, we need 10,000-12,000 additional hectares. These regions or forests are not defined and need to be identified in order to focus actions of protection and management, and thus to enable the management of the metapopulation and the viability of the species in the long term. Little information and action exist for the Serra region where a large population of L. rosalia is located. In addition, the current working areas are not consolidated – that is, they lack adequate protection for the long term and lack implementation of landscape management in order to have viable populations. This includes identification, mapping, and control of the principal threats and a survey of biodiversity.

Goal I)

20,000 ha of forested areas protected within a consolidated landscape within 10 years (by 2015)

Goal I.a)

20,000 ha of forested areas identified and selected within 2 years (by 2007)

Actions (in sequential order):

I.a.i) Identify and select potential forest areas for the species
Responsible (Lead is in bold): **Marcio Schmidt**, Andréia Martins, Carlos Ruiz, Rosan Fernandes
Time Frame: January 2006
Product: Map with the selected areas
Collaborating Institutions: UENF, AMLD, UFRJ, IBAMA
Resources Available: 70%

I.a.ii) Prioritize the areas appropriate to reach the goal
Responsible: **Marcio Schmidt**, Carlos Ruiz, Rosan Fernandes, Adriana Grativol, Ben Beck, Paula Procópio, James Dietz
Time Frame: April 2006
Product: Map of identified areas
Collaborating Institutions: UENF, AMLD, UFRJ, IBAMA, SI/NZP, UMCP
Resources Available: 90%

Goal I.b)

At least 50 % (10,000 ha) of the forested areas connected by corridors in 5 years (by 2010)

Actions (in priority order):

I.b.i) Identify the most appropriate areas to re-establish connectivity through the use of SIG and Vortex
Responsible: **Marcio Schmidt**., Carlos Ruiz, James Dietz, Rosan Fernandes, Jennifer Mickelberg, Jon Ballou
Time Frame: January 2006
Product: Map of identified areas,
Collaborating Institutions: UENF, AMLD, UFRJ, IBAMA, SI/NZP
Resources Available: 100%

I.b.ii) Prioritize areas for the implementation of corridors (APPs, RLs, fragments with good quality, impact on the viability of the metapopulation)
Responsible: **Carlos Ruiz**, Marcio Schmidt, James Dietz, Rosan Fernandes, Jennifer Mickelberg, Adriana Grativol
Time Frame: June 2006
Product: Map of the prioritized areas
Collaborating Institutions: UENF, AMLD, UFRJ, IBAMA, SI/NZP, CILSJ
Resources available: 100%

I.b.iii) Implement forest corridors in the prioritized areas with the participation of landowners
Responsible: **Rosan Fernandes**, Marcio Schmidt, Andréia Martins, Maria Inês Bento, Rodrigo Bacelar
Time Frame: June 2010
Product: Implemented corridors and maps
Collaborating Institutions: AMLD, landowners, Aracruz, community plant nursery, small farmers, IBAMA, WWF, Municipal Government, rural schools near corridors
Resources available: 50%

I.b.iv) Identify fragments within the landscape unit that could potentially function as *stepping stones*
Responsible: **Rosan Fernandes**, Sinara Vilela, Andréia Martins
Time Frame: June 2008
Product: Map and scientific publications
Collaborating Institutions: UENF, AMLD, UFRJ, IBAMA
Resources available: 0%

I.b.v) Monitor the use of corridors and *stepping stones* by wildlife
Responsible: **Carlos Ruiz**, Andréia Martins, Jennifer Mickelberg, Benjamin Beck
Time Frame: June 2009
Product: Scientific publication
Collaborating Institutions: AMLD, SI/NZP, GATI, UENF
Resources available: 10%

I.b.vi) Develop and test at least one method of overpass for tamarins to cross BR-101
Responsible: **Rodrigo Bacelar**, Paula Procopio, Andréia Martins
Time Frame: June 2007
Product: At least one overpass structure implemented
Collaborating Institutions: IBAMA (Ucs e DILIQ), AMLD, UENF, DNIT
Resources available: 100% (included in the licensing process of BR 101)

Goal I.c)

20,000 ha of the forest legally protected in 10 years (by 2010)

Actions (in priority order):

I.c.i) Identify and implement a mechanism to permanently and effectively protect the forest fragments of Rio Vermelho
Responsible: **Denise Rambaldi**, Rosan Fernandes, Andréia Martins
Time frame: June 2007
Product: signed mechanism document, map of the forest cover of the fragments
Collaborating Institutions: IBAMA, AMLD, landowners, government registrar's office
Resources available: 70%

I.c.ii) Develop strategies for enforcing the requirements of APP and RL (action I.b.ii will define priority areas)
Responsible: **Rodrigo Barcelar**, Rosan Fernandes, Denise Rambaldi, Marcio Schmidt
Time Frame: June 2010
Product: Map of the APPs and Registry of the Legal Reserves, Official Registration of Legal Reserve
Collaborating Institutions: IBAMA, AMLD, MP, property registry office, landowners, CILSJ, mayors' offices
Resources available: 5% (proposal submitted to PDA)

I.c.iii Support the creation and implementation of RPPNs (30% of the 20,000 ha)
Responsible: **Rosan Fernandes**, Marcio Schmidt, Andréia Martins, Onildo Marini Filho (Leontopithecus Committee - ICCM)
Time Frame: continuously up to 2015
Product: Number and total area of RPPNs created and those being processed by IBAMA, regional map with RPPNs, Registry of rural properties
Collaborating Institutions: IBAMA (DIREC, GEREX/RJ), AMLD, APN, landowners
Resources available: 10%

Goal I.d)

Threats reduced and maintained at tolerable levels in 10 years (by 2015)

Actions (in sequential order):

1.d.1) Determine the current status of threats (**Callithrix*****, loss and degradation of habitat, predation, disease and poaching), assess the degree of impact and the level of tolerance.***
Responsible: **Carlos Ruiz**, Jon Ballou, Sinara Vilela, Rafael Monteiro, Márcio Schmidt, Denise Rambaldi, Rodrigo Bacelar, James Dietz
Time Frame: 2008
Products: Estimate of probability and intensity of threat events (Vortex), matrix of analysis of risk/ tolerance, estimate of rate of habitat loss, poaching pressure study, data base of road kills near REBIO União, map of distribution and abundance of the populations of invasive species (*Callithrix* spp) within the landscape unit, predation results at REBIO Poço das Antas, occurrence of disease in wild-living tamarins
Collaborating Institutions: IBAMA, FIOCRUZ, UENF, AMLD, SI/NZP
Resources available: 30%

I.d.ii) Identify the weaknesses of the law enforcement system for environmental crimes (poaching and deforestation)
Responsible: **Denise Rambaldi**, Rodrigo Bacelar, Sinara Vilela
Time Frame: 2008
Products: MS Theses
Collaborating Institutions: UFF, IBAMA, Forestry Police (Forestry and Civil), Public Ministry, Municipal Secretary of the Environment, IEF, Judges, AMLD, CILSJ
Resources available: 40%

I.d.iii) Develop and implement a plan for fighting and monitoring each of the identified threats

Responsible: **Rodrigo Bacelar**, Carlos Ruiz, Denise Rambaldi, Sinara Vilela, Onildo Marini Filho (*Leontopithecus* Committee, Patrícia Mie Matsuo
Time Frame: 2010 and continuous monitoring
Products: Document of specific plans, threat management group, implementation of the plans, monitoring system for each plan/threat
Collaborating Institutions: UFF, IBAMA, Forest and Civil Police, Ministry of Justice, Municipal Secretaries of the Environment, State Forest Institute of Rio de Janeiro - IEF, Judges, AMLD, CILSJ
Resources available: 5%

Problem 2

Lack of a comprehensive metapopulation management plan

The wild, translocation and reintroduction populations are not viable if managed individually. Small, isolated populations are vulnerable to extinction due to:

1) genetics (loss of genetic diversity, inbreeding, lack of dispersal, differentiation)
2) disease (evidence of disease threats exist)
3) fluctuations in predation pressure
4) degradation (due to fragmentation) and habitat loss (due to urban sprawl on the coastal side of BR 101)

Problem 2a

Lack of metapopulation management strategies/techniques

1) The limits of the populations are not well defined.
2) Criteria to prioritize the value of the populations for conservation are not established (prioritizing the value of a small, isolated population versus a large population?)
3) We are not sure how to manage migration
4) The management of human and financial resources are not optimized for metapopulation management
5) The lack of standardized data collection techniques, limits the access to information necessary to make management decisions

Goal II)

Develop and implement a metapopulation management plan (10 years; by 2015)

Goal II.a)

Define the parameters of the population in one year (by 2006)

Actions:

Parameter 1: Demographic and Geographic Distribution

II.a.i) Determine the size and extent of the entire metapopulation
Responsible: **Paula Procópio**, Carlos Ruiz, Andréia Martins, Ben Beck
Time frame: May 2006
Product: Refined data to be used in Vortex and GIS, report this information during the 2006 ICCM meetings
Collaborators: AMLD, UENF, GATI, landowners, mayors
Secured Resources: 60%
Priority: 1

II.a.ii) Determine the number of populations and their limits within the metapopulation
Responsible: **Paula Procópio**, Carlos Ruiz, Andréia Martins, Ben Beck
Time frame: May 2006
Product: Refined data to be used in Vortex and GIS, report this information during the 2006 ICCM meetings
Collaborators: AMLD, UENF, GATI, landowners, mayors
Secured Resources: 60%
Priority: 1

II.a.iii) Define which populations to include in the metapopulation based on:
Genetic representation
Potential for connectivity/degree of isolation
Costs and feasibility
Health of the population
Probability of reproduction
Public opinion

Responsible: **Carlos Ruiz**, Paula Procópio, Andréia Martins, Ben Beck, Adriana Grativol, Jon Ballou
Time frame: May 2006
Product: Refined data to be used in Vortex and GIS, report this information during the 2006 ICCM meetings
Colaborators: AMLD, UENF, GATI, landowners, mayors
Secured Resources: 60%
Priority: 1

Parameter 2: Genetics
Characterize the genetic structure of the metapopulation (using microsatellite and mitochondrial DNA as well as looking at new techniques and pedigree data) and use this information in the modelling (Vortex).

Actions:

II.a.iv) Assemble the information on samples that already exist
Responsible: **Adriana Grativol**, James Dietz, Andréia Martins, Paula Procópio, Jennifer Mickelberg, Jon Ballou
Time frame: August 2005
Product: List of the sampled population and categorization of the samples that already exist
Collaborators: UMD, AMLD, SI/NZP
Secured Resources: 100%
Priority: 1

II.a.v) Assemble the current information available for pedigrees
Responsible**: Jennifer Mickelberg**, Jon Ballou
Time frame: By the end of this PHVA
Product: List of the categories of data that exist
Collaborators: SI/NZP
Secured Resources: 100%
Priority: 1

II.a.vi) Define and sample the priority populations
Responsible: **Adriana Grativol**, Carlos Ruiz, Ben Beck, Paula Procópio, Andréia Martins, Jon Ballou
Time frame: December 2005
Product: List/map of the priority areas
Collaborators: AMLD, UENF, GATI, SI/NZP
Secured Resources: 40%
Priority: 1

II.a.vii) Analyze the genetic samples
Responsible: **Adriana Grativol**, Jennifer Mickelberg, Jon Ballou
Time frame: June 2007

Product: A data base containing the genetic characterization of the metapopulation
Collaborators: AMLD, SI/NZP
Secured Resources: 40%
Priority: 1

II.a.viii) Use the obtained results to run and refine the VORTEX model
Responsible: **Jennifer Mickelberg**, James Dietz, Adriana Grativol, Jon Ballou
Time frame: December 2007
Product: Written report with an action plan
Collaborators: UMD, AMLD, SI/NZP
Secured Resources: 100%
Priority: 1

Parameter 3: Population Health
Evaluate the health of the populations and its interference with the viability of the metapopulation through long-term monitoring

Actions:

II.a.ix) Characterize the principle infectious agents that present real or potential risk to the metapopulation
Responsible: **Rafael Monteiro**, Alcides Pissinatti
Time frame: September 2005
Product: List of the relevant infectious agents
Collaborators: FIOCRUZ, CPRJ
Secured Resources: 100%
Priority: 1

II.a.x) Implement alternative diagnostic techniques that are more specific, sensitive, and less expensive
Responsible: **Rafael Monteiro**, Alcides Pissinatti
Time frame: Continuous
Product: Effective utilization of the new techniques
Collaborators: FIOCRUZ, CPRJ
Secured Resources: 0%
Priority: 2

II.a.xi) Collaborate in management actions by providing information on health
Responsible: **Rafael Monteiro**, Alcides Pissinatti
Time frame: Continuous
Product: Effective incorporation of health data in action plans
Collaborators: FIOCRUZ, CPRJ, universities, research institutes, NGOs, Ministério da Agricultura, Ministério da Saúde
Secured Resources: 70%
Priority: 1

Goal II.b)

Define and implement strategies/techniques for metapopulation management (5 years; by 2010)

Technique 1: Facilitating Movement
Use and refine techniques for moving animals between populations within the metapopulation

Actions:

II.b.i) Define which populations need to be connected and investigate the possibility of connecting populations with forest corridors and/or "stepping stones"
Responsible: **Carlos Ruiz**, Adriana Grativol, Jennifer Mickelberg, Paula Procópio, Rosan Fernandes
Time frame: December 2005 for those that have already been genetically characterized, continuous
Product: GIS map with corridors/stepping stones
Collaborators: UENF, AMLD, SI/NZP
Secured Resources: 30%
Priority: 1

II.b.ii) Determine and carry out necessary animal movements based on the model VORTEX and other analysis
Responsible: **Paula Procópio**, Jon Ballou, Andréia Martins, Jennifer Mickelberg, James Dietz, Carlos Ruiz
Time frame: 2006 and continuous
Product: recommendation for movement and action plan
Collaborators: AMLD, SI/NZP, UMD, UENF
Secured Resources: 10%
Priority: 1

II.b.iii) Promote the development and implementation of projects in order to refine current techniques and investigate new techniques for reintroduction and translocation
Responsible: Ben Beck, Andréia Martins, Paula Procópio, Carlos Ruiz
Time frame: 2006
Product: Submitted proposal to the ICCM to test new techniques
Collaborators: Cristiana Martins, GATI, AMLD, UENF
Secured Resources: 80%
Priority: 1

II.b.iv) Define criteria to evaluate the results of reintroduction, translocation, and other techniques of metapopulation management
Responsible: **Jennifer Mickelberg**, Carlos Ruiz, Paula Procópio
Time frame: January 2006
Product: Draft of the criteria submitted to the ICCM, Approval of dissertation proposal
Collaborators: SI/NZP, GMU, UENF, AMLD
Secured Resources: 80%
Priority: 1

II.b.v) Develop outlines for courses on: reintroduction and translocation techniques, conservation medicine, conservation genetics
Responsible: Ben Beck, Adriana Grativol, Rafael Monteiro, Denise Rambaldi
Time frame: December 2005 to develop a course outline
Product: Proposal of the program outline submitted for review
Collaborators: GATI, AMLD, FIOCRUZ
Secured Resources: 100%
Priority: 3

Technique 2: Collection of data

Standardize and systemize the collection of metapopulation data

Actions:

II.b.vi) Collaborate on the structure of a database integrated with GIS for the four species of lion tamarins
Responsible: **Carlos Ruiz**, Ben Beck, Marcio Schmidt, James Dietz
Time frame: December 2005
Product: A database structure submitted for review
Collaborators: GATI, UENF, AMLD
Secured Resources: 100%

Priority: 1

II.b.vii) Compile, systematize, and make available biological information for all populations of GLTs
(For Example: Number of groups, total abundance, density, distribution, dispersal age and probability, pedigrees, home range, habitat use, causes of loss, age-specific mortalities, reproductive period, age at first reproduction, reproductive parameters, parental experience, habitat quality - diet, tree holes, predation, behaviour, data collection on supplemented groups)

Responsible: **Carlos Ruiz**, Ben Beck, Rafael Monteiro, Paula Procópio, James Dietz, Andréia Martins
Time frame: 2007
Product: implemented and operational data base
Collaborators: UENF, GATI, FIOCRUZ, AMLD, UMD
Secured Resources: 100%
Priority: 1

II.b.viii) Analyze data base to identify areas where information is lacking and promote research projects to provide this information.
Responsible: **Carlos Ruiz**, Ben Beck, Rafael Monteiro, Paula Procópio, James Dietz, Andréia Martins
Time frame: 2007
Product: Priority list of research needed and proposals submitted to the ICCM
Collaborators: UENF, GATI, FIOCRUZ, AMLD, UMD
Secured Resources: 20%
Priority: 1

Problem 3

Financial and Infrastructure Limitations

1. Obtaining long-term stable and flexible funding is difficult and becoming more competitive and time-consuming.
2. Insufficient and inefficient integration and communication among all actors involved with rosalia conservation make efforts less cost-effective.
3. Insufficient standardization, integration, and availability of landscape, rosalia, biodiversity, climate, and other data retards planning and implementation of conservation actions.

Goal III.

Financial and institutional stability guaranteed in five years (by 2010) for implementation of the action plan

Actions (in priority order):

III.i) Raise funds to establish an endowment fund
Responsible: **Lou Ann Dietz** e Ben Beck
Time frame: 2015
Product: An endowment that contributes a portion of the flexible resources in the annual AMLD budget
Collaborators: Devra Kleiman, Inês Castro, Bengt Holst, Zoos, SGLT
Secured resources: 0%

III.ii) Work to help Save the Golden Lion Tamarin - SGLT raise funds
Responsible: **Ben Beck**, Lou Ann Dietz, Devra Kleiman, James Dietz
Time frame: 1 year
Products: an average of US$40,000 per year in the next 10 years
Collaborators: Denise Rambaldi, Inês Castro, James Dietz, AMLD
Secured resources: 100%

III.iii) Establish an institutional policy for providing services

Responsible: **Denise Rambaldi**, Lou Ann Dietz
Time frame: June 2006
Products: Contribution of a portion of the flexible funds in the annual AMLD budget
Collaborators: Board members and technical staff of the AMLD
Secured resources: 100%

III.iv) Establish a project administration fee
Responsible: **Denise Rambaldi**, Lou Ann Dietz
Time frame: June 2006
Products: Contribution of a portion of the flexible funds in the annual AMLD budget
Collaborators: AMLD Board members, Patrícia Proença
Secured resources: 100%

III.v) Carry out an annual independent financial audit of the AMLD
Responsible: Denise Rambaldi
Time frame: June 2006
Products: audited and published fiscal balance sheet
Collaborators: AMLD Board members
Secured resources: 0%

III.vi) Stengthen and expand the* Adopt a Tamarin *Program
Responsible: **Jennifer Mickelberg**, Bengt Holst, James Dietz & Patrícia Mie Matsuo
Time frame: 10 years
Products: 20 tamarin groups adopted and the resources contributing a portion of the flexible funds in the AMLD annual budget
Collaborators: Devra Kleiman, Lou Ann Dietz, Ben Beck, Andréia Martins, Denise Rambaldi, Paula Procópio, Otavio Narciso
Secured resources: 100%

III.vii) Cooperate with the staffs of IBAMA to develop proposals and identify sources of funding for the Conservation Units
Responsible: **Denise Rambaldi**, Rodrigo Bacelar, Sinara Vilela, Paula Procópio
Time frame: 1 year
Products: Conservation Units functioning with funding from diversified sources
Collaborators: Directors of the Conservation Units, AMLD technical staff
Secured resources: 50%

III.viii) Work with IBAMA headquarters to help the Conservation Units within the golden lion tamarin species range to obtain budgets that are adequate to solve problems relating to the species
Responsible: **Rodrigo Bacelar**, Denise Rambaldi, Onildo Marini Filho (*Leontopithecus* ICCM)
Time frame: June 2010
Products: 1,000% increase in the budgets of the Conservation Units
Collaborators: Directors of the Conservation Units, AMLD, IBAMA
Secured resources: 70%

III.ix) Establish partnerships for the development/implementation of large projects (4 species, regional institutions, etc.)
Responsible: **Denise Rambaldi**, Cristiana Saddy Martins, Carlos Eduardo Carvalho
Time frame: 2010
Products: integrated projects in implementation
Collaborators: AMLD, IPÊ, IESB, local mayors' offices
Secured resources: 50%

III.x) Develop a viable system for licensing the AMLD logo and photos of rosalia (in Brazil & in the U.S.A.)
Responsible: **Lou Ann Dietz**, Devra Kleiman, Denise Rambaldi,
Time frame: June 2010
Products: Products developed and widely marketed and contributing a portion of the flexible funds in the AMLD annual

Collaborators: Ben Beck, Jennifer Mickelberg, Jill Menzel, Patrícia Mie Matsuo, Rosan Fernandes
Secured resources: 40%

III.xi) Increase the operational capacity of the ecotourism program by 1,000%
Responsible: **Rosan Fernandes**, Jennifer Mickelberg, Devra Kleiman, Andréia Martins, Lou Ann Dietz & Denise Rambaldi
Time frame: June 2015
Products: ecotourism package marketed and operated together by the 4 species; ecotourism package for rosalia contributing 10% of the flexible resources in the AMLD annual budget
Collaborators: Roberto Mourão, IESB, AMLD, IPÊ, SI/NZP, tourism operators
Secured resources: 30%

III.xii) Increase and diversify product marketing
Responsible: **Patrícia Mie Matsuo**, Jennifer Mickelberg
Time frame: 2015
Products: 1,000% increase in funds raised from product sales and resources contributing to a portion of the flexible funds within the AMLD annual budget
Collaborators: Devra Kleiman, Denise Rambaldi, Lou Ann Dietz, Ben Beck, Bengt Holst
Secured resources: 50%

Goal IV)

Integrated action among local players involved in golden lion tamarin conservation in 3 years (by 2008)

Actions (priority: 1-high, 2-medium, 3-low):

IV.i) Create a technical advisory committee to discuss questions related to research and conservation of golden lion tamarins
Responsible: **Sinara Vilela**, Denise Rambaldi
Time frame: immediately and continuously
Products: Committee established with functioning guidelines
Collaborators: project/team coordinators, associated researchers, AMLD Board of Directors
Secured resources: 100%
Priority: 1

IV.ii) Organize joint meetings among the AMLD teams to develop and implement a plan for monitoring and periodic evaluation of the strategic plan
Responsible: **Sinara Vilela**, Denise Rambaldi,
Time frame: 2006 and continuously
Products: monitoring and evaluation plan implemented
Collaborators: AMLD project/team coordinators, associated researchers, AMLD Board members
Secured resources: 50%
Priority: 1

IV.iii) Promote and stimulate the involvement of the IBAMA teams – Reserves and APA – in AMLD technical discussions
Responsible: **Sinara Vilela**, Rodrigo Bacelar
Time frame: immediately & continuously
Products: IBAMA & AMLD acting in an integrated and harmonious fashion for the conservation of the golden lion tamarins
Collaborators: IBAMA & AMLD technical teams
Secured resources: 50%
Priority: 1

IV.iv) Recuperate mutual confidence and respect between the staffs of IBAMA and AMLD to strengthen cooperation for detection of environmental crimes, especially hunting and deforestation

Responsible: **Sinara Vilela**, Denise Rambaldi, Rodrigo Bacelar
Time frame: immediately and continuously
Products: plan for law enforcement cooperation agreed among the parties
Collaborators: directors of the Conservation Units, technical teams of the AMLD & law enforcement team
Secured resources: 50%
Priority: 1

IV.v) Formalize by means of a legal instrument the relationship between IBAMA (União and Poço das Antas Reserves and São João River APA) and AMLD
Responsible: Sinara Vilela, Denise Rambaldi, Rodrigo Bacelar
Time frame: immediately
Products: document agreed and signed by the parties
Collaborators: Rodrigo Mayerhofer, Whitson Costa, IBAMA
Secured resources: 50%
Priority: 1

IV.vi) Establish together a policy for public use of the Education Center and of its resources
Responsible: **Patricia Mie Matsuo**, Denise Rambaldi, Rodrigo Bacelar
Time frame: immediately
Products: document agreed among the parties and disseminated among the staffs of IBAMA and AMLD
Collaborators: Rodrigo Mayerhofer, Sinara Vilela, Whitson Costa
Secured resources: 50%
Priority: 2

Problem 4

Weak local/regional culture of conservation

1) Limited regional culture (knowledge , values, self-esteem) to achieve sustainable development
2) An integrated action strategy among institutions is weak (methodology of action, incentives for conservation and public policy)

Goal V)

30% of the human population of the landscape participating in sustainable development actions in 30% of the landscape in 10 years (by 2015)

Actions:

V.i) Identify a set of sustainable economic activities appropriate for the region
Responsible: **Rodrigo Bacelar**, Inês Bento, Rosan Fernandes
Time frame: June 2006
Product: Sustainable activities identified
Collaborating Institutions: AMLD, IBAMA, EMATER, Mayors'offices, comunities, EMBRAPA-Agrobiologia, PESAGRO, UNACOOP, SEBRAE, APN, SALVE, tour operators, Luiz Nelson Cardoso
Secured resources: 0% (resources to carry out this action have been requested from PDA)
Priority: 1

V.ii) Disseminate and publicize agroecological practices appropriate for the region
Responsible: **Inês Bento**, Rodrigo Bacelar
Time frame: Continuous
Product: Farmers trained to use agroecological practices
Collaborating Institutions: AMLD, IBAMA, EMATER, Mayors'offices, communities, EMBRAPA-Agrobiologia, PESAGRO, UNACOOP
Secured resources: 10% (a portion of the resources needed to carry out this action have been requested from PDA)
Priority: 1

V.iii) Identify rural landowners with potential to act as multipliers
Responsible: **Inês Bento**, Rodrigo Bacelar, Rosan Fernandes
Time frame: June 2007
Product: Multipliers identified and trained
Collaborating Instituições: AMLD, IBAMA, EMATER, mayors' offices, communities, EMBRAPA-Agrobiologia, PESAGRO, UNACOOP, landowners
Secured resources: 0% (resources to carry out this action have been requested from the PDA)
Priority: 2

V.iv) Promote the use of agroecological practices on the properties
Responsible: **Rodrigo Bacelar**, Inês Bento
Time frame: Continuous
Product: Sustainable practices adopted
Collaborating institutions: AMLD, IBAMA, EMATER, mayors' offices, communities, EMBRAPA-Agrobiologia, PESAGRO, UNACOOP
Secured resources: 10% (resources to carry out this action have been requested from PDA)
Priority: 1

V.v) Develop a market study for agroecological products of the region
Responsible: **Inês Bento**, Rodrigo Bacelar
Time frame: December 2008
Product: Report of the market study
Collaborating institutions: AMLD, IBAMA, EMATER, mayors' offices, EMBRAPA-Agrobiologia, UNACOOP, CACAL, WWF
Secured resources: 0% (resources to carry out this action have been requested from the PDA)
Priority: 1

V.vi) Plan and develop a strategy to involve the urban communities in sustainable development actions
Responsible: **Patricia Mie Matsuo**, Denise Rambaldi
Time frame: June 2006
Product: Strategy developed
Collaborating institutions: AMLD, IBAMA, mayors' offices, associations, urban communities
Secured resources: 10% (resources to carry out this action have been requested from Disney)
Priority: 1

V.vii) Develop audiovisual mechanisms that reinforce the relationship between the environment and human well being
Responsible: **Patricia Mie Matsuo**, Rosan Fernandes, Inês Bento, Rodrigo Bacelar, Denise Rambaldi
Time frame: June 2010
Product: Audiovisual mechanisms developed
Collaborating institutions: AMLD, IBAMA, mayors' offices, CILSJ, UENF
Secured resources: 0%
Priority: 2

V.viii) Develop and implement a strategy for reception of the different stakeholder groups at the Education Center
Responsible: **Patricia Mie Matsuo**, Rosan Fernandes, Inês Bento, Rodrigo Bacelar, Denise Rambaldi
Time frame: June 2007
Product: Strategy developed and implemented
Collaborating institutions: AMLD, IBAMA, mayors' offices, CILSJ
Secured resources: 10%
Priority: 2

V.ix) Train and support teachers in each municipality to carry out sustainable development activities
Responsible: **Patricia Mie Matsuo**, Rosan Fernandes, Inês Bento, Rodrigo Bacelar, Denise Rambaldi

Time frame: Continuous
Product: Trained teachers
Collaborating institutions: AMLD, researchers, IBAMA, mayors' offices, schools, CILSJ
Secured resources: 20% (resources to carry out this action have been requested from Disney and from PDA)
Priority: 1

V.x) Stimulate greater participation of society and of government entitities in advisory councils of all types (AMLD, conservation units, environment, rural development, tourism, health, watersheds, etc.)
Responsible: **Rosan Fernandes**, Inês Bento, Rodrigo Bacelar, Denise Rambaldi, Patricia Mie Matsuo, Sinara Vilela
Time frame: Continuous
Product: The general public and the government sector participating in the decision making of the advisory councils
Collaborating institutions: AMLD, researchers, IBAMA, mayors' offices, schools, CILSJ
Secured resources: 20% (resources to carry out this action have been requested from Disney and from the PDA)
Priority: 1

Problem 5

Insufficient inter-institutional cooperation

There is a need for mechanisms that facilitate, permit and promote efficient inter-institutional actions, including NGOs, governmental institutions (Federal, State and Municipal) and private institutions integrating environmental concerns with socio-economic development.

Priorities:
1. INCRA RJ X IBAMA RJ X FETAG X MST
2. IBAMA RJ X CPB X DIFAP X DIREC
3. DIREC X IBAMA RJ X owners X NGOs
4. AMLD X MUNICIPIOS (agriculture, environment, education)

Goal VI)

Effective and continuous communication among the institutions affecting golden lion tamarin conservation, immediately

Goal VIa)

Regional public policy of INCRA and Social Movements compatible with golden lion tamarin conservation objectives

Actions (in priority order):

VIa.i) Organize meetings among stakeholders to resolve conflicts, define roles, interests, and common objectives, to promote conservation action
Time frame: Immediate and continuous
Responsible: **Denise Rambaldi**, Maria Inês Bento, Rodrigo Bacelar, Sinara Vilela, Onildo Marini Filho (ICCM *Leontopithecus*)
Product: Number of meetings held and percent of conflicts resolved
Collaborators: AMLD, Ibama (local & headquarters), MST, FETAG, Incra, landowners, CILSJ.
Secured resources: 50%
Priority: 1

VIa.ii) Strategically identify, participate, and organize meetings and actions together with Incra and Social Movements, with the objective of greater integration among the institutions, introducing conservation of golden lion tamarins into their actions.
Time frame: Immediately and continuously
Responsible: **Rodrigo Bacelar**, Maria Inês Bento, Denise Rambaldi, Sinara Vilela, Onildo Marini Filho (ICCM *Leontopithecus*)
Product: Number of meetings and actions developed with agendas including conservation of golden lion tamarins
Colaborators: AMLD, Ibama (local & headquarters), MST, FETAG, CILSJ, Incra, agrarian reform settlers.
Secured resources: 50%
Priority: 1

Goal VI.b)

Obtainment of research permits facilitated

Actions (in priority order):

VI.b.i) Develop and make available an orientation guide for the procedures to obtain permits for research in a Federal Conservation Unit (Protected Area).
Obs: This action is integrated with the cross-cutting Goal of Institutional Cooperation for the four species
Time frame: October 2005
Responsible: **Mônica Mafra**, Sinara Vilela, David Bossi
Product: guide finalized and disseminated
Collaborators: AMLD, CPB, Ibama (DIREC, DIFAP), some researchers with problems with permits
Secured resources: 70%

VI.b.ii) Encourage the participation of a representative of the researchers working with **rosalia** ***in meetings between representatives of the ICCM for Lion Tamarins and directors of IBAMA.***
Time frame: Immediately
Responsible: **Sinara Vilela/Denise Rambaldi;** Mônica Mafra, ICCM *Leontopithecus* (Onildo Marini Filho)
Product: Participation in all the meetings held
Collaborators: AMLD, CPB, Ibama
Secured resources: 50%

VI.b.iii) Conduct technical visits related to golden lion tamarin research with the objective of greater clarification among the IBAMA analysts (DIREC and DIFAP) concerning the conservation program for the species
Time frame: Immediately and continually
Responsible: **Sinara Vilela/Denise Rambaldi;** Mônica Mafra, ICCM *Leontopithecus* (Onildo Marini Filho).
Product: Number of meetings with participation of the IBAMA analysts
Collaborators: AMLD, CPB, Ibama (DIREC, DIFAP)
Secured resources: 50%

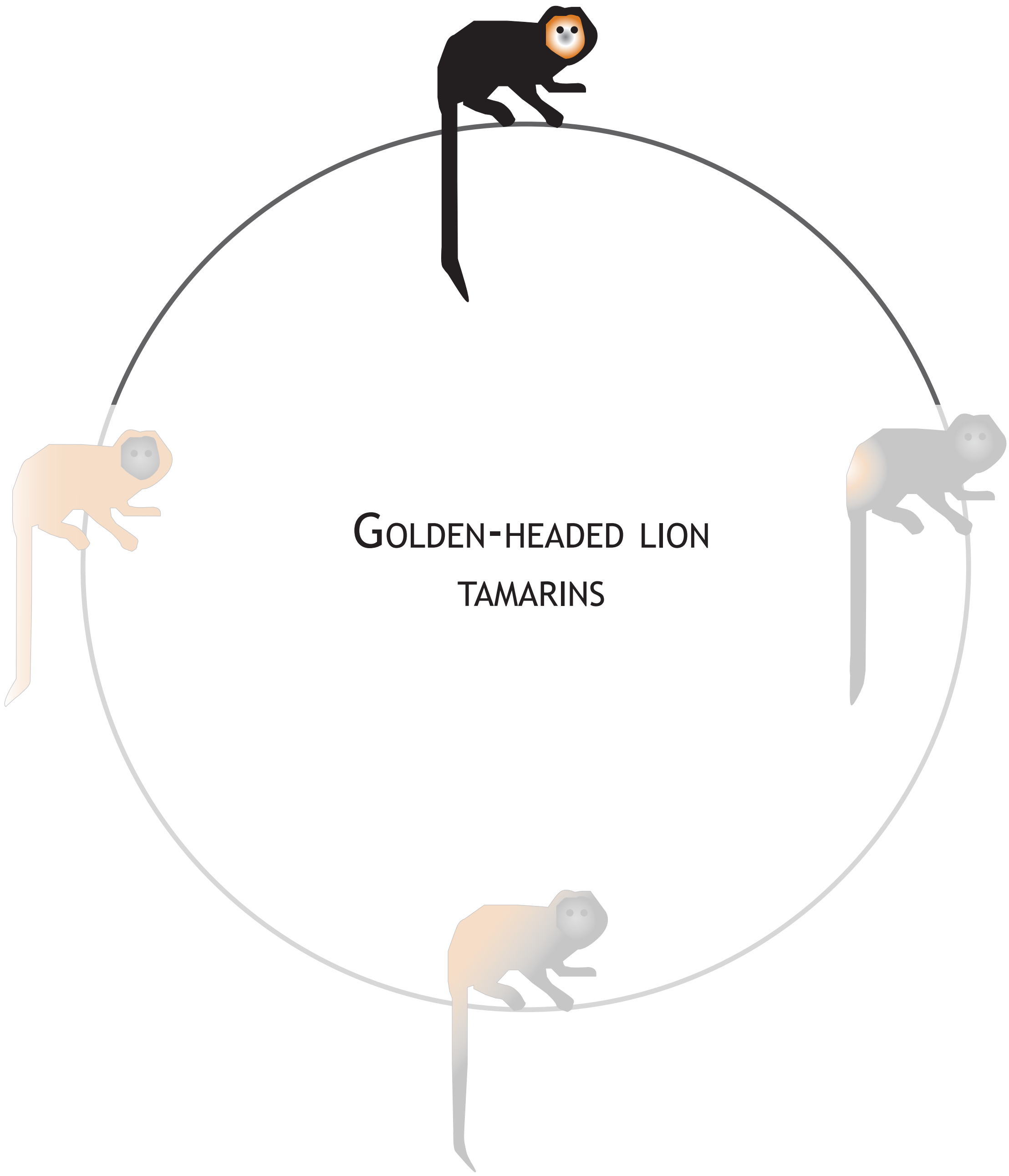
Goal VI.c)

Golden Lion Tamarin conservation incorporated into the regional mechanisms for land use planning

Actions:

VI.c.i) Identify and strategically participate in regional planning forums thus integrating conservation of golden lion tamarins in their guidelines
Time frame: Immediately and continually

Responsible: **Denise Rambaldi**, Rodrigo Bacelar
Product: Number of regional planning forums with conservation of golden lion tamarins in their guidelines
Collaborators: AMLD, regional offices of Ibama, mayors’ offices, CILSJ
Secured resources: 50%


GOLDEN-HEADED LION
TAMARINS

Golden-headed Lion Tamarins

Leontopithecus chrysomelas

Facilitator: Leandro Jerusalinsky
Reporter: Kristel De Vleeschouwer
Presenter: Carlos Bianchi, Leandro Jerusalinsky
Participants: Leandro Jerusalinsky, Kristin Leus, Jim Dietz, Rafael Monteiro, Saturnino Neto, Carlos Bianchi, Carlos Guidorizzo, Kristel De Vleeschouwer, Adriano Paglia

The working group participants started by brainstorming and listing all current problems relating to the conservation of golden-headed lion tamarins.

List of problems mentioned by the participants:

- indigenous areas, land reform settlement
- lack of connectivity
- lack of knowledge on effects of parasitism on health
- lack of communication/coordination/partnership between institutions/researchers
- loss of habitat (quality, extent)
- lack of guaranteed financial resources for research and monitoring
- lack of activities in the western part of the distribution range
- lack of knowledge on genetic variability
- lack of Conservation Units representative for the region (size, number, phytophysiognomy)
- lack of information on the spatio-demographic structure of the metapopulation
- insufficiency of law enforcement system
- lack of knowledge on the range of infectious agents in populations of GHLTs
- lack of agility in the creation and implementation of Conservation Units
- lack of knowledge on the use of cabruca
- lack of involvement of foreign zoos in *in situ* activities ($, interaction, information exchange)
- lack of knowledge on the origin/ways of withdrawal/destination/impact on populations of illegal GHLTs in captivity
- lack of information on areas essential for the conservation of the species
- problems with the destination of confiscated animals (placing)
- lack of medical monitoring of populations
- lack of legislation on tax incentives for conservation (Ecological ICMS)
- increase in bureaucracy required to obtain research permits (CGEN/CPB/several instances involved in the procedures)
- lack of regional coordinator for Brazil for captive population
- failure of researchers to return reports of results to support decision process of IBAMA
- insufficiency in infrastructure for management of CUs
- few environmental education activities in the entire distribution area
- lack of understanding about the interaction between area of use and parasites
- lack of knowledge about the impact of domestic and production animals on population
- lack of training of teams that manipulate specimens (bio-safety)
- no use of animals that die in the wild (training/necropsy/etc)
- lack of information on interactions between primates (ecology, parasites, etc)

These problems were later clustered into six main topics:

1. Conservation Medicine
2. Biology of GHLTs
3. Protection of the species/populations and habitat
4. Management of captive population
5. Institutional politics
6. Resources

The problems were distributed over the topics as follows:

lack of knowledge on effects of parasitism on health	1
lack of knowledge on the range of infectious agents in populations of GHLTs	1
lack of medical monitoring of populations	1
lack of understanding about the interaction between area of use and parasites	1
lack of knowledge about the impact of domestic and production animals on population	1
lack of training of teams that manipulate specimens (bio-safety)	1
lack of involvement of foreign zoos in *in situ* activities ($, interaction, information exchange)	1, 4, 5, 6
no use of animals that die in the wild (training/necropsy/etc)	1,2
lack of information on interactions between primates (ecology, parasites, etc)	1,2
lack of knowledge on genetic variability	2
lack of information on the spatio-demographic structure of the metapopulation	2
lack of knowledge on the use of cabruca	2
lack of information on areas essential for conservation of the species	2
lack of activities in the western part of the distribution range	2, 3
lack of connectivity	3
loss of habitat (quality, extent)	3
lack of Conservation Units representative for the region (size, number, phytophysiognomy)	3
insufficiency of law enforcement system	3
few environmental education activities in the total distribution area	3
lack of knowledge on the origin/ways of withdrawal/ destination/impact on populations of illegal GHLTs in captivity	3, 4
indigenous areas, land reform settlement	3, 5
lack of agility in the creation and implementation of Conservation Units	3, 5
problems with the destination of confiscated animals (placing)	4
lack of regional coordinator for Brazil for captive population	4
lack of communication/coordination/partnership between institutions/researchers	5
lack of legislation on tax incentives for conservation (‘Ecological ICMS’)	5
increase in bureaucracy to obtain research permits (CGEN/CPB/several instances involved in the procedure)	5
failure of researchers to return reports of results to support decision process of IBAMA	5
lack of coordination of action in general between institutions working with conservation in the region of South Bahia	5
insufficiency in infrastructure for management of Cus	5, 6
lack of guaranteed financial resources for research and monitoring	6

For each cluster, clear problem statements were developed and later prioritised. For each problem statement, specific goals and actions were identified:

Problem 1.

Insufficiency of protected areas for the preservation of the species, principally Conservation Units of Complete Protection (CUCPs), their implementation and infrastructure.

Goal 1.1.

Sufficient protected areas to guarantee the viability of the GHLT Metapopulation, including at least two protected subpopulations within Conservation Units of Complete Protection (CUCP)

1.1.1. Action 1
Identify priority areas for conservation of GHLTs based on the results of the GHLT Connection Project
Responsible: Becky
Product: list of priority areas identified
Time frame: 2 years
Resources: ? (partly available already)
Priority 1

1.1.2. Action 2
Elaborate document to support the proposal to create CUCPs in Serra das Lontras and Serra do Baixão and to enlarge the REBIO-Una, formulated by IESB/Aliança para Conservação da Mata Atlântica/Flora Brasil, and send to MMA, DIREC, GEREX Salvador, GEREX Eunápolis.
Responsible: ICCM (Kristin)
Product: letter/document of support written and sent
Time frame: immediately
Resources: none
Priority 2

1.1.3. Action 3
Promote meetings between the REBIO-Una, Project BioBrasil and the GHLT Connection Project on one hand, and IESB and PRESERVA on the other hand to indicate priority areas for conservation of GHLTs, principally in the areas that connect the REBIO-Una, Serra das Lontras and Serra do Baixão, and to encourage programs to create RPPNs
Responsible: Kristel, Becky, Saturnino
Product: number of meetings, number of properties identified together
Time frame: immediately, one meeting every 6 months
Resources: none
Priority 3

1.1.4. Action 4
Promote meetings between IBAMA (REBIO-Una/Regional Office Ilhéus/Gerência Eunapolis), IESB and the GHLT Connection Project in order to indicate priority areas for implementation of Legal Reserves and APPs
Responsible: Saturnino, Becky, Carlos
Product: number of meetings, number of properties identified together with priority for implementation of Legal Reserves and APPs
Time frame: immediately, at least one meeting per year
Resources: none
Priority 3

1.1.5. Action 5
Write document to support the implementation of Legal Reserves and APPs in priority areas for conservation of GHLTs, principally in the areas connecting the REBIO-Una, Serra das Lontras and Serra do Baixão, to be sent to GEREX-Salvador, GEREX-Eunápolis, ESREG Ilhéus, REBIO Una
Responsible: ICCM (Kristin)
Product: document written
Time frame: immediately
Resources: none
Priority 3

1.1.6. Action 6
Write letter of support for GHLT Connection Project, given that this project will identify priority areas for conservation of GHLTs, aiming to support the process of obtaining funding

Responsible: ICCM (Kristin)
Product: letter written and sent
Time frame: immediately
Resources: none
Priority 3

Goal 1.2.

Provide REBIO-Una with an infrastructure sufficient to accomplish its role with respect to the protection of GHLTs

1.2.1. Action 7
Write document to support the enlargement/qualification of the infrastructure of REBIO-Una, justifying the importance of its population of GHLTs for the conservation of the species and other elements of biodiversity, based on the results of the PHVA, detailing the needs of this CU to fulfil its objectives, to be sent to MMA, DIREC, GEREX-Salvador, GEREX-Eunapolis, ESREG-Ilhéus and Projeto Corredores Ecológicos
Responsible: ICCM (Kristin)
Product: letter
Time frame: immediately
Resources: none

Problem 2.

Loss (extent and quality) and isolation of primary forest, as a result of the activities of the logging industry and cattle ranching.

Goal 2.1.

Efficient law enforcement process installed, in order to prevent habitat loss and traffic in GHLTs

2.1.1. Action 8
Write document to support actions against deforestation in the GHLT distribution area, listing in the document the target communities, to be sent to MMA, DIREC, GEREX-Salvador, GEREX-Eunapolis, ESREG-Ilhéus and Projeto Corredores Ecológicos
Responsible: ICCM (Kristin)
Product: letter
Time frame: immediately
Resources: none
Priority 1

2.1.2. Action 9
Write document requesting the participation of the Federal and State Public Ministries in actions against deforestation and traffic in GHLTs, based on the results of this PHVA, pointing out the importance of agility in the fulfilment of environmental legislation.
Responsible: ICCM (Kristin)
Product: letter
Time frame: immediately
Resources: none
Priority 2

2.1.3. Action 10
Spread information about research, the PHVA and especially the importance of the REBIO-Una for the conservation of GHLTs to the media.

Responsible: Kristel, Jim, Becky, Carlos, Saturnino
Colaborator: CPB/Sector for Communication and Marketing (Leandro)
Product: number of published subjects
Time frame: onset immediately and action continuous, aiming at least one subject per semester
Resources: none
Priority 3

Goal 2.2.

Programs to prevent deforestation installed in the different sectors of society, to prevent the loss of habitat for GHLTs

2.2.1. Action 11
Promote meetings between actors with a potential contribution to GHLT conservation, in order to encourage institutional actions and enpower partnerships to enlarge, qualify and create programs that focus on the prevention of deforestation, such as environmental education, sustainable production, among others, based on the results of this PHVA.
Responsible: Carlos, Kristel, Saturnino
Product: number of meetings
Time frame: immediately and continuous, at least one meeting per semester
Resources: none

Problem 3

Lack of information on the biology of the species and its habitat, including ecological interactions between primates, genetic variability, use of cabruca and areas essential for conservation.

Goal 3.1.

Data base containing existing data on GHLTs and their habitat created, in order to compile information and identify knowledge gaps.

3.1.1. Action 12
Develop a basic structure for the GHLT Data Base
(Should we have a general Data Base for all species of lion tamarins?)
Responsible: Leandro CPB
Product: data base structure developed
Time frame: 6 months
Resources: none (if using available institutional structures)

3.1.2. Action 13
Develop rules for the management of information deposited in the GHLT Data Base
Responsible: CPB (Leandro), Kristel, Becky, James, Carlos, Saturnino
Product: Internal Regiment of the data base developed
Time frame: simultaneous with the development of the basic structure, but completed within a maximum of one year, and with updates when necessary
Resources: none

3.1.3. Action 14
Send data to feed the GHLT Data Base
Responsible: Kristel, Becky, James, Carlos, Rafael, Saturnino
Product: updated Data Base, with further updates at least anually (ICCM meetings)
Time frame: 1 year (until the next ICCM meeting) for the inclusion of already existing data and continuous
Resources: None

Goal 3.2.

Continous research to obtain data necessary for conservation of GHLTs and their habitat realized, including long term studies to understand patterns of fluctuations within populations

3.2.1. Action 15
Continue long term studies on vegetation, ecology, area of use, behaviour, demographics of GHLT populations in Maruim and Piedade within the REBIO-Una
Responsible: Becky, Kristel, Jim
Product: number of long term projects in progress
Time frame: continuous
Resources: $$$$$
Priority 1

3.2.2. Action 16
Establish contacts to realize genetic research with GHLTs
Responsible: Jim, Kristel, Carlos
Colaborators: Adriana, Leandro
Product: contacts and number of investigations realized
Time frame: immediately, with research realized within one year
Resources: none?
Priority 2

3.2.3. Action 17
Advise the elaboration of projects that investigate the use of cabruca by GHLTs
Responsible: Jim, Kristel
Product: number of research projects initiated
Time frame: 2 years
Resources: ?
Priority 3

3.2.4. Action 18
Elaborate study on vegetation, ecology, area of use, behaviour and demography of GHLT populations in Limoeiro, Itapetinga/BA (western part of the species' distribution)
Responsible: Carlos
Product: data obtained
Time frame: start immediately, results obtained within 1,5 years
Resources: ?
Priority 4

Problem 4

Low interactivity between the conservation agents, (*in situ* and *ex situ*): lack of involvement of foreign zoos, lack of communication between researchers/institutions of GHLTs, lack of coordinated action between institutions acting on conservation in the region, failure of researchers to return research results to IBAMA.

Goal 4.1.

All actors that can potentially contribute to achieving the goals of the GHLT Action Plan identified and integrated in the process

4.1.1. Action 19

Give continuity to the GHLT Communication Forum, through periodic meetings and electronic communication
Responsible: Kristel
Product: number of meetings, number of communications
Time frame: continuous with at least one meeting per semester
Resources: none
Priority 1

4.1.2. Action 20
Encourage the participation of all actors involved in GHLT conservation in the meetings of Projeto Corredores Ecológicos
Responsible: REBIO-Una (Saturnino), IESB (Kristel, Carlos)
Product: number of meetings with participation of these actors
Time frame: start immediately and continuous
Resources: none
Priority 2

4.1.3. Action 21
Promote the organization of a seminar on conservation of GHLTs and their habitat, open to students, NGOs, Organized Civil Society, Universities and the general public, with invitation of the press, to spread and encourage projects and actions for GHLT conservation
Responsible: Saturnino, Kristel, Jim, Carlos, Becky
Product: seminar organized
Time frame: 1 year
Resources: R$ 5.000 to 10.000 (CNPq ?)
Priority 3

4.1.4. Action 22
Identify other actors with potential contribution to the conservation of GHLTs, through the various available professional and institutional canals
Responsible: Saturnino, Kristel, Jim, Carlos, Becky
Product: new institutions proposing/elaborating new actions or collaborating with actions towards the conservation of GHLTs
Time frame: continuous
Resources: none
Priority 4

4.1.5. Action 23
Send an extract of the GHLT part of the PHVA to zoos participating in the conservation breeding program in captivity
Responsible: Kristin, Rogério
Product: document developed and sent to all institutions
Time frame: immediately, to be accomplished within 6 months
Resources: few?
Priority 5

4.1.6. Action 24
Request space/time at the Annual Reunions of the Brazilian Zoo Society and of AAZA to communicate about the importance for GHLT conservation of zoos participating in the conservation breeding program for GHLTs in captivity
Responsible: Kristel, Jim
Product: number of presentations accomplished
Time frame: 2 years
Resources: ?
Priority 5

Problem 5

Lack of information on the actual situation, changes in extent and distribution,

threats, trends and economy of cabruca.

Goal 5.1.

Actors that work with cabruca integrated in the process of conservation of GHLT habitats

5.1.1. Action 25
Establish contact with CEPLAC and other actors working with cabruca, with the aim to compile information relevant to conservation of GHLTs, such as: past and current extension, physical characteristics, in order to obtain suggestions for strategies for the conservation of cabrucas.
Responsible: Saturnino, Kristel, Carlos
Product: information obtained
Time frame: 6 months
Resources: none
Priority 1

5.1.2. Action 26
Write document informing about the relevance of cabruca around the REBIO-Una for GHLT conservation, based on the results of the PHVA, to be delivered to the Setor de Extensão de CEPEC
Responsible: ICCM (Kristin)
Product: document written and delivered
Time frame: immediately
Resources: none
Priority 2

Problem 6

Insufficiency of the law enforcement system for protection of areas, and to avoid the capture and commercialization of wild specimens.

Included in Goal 2.1 – Efficient Law Enforcement Process

Problem 7

Lack of a metapopulation plan, including information on the spatio-demographic structure.

Done by the Metapopulation Working Group

Problem 8

Lack of guaranteed resources for research and monitoring.

Partly done by the Metapopulation Working Group. The following suggestions should also be considered by this group:

- Campaign to collect $$ in American Zoos
- Legalization of “jogo de bicho”- combined with fundraising
- Identify potential permanent donors within the Brazilian society
- Form a network of Zoos for long term fundraising and exchange of information and educational resources

Problem 9

Insufficiency of information about the western region of the GHLT distribution area, permitting evaluation of its importance for the conservation of the species

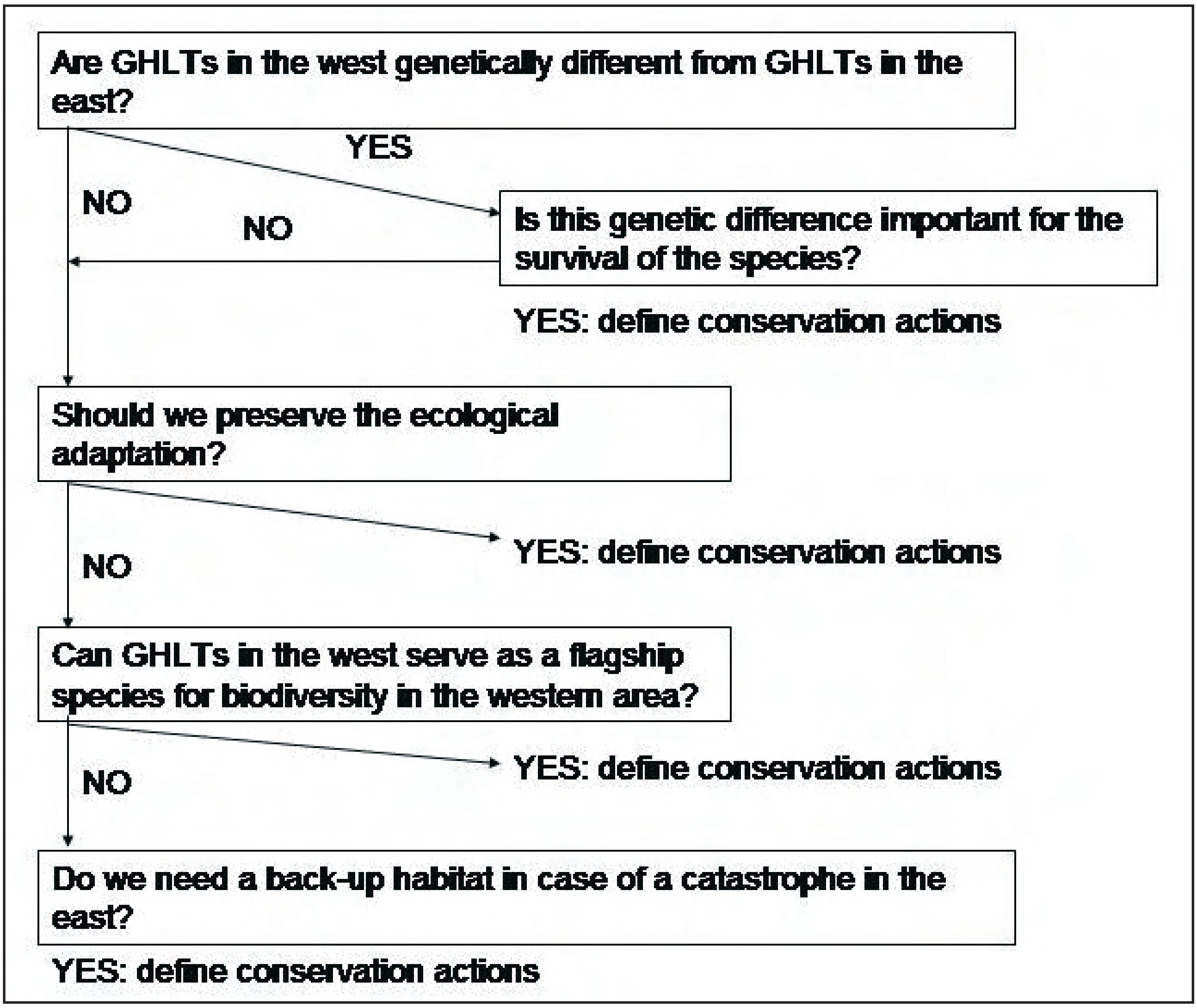
Rephrased from: Insufficiency of activities in the entire distribution area of the species (with the exception of REBIO-Una) and principally in the western region, including research and conservation actions (environmental education, protection of areas, socio-economic programs)

Goal 9.1.

Strategy for GHLT conservation in the western part of its distribution defined

9.1.1. Action 27
Compile historic data regarding landscape evolution within the GHLT distribution area, in order to determine the time of isolation of the western populations
Responsible: IESB (Carlos)
Product: data compiled
Time frame: start immediately, to be accomplished within 6 months
Resources: none

9.1.2. Action 28
Identify potential areas to protect GHLTs in the western part of the distribution range, including private as well as public areas at the local, state and federal level



Responsible: Becky, IESB (Carlos)
Product: list of identified potential areas
Time frame: continuous, with at least a preliminary list within one year
Resources: none

9.1.3. Action 29
Promote a working meeting with the actors that work with GHLT conservation, to define a conservation strategy for the western part of the GHLT distribution
Responsible: Kristin, Kristel
Product: meeting realized and strategy defined
Time frame: to be realized during the next ICCM meetings, after obtaining the basic data
Resources: none

Problem 10

Lack of a Conservation Medicine Program for the species, focussing on parasitism, infectious agents, impact of domestic and production animals, interaction between area of use and parasites, interactions with other primates, training of people manipulating specimens, and health monitoring of populations, with better use of animals that die in nature.

Done by the Metapopulation Working Group

Problem 11

Low relevance of the environmental issues on politics that decide on land reform settlements and indigenous areas.

Done by the Communications Working Group

Problem 12

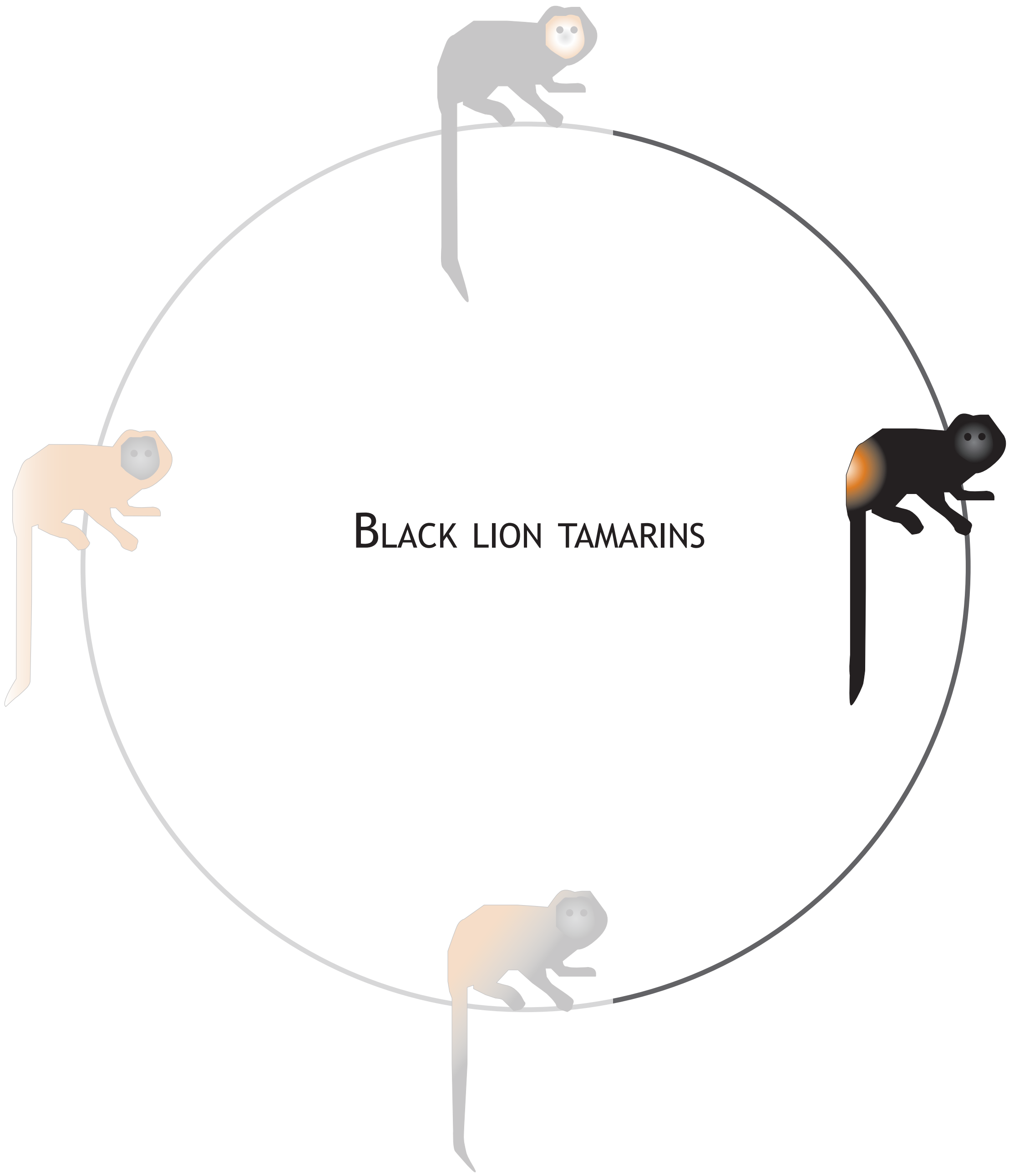
Lack of knowledge on the dynamics of trade (areas of origin, destination, impact on natural populations) and mechanisms to determine the destiny of confiscated animals.

Included in the Goals of Problem 2

Problem 13

Lack of agility in the process of obtaining research permits.

Done by the Communications Working Group


Black lion tamarins

Black Lion Tamarin

Leontopithecus chrysopygus

Problem 1

The known black lion tamarin populations occur in low density in isolated areas. This situation causes genetic and demographic problems that affect the survival of the species, and lack of strategic knowledge to help species conservation aggravates the problem.

Goal 1

Metapopulation Management Plan developed and implemented in 10 years.

1.1) Defining population parameters (demographic, genetic and health) for a metapopulation management planning.

A) Demographic: 5 years
B) Genetic: 5 years
C) Health: 5 years

Actions
A) Demographic

A.1) Determining the number of populations where the species occurs and its southeastern distribution. (Cristiana Martins)
Time frame: July 2006
Collaborators: Instituto Florestal de São Paulo, IBAMA, FUNBIO, Wildlife Trust, ICCM, CPB.
Product: Updated species distribution map.

A.2) Carrying out censuses of newly identified populations, and updating data on the populations of Caitetus, Rio Claro Farm and BLT ESEC. (Karla Paranhos, Marcio Port)
Time frame: End of 2007
Collaborators: Instituto Florestal de São Paulo, IBAMA, Wildlife Trust, ICCM, CPB.
Products: Updated report containing an estimate for population size, according to standard protocol; publication of paper; information available in database.

B) Genetic

B.1) Compiling information about existing samples and data. (Cristiana Martins)
Time frame: Until the end of the PHVA.
Product: List of sampled populations.

B.2) Compiling information about pedigree, (Jennifer M., Studbook)
Time frame: Until the end of the PHVA
Product: List of categories of existing data.

B.3) Defining priority populations and areas to be sampled. (Cristiana Martins, Fernando Passos)
Time frame: 2 months
Product: List and map of priority areas.

B.4) Taking samples for a genetic analysis of the populations identified as priority. (Karla Paranhos, Rogério Paschoal, Alcides Pissinatti, Cristiana Martins)
Time frame: 3 years (2008)
Collaborators: IBAMA, Instituto Florestal de São Paulo, Wildlife Trust, ICCM, CPRJ, SZB, CPB.
Product: Samples taken in each one of the priority areas.

B.5) Carrying out genetic analysis. (Cristiana Martins, Karla Paranhos)
Time frame: 4 years (2009)
Collaborators: Adriana Grativol, IBAMA, Instituto Florestal de São Paulo, Wildlife Trust, ICCM, CPB.
Product: Database containing the genetic caracterization of all black lion tamarin populations sampled.

C) Health

Actions

C.1) Characterizing the main infectious agents posing potential or actual risks to black lion tamarin populations. (Alcides Pissinatti, Paula Mangini)
Time frame: 2 months
Collaborators: Conservation medicine teams for all lion tamarin species.
Product: List of relevant infectious agents.

C.2) Implementing more specific and inexpensive alternative diagnosis techniques. (Alcides Pissinatti, Paula Mangini)
Time frame: Implementation in 4 years; continuous
Collaborators: Conservation medicine teams for all lion tamarin species.
Product: Use of diagnosis methods.

C.3) Registering reference institutions and researchers to carry out diagnostic analyses. (Alcides Pissinatti, Monica)
Time frame: Implementation in 2 years; continuous
Collaborators: Conservation medicine teams for all lion tamarin species.
Product: List of institutions and researchers officially committed to get involved in the process.

C.4) Stimulating the commitment of different actors involved in conservation projects concerning sanitary processes. (Alcides Pissinatti)
Time frame: Immediate and continuous
Collaborators: Conservation medicine teams for all lion tamarin species.
Product: Gathering more data on health information concerning the period 1997-2005.

C.5) Collaborating with management actions providing health data. (Alcides Pissinatti)
Time frame: Continuous
Product: Health evaluations effectively applied to management actions.
Collaborators: Universities, research institutes, NGOs, Ministry of Agriculture, Ministry of Health, conservation medicine teams for all lion tamarin species.

C. 6) Carrying out a preliminary study on pathogens in wild black lion tamarin populations. (Alcides Pissinatti)
Time frame: 3 years (2008)
Collaborators: Conservation medicine teams for all lion tamarin species.
Product: List of pathogens found in black lion tamarin populations.

1.2) Metapopulation management strategies

Actions

A) Defining which populations are to be included in the model, based on:

-genetic representation (rare alleles, local adaptations);
-habitat quality;
-population diseases;
-costs and feasibility;
-public opinion. (Cristiana Martins, Andreia, Marcio Port)
Time frame: 2009
Product: Detailed data to feed the model (VORTEX , GIS); report of actions to be submitted to ICCM in 2009.

B) Updating and refining the VORTEX modelling with new data. (Cristiana Martins, Karla Paranhos)
Time frame: 4 years
Product: Metapopulation Management Plan defined and available on a database.

C) Defining criteria to evaluate the results of reintroduction, translocation, and other management techniques. (Jennifer Mickelberg)
Time frame: January 2006
Product: Draft of criteria submitted to ICCM.

D) Defining which populations should be connected under projects of corridors and/or stepping-stones. (Cristiana Martins, Karla Paranhos, João Andreia, Jefferson, Wilson, Cecílio)
Time frame: 6 months for areas with genetic patterns already identified and, later, continuous
Produto/Product: SIG com proposta de mosaico/GIS with mosaic proposal.

E) Defining and carrying out the necessary animal transfers, based on VORTEX model (Jon Ballou, Kristin Leus, Cristiana Martins, Alexandre Amaral, Rogério Paschoal, Studbook Keeper)
Time frame: Beginning in 2008 and continuous
Collaborators: ICCM, IBAMA, IF, CPRJ, SZB, international zoos, CPB.
Product: Number of animal transfers; report of tranfers effectiveness.

F) Designing and carrying out projects to refine current techniques and to investigate new animal transfer techniques. (Cristiana Martins, Karla Paranhos, Rogério Paschoal)
Time frame: 2009
Product: Proposals to test new techniques submitted to ICCM; technical report and publication of techniques.

G) Carrying out demographic monitoring to evaluate metapopulation status. (Karla Paranhos, Márcio Port)
Time frame: Beginning in 2007 and continuous
Collaborators: IBAMA, Instituto Florestal de São Paulo, Wildlife Trust, ICCM, CPB.
Product: Technical report of population demographic parameters; publication of results.

1.2.3 Captive populations

1.2.3.1) Reversing the decline of the captive population

A) Carrying out a new Master Plan for the captive black lion tamarin population. (Cristiana Martins, Jennifer Mickelberg, Rogério Paschoal, Studbook Keeper)
Time frame: March 2006
Collaborators: CPRJ, SZB, international zoos, CPB.
Product: Pairing recommendations for captive population.

B) Zoos that hold black lion tamarins, CPB, Rogério Paschoal, Alcides Pissinatti).
Time frame: End of 2006
Collaborators: ICCM, IBAMA, SZB, IF, CPB.
Product: Recommendations carried out.

Problem 2

The greater the habitat fragmentation, the higher the anthropic pressure on black lion tamarin occurrence areas.

Goal 2

2.1) All known black lion tamarin occurrence areas legally protected and consolidated in 10 years (+ 6,700 ha).

Actions

A) Implementing infrastructure for conservation units, legalizing landownership, and designing a plan to protect conservation units effectively. (João , Andreia , Wilson, Cecílio , Marcio Port, Jefferson)
Time frame: 10 years
Product: Conservation units with active advisory boards and an operational management plan.

B) Consolidating protected areas, establishing active advisory boards and implementing management plans. (João, Andreia, Wilson, Cecílio,, Marcio Port, Jefferson)
Time frame: 10 years
Product: Conservation units with active advisory boards and operational management plan.

2.2) Reducing anthropic pressure on natural resources bordering on protected areas and potential areas (not studied yet) by 30% in 10 years.

Actions

A) Establishing and/or restoring benefit zones (corridors, stepping stones, green hugs), defining buffer zones, and increasing connectivity. (Jefferson, Andreia, Cecílio, Cristiana Martins, Wilson, João)
Time frame: 10 years and continuous
Product: Benefit zones established (10 corridors in Pontal; 6 green hugs; 10 stepping stones projects); buffer zones defined.

B) Promoting actions to publicize the conservation units in the community; promoting the community involvement in the conservation of the species and its habitat, through educational campaigns and distribution of printed material, aiming at reaching 50% of the landscape unit. (Graça)
Time frame: Pontal (immediate and continuous); Caitetus (2007 and continuous); Buri and southeastern border (2006 and continuous)
Collaborators: IF, IBAMA, IPÊ, and Secretaries of Education, Culture and the Environment.
Product: At least one educational campaign per year in each region, aiming at making the species known in 50% of the community approached.

C) Together with the education departments of the landscape unit, planning environmental education activities directed to black lion tamarin conservation to be included in the schools' calendars.
Time frame: Pontal (immediate and continuous); Caitetus (2007 and continuous); Buri and southeastern border (2006 and continuous)
Collaborators: IF, IBAMA, IPÊ, and Secretaries of Education.
Products: Plan of environmental education activities for black lion tamarin conservation included in the calendar of at least 50% of schools in each region.

D) Diagnosing the actual anthropic pressures on species occurrence areas still to be studied (Jefferson, Andreia, Cecílio, Cristiana Martins, Wilson, João)
Time frame: 2007
Product: GIS containing the anthropic pressure scenario.

E) Identifying suitable alternatives to reducing anthropic pressure (income generation, community mobilization etc.) to be developed together with the communitites living around the conservation units.
Time frame: Pontal (continuous); Caitetus (2008 and continuous); Buri and southeastern border (2007 and continuous)
Collaborators: IF, IBAMA, IPÊ, and community associations.
Product: Sustainable socio-environmental activities implemented in at least 50% of the landscape unit in 10 years.

Problem 3

Lack of environmental public policies for black lion tamarin conservation.

Goal 3

Black lion tamarin conservation included in regional public policies in 5 years.

Action

A) Identifying and participating strategically in regional development forums, including black lion tamarin conservation in their agendas. (Marcio Port, Andréia Pires, Karla Paranhos, João, Cecílio , Wilson Jefferson , Graça)
Time frame: Immediate and continuous
Product: Black lion tamarin conservation agendas included in regional public policies (ex.: town planning).

B) Holding periodic meetings to disseminate strategic information to stakeholders (Department of Justice, city halls, town and state assemblies, secretaries etc.).
Tempo: Immediate and continuous
Product: Number of meetings held.

Problem 4

Lack of information on the availability and quality of potential habitats to be managed (lack of areas admittedly viable for species conservation and habitat quality).

Goal 4

Potential areas for management identified, characterized, and prioritized in 2 years.

Actions

A) Using environmental variables (survey of species occurrence, vegetation, soil, climate, hydography etc.) on a GIS system to integrate actions and identify priority areas for conservation. (Andréia Pires, João, Wilson, Cecílio, Cristiana Martins)
Time frame: 2007
Product: Theme maps depicting priority areas.

Problem 5

Relationship problems among the institutions involved are impairing the definition of conservation strategies.

Goal 5

5.1) Consolidating an effective and continuous communication among the several national and international institutions involved in black lion tamarin conservation.

Actions

A) Holding meetings with the concerned institutions to solve conflicts, define roles and common objectives to potentialize actions for the species conservation. (Marcio Port, Wilson, Cecílio, Gracinha, Joao, Jefferson , Andreia)
Time frame: Immediate and continuous (first meeting – 3 months)

Product: Number of meetings held.

B) Forming partnerships to empower black lion tamarin conservation. (Marcio Port, João , Graça , Wilson Cecílio , Andréia Pires, Karla Paranhos)
Time frame: Immediate and continuous
Product: Number of partnerships formed.

Problem 6

Lack of qualified personnel in several fields limits black lion tamarin management and conservation actions.

Goal 6

6.1) Adopting a continuous qualification process for professionals from different fields and with different levels of knowledge aiming at having available personnel to carry out conservation actions.

Actions

A) Encouraging the qualification of professionals already working in the conservation field (IPÊ, IBAMA, IF, SZB and zoos, universities).
Time frame: Beginning in 2006 and continuous
Collaborators: AMLD, CPRJ, CPB.
Product: Number of qualified professionals.

B) Encouraging the qualification of new professionals.
Time frame: Beginning in 2006 and continuous
Collaborators: AMLD, CPRJ, CPB.
Product: Number of professionals qualified.

C) Encouraging opportunities of professional qualification in biodiversity conservation (Target audiences: Department of Justice, Environment Police, Federal Police, among others).
Time frame: Beginning in 2006 and continuous
Product: Number of professionals qualified.

D) Integrating governmental and non-governmental organizations to develop environmental education programs in the conservation units where black lion tamarins occur, aiming at contributing to the environmental education of local leaders, organizations personnel, local community members.
Time frame: Pontal BLT ESEC, immediate and continuous; Caitetus, 2007 and continuous; Buri and southeastern border, 2006 and continuous.
Collaborators: IF, IBAMA, IPÊ and regional NGOs.
Products: Environmental education program for black lion tamarin conservation implemented in the conservation units located in black lion tamarin occurrence areas (ESEC MLP, ESEC Caitetus, FLONA Angatuba, FLONA Capão Bonito and Buri Experimental Station).

Problem 7

Lack of organized and easily accessible information is impairing integrated research and management actions.

Goal 7

7.1) Creating a culture of publication among the institutions and researchers involved in species conservation.

A) Encouraging proper publication of research results.
Time frame: Immediate and continuous.
Product: At least one published paper per approved project within 3 years after conclusion.

7.2) Existing information concerning the species and its habitat organized and available within one year and being continuously updated.

Actions

A) Developing, standardizing, implementing, and making available a database for the species (Andreia Pires, Rafael Monteiro, Marcio Schmidt, Lucia Schimdlin, Fernando Passos, Leandro Jerusalinsky).
Time frame: Two years for the whole process
Product: Operational database.

Problem 8

Bureaucracy is an obstacle to research and management actions.

Goal 8

8.1) Administrators and researchers working together to minimize bureaucratic problems related to conservation research and management.

Actions

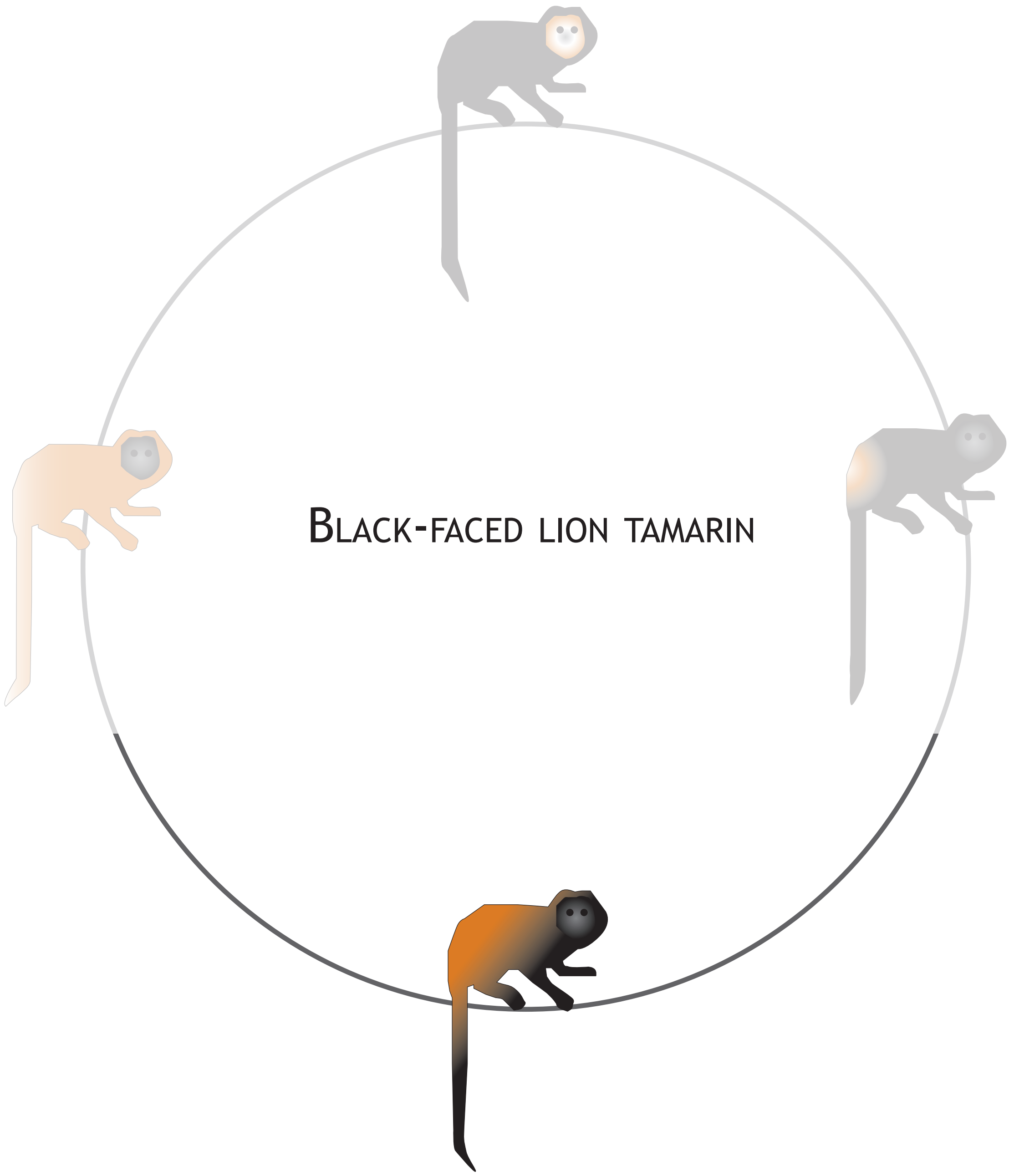
A) Developing and distributing a reference document to direct the procedures to obtain research permits. (IBAMA, David; IF, Márcio Port; IPÊ, Karla Paranhos; CPB, Monica ; AMLD, Sinara)
Time frame: 2005
Collaborators: Researchers
Product: Reference document finished and distributed.

B) Holding meetings between members from the black lion tamarin conservation committee and directors from IBAMA and IF. (DIREC/Ibama; DIFAP/Ibama; COTEC-IF/SP; Committee, Ricardo Soavinsky)
Time frame: Scheduling until the end of 2005
Collaborator: Márcio Port (IF/SP)
Product: Meetings held.

C) Scheduling visits of IBAMA analysts to black lion tamarin research sites and visits of researchers to IBAMA headquarters and regional offices. (Comitê/IBAMA, Ricardo, IPÊ,/Karla Paranhos; IF/ Marcio Port; CPB, Monica)
Time frame: 2006 and continuous
Product: Number of visits.

D) Encouraging and facilitating the participation of proposal analysts from IBAMA in events related to species conservation. (Comitê/IBAMA, Ricardo ; IPÊ, Karla Paranhos; IF, Marcio Port; CPB, Monica)
Time frame: 2006 and continuous
Product: Number of events with the participation of proposal analysts.

E) Recommend that the Brazilian Primate Center (IBAMA) becomes a controlling agent for animal transfers, according to captive management recommendations. (Alcides Pissinatti)
Time frame: Immediate
Product: Send document to the IBAMA with suggestions


Black-faced lion tamarin

Black-faced Lion Tamarin

Leontopithecus caissara

Alexandre Túlio Amaral Nacimento (IPÊ)
Fabiana C. Prado (IPÊ)
Guadalupe Vivekananda (IBAMA)
Humberto Zontini Malheiros (IPÊ)
Juliana G. Ferreira (IBAMA – CPB)
Lucia Agathe J. Schmidlin (IPÊ)
Natanael Neves da Graça (IPÊ – from Barra do Superagüi vilage)
Paula Beatriz Mangini (IPÊ)
Selma Ribeiro (IBAMA)

Problem 1:

The genetic status of the Black-Faced Lion Tamarin's (BFLT) is unknown. This knowledge is necessary for better conservation management decision-making. Observation: being a priority, this research is dissociated from the others.

Goal 1:

Characterize the genetic structure of the BFLT populations and improve PHVA models (Vortex).

Action 1.1: Conduct the genetic analyses with the available samples that were collected during the population health study (2002-2004).
Output: Technical report
Participants: Cristiana and Paula
Time frame: 2 years

Action 1.2: Update the PHVA models (Vortex) with the BFLT genetic information.
Output: Updated scenarios
Participants: Alexandre, Lucia and Fabiana
Time frame: 2.5 years

Problem 2:

Lack of information on: 1) phenology (BFLT x vegetation relationship), 2) ecological patterns on the mainland distribution area, 3) impact of invasive fauna and flora species (giant African snail, Achatina fulica and "bambuzinho"), 4) predation pressure in the continent, and 5) detailed distribution of the species in the foothills and other areas on the continent to help design management actions.

Goal 2:

Fill in the information gaps on: 1) phenology (BFLT x Vegetation relationship), 2) ecological patterns on the mainland distribution area, 3) impact of invasive fauna and flora species, 4) predation pressure in the continent, and 5) fine scale distribution of the species in the foothills and other areas on the continent to help design management actions.

Action 2.1: Systematize ecological information from different studies on the species' database.
Output: Database permanently updated
Participants: Alexandre and Lucia
Time frame: Immediate and continuous

Action 2.2: Establish the Landscape United based on GIS (geographic information system) studies.

Output: GIS of Landscape United
Participants: Lucia and Alexandre
Time frame: Immediate with a 3-year period (this time frame finishes the distribution account).

Action 2.3: Conduct a study on the dispersal of BFLT between Rio dos Patos and Ariri regions.
Output: A study on the dispersal of BFLT between Rio dos Patos and Ariri regions concluded.
Participants: Alexandre
Time frame: 4 years

Action 2.4: Conduct at least one study on predation pressure in the continent.
Output: A study on predation pressure in the continent concluded.
Participants: Alexandre
Time frame: 6 years

Action 2.5: Conduct at least one study on the distribution of the species on the foothills and other areas in the continent.
Output: Study on the distribution of the species on the foothills and other areas in the continent concluded.
Participants: Lucia and Alexandre
Time frame: 3 years

Action 2.6: Conduct at least one study on the species' phenology.
Output: Study on the species´ phenology on the island and the continent.
Participants: Guadalupe and Alexandre
Time frame: 4 years

Action 2.7: Start the long term monitoring of at least two groups of BFLT to gather information on demographic parameters such as mortality, dispersion, fecundity, etc.
Output: Monitoring of at least two groups started.
Participants: Lucia and Alexandre
Time frame: Start on the 5th year (long term monitoring)

Action 2.8: Stimulate at least one study on invasive fauna and flora species.
Output: At least one study on invasive fauna and flora conducted.
Participants: Guadalupe and Paula
Time frame: 4 years

Action 2.9: Study the species' reproductive cycle - female estrus cycle - to inform the species´ management plan.
Output: Report on the species' reproductive parameters, with special emphasis on estrus cycle.
Participants: Paula
Time frame: 4 years

Problem 3:

The isolation of island and continental populations of BFLT, which hampers the genetic flow and associated ecological processes.

Direct contact between human and BFLT populations in Barra do Superagüi, which can transmit pathogens to the tamarins, promote the loss of ecological fitness, and tamarin mortality; which in turn causes demographic problems.

3. Goal:

Species management in a metapopulation scenario.

Action 3.1: Define which populations should be managed based on the Vortex model.
Output: Definition of management scenarios

Participants: Alexandre and Lucia
Time frame: 3 years

Action 3.2: Conduct pilot translocation.
Output: Translocation conducted
Participants: Alexandre, Paula, Selma and Lucia
Time frame: 5 years

Action 3.3: Plan management actions for the species in order to refine the management techniques.
Output: Management Plan
Participants: Alexandre and Guadalupe
Time frame: 6 years

Problem 4:

Lack of coordination on governmental actions affect the protection of the species and its habitat (e.g.: relationship between IBAMA and FUNAI; IBAMA and Tourism Agency; IBAMA and INCRA), as well as internal relationships within IBAMA´s different administrative levels.

Bureaucratic inertia in the granting of research permits and lack of long term funding sources hampers conservation of the species and its habitat.

Goal 4:

Influence regional public policies to support the conservation program for the BFLT.

Action 4.1: Develop a communication plan for the BFLT Conservation Program in order to attract media attention and funding sources.
Outputs: Communication Plan
Participants: Alexandre, Lucia (IPÊ's communication department) and Guadalupe
Time frame: 1 year (Committee Meeting 2006), continuous

Action 4.2: Definition of a standard procedure for BFLT research permit request between IBAMA and IPÊ.
Outputs: Procedure for BFLT research permit request defined
Participants: Guadalupe and Alexandre
Time frame: Immediate and continuous

Action 4.3: Identify and participate on regional planning forums in order to incorporate the conservation of the BFLT into the agenda.
Outputs: Participation in the forums
Participants: Guadalupe and Lucia
Time frame: Immediate and continuous

Action 4.4: Identify and formulate partnerships in order to promote the species' conservation.
Outputs: Formalization of partnership
Participants: Guadalupe and Lucia
Time frame: Immediate and continuous

Action 4.5: Stimulate the use by governmental agencies of GIS of the Landscape Unit as a tool for environmental planning.
Outputs: Environmental Planning using GIS of Landscape Unit
Participants: Lucia, Guadalupe and Humberto
Time frame: start in 1 year (continuous)

5. Goal:

Stimulate the effective and continuous communication among the different institutions involved in the BFLT conservation.

Action 5.1: Promote meetings among institutions in order to address and solve conflicts, define roles, interests and common objectives.
Outputs: Meetings between institutions
Participants: Guadalupe and Lucia
Time frame: Immediate and continuous

Problem 5:

The growth of villages, the lack and decline of alternatives income and the loss of cultural identity can drive habitat loss and increase the pressure over natural resources.

Unstructured tourism practices stimulate loss of cultural identity, wildlife trafficking, habitat loss and the increase in pressure on natural resources.

6. Goal:

Stimulate sustainable economic practices within the Landscape Unit.

Action 6.1: Based on socio-economic studies, identify potential economic practices that area sustainable and compatible with the local culture, and stimulate sustainable practices already in place.
Outputs: Business Plan for the practices identified
Participants: Selma and Humberto
Time frame: 5 years

7 Goal:

Prevent that urban expansion translates into habitat loss and the increase of the pressure on natural resources

Action 7.1: Temporal analysis of the urban area within the Landscape Unit using GIS.
Outputs: Temporal analysis done and continually updated
Participants: Lucia and Guadalupe
Time frame: Immediate; updated and monitored each year

Action 7.2: Study of the carrying capacity for human population within the geographic boundaries of villages in the surroundings of Superagui using GIS.
Outputs: Definition of carrying capacity
Participants: Lucia, Humberto and Guadalupe
Time frame: 10 years

Action 7.3: Stimulate the elaboration, implementation and updating of participatory planning that structures the human occupancy and landscape use within the Landscape Unit.
Outputs: Elaboration, implementation and updated plan
Participants: Lucia, Humberto and Guadalupe
Time frame: 10 years

Problem 6:

Insufficient enforcement hampers the protection of the species.

8 Goal:

Enhance the protection of the species and its habitat within the Landscape Unit.

Action 8.1: Make a diagnosis of enforcement failures
Output: Diagnosis
Participants: Selma and Humberto
Time frame: Immediate and continuous

Action 8.2: Develop a protection plan based on the results of the diagnosis with the community participation.
Outputs: Integrated protection plan
Participants: Selma and Humberto
Time frame: Start in 1 year (continuous)

Action 8.3: Identify priority areas for protection (UC, APP, Legal Reserve, etc.) using GIS.
Outputs: Map and list of priority areas
Participants: Lucia and Selma
Time frame: 10 years

Action 8.4: Monitoring of conservation actions using GIS.
Outputs: 20% reduction of pressure on the habitat
Participants: Selma and Lucia
Time frame: Continuous

Action 8.5: Stimulate the implementation of protected areas (Ucs, Legal Reserve, APP, etc) within the Landscape Unit.
Outputs: Creation of two private reserves of the national patrimony (RPPNs). Recover 20% of the legally recognized reserves and 20% of the permanent protection areas (APP).
Participants: Selma, Humberto and Lucia
Time frame: 10 years

Problem 7:

Lack of a consolidation of the Conservation Medicine program for the species.

9 Goal:

Continuously evaluate the health of BFLT and its effects on the viability of its populations.

Action 9.1: Complete the serological study of Superagui Island and Ariri populations, following the recommendation of the "2005 Population and Habitat Viability Assessment (PHVA) metapopulation management" group.
Output: Serologic profile of the populations.
Participants: Paula
Time frame: 2007

Action 9.2: Evaluate the health of the continental population, with special emphasis on the one in Vale do Rio dos Patos.
Output: Definition of the health status of the continental population, with special emphasis on the one in Vale do Rio dos Patos.
Participants: Paula
Time frame: 5 years

Action 9.3: Study the effect of philariosis on infected individuals.
Output: Report on the effects of philariosis on infected individuals with recommendations for disease management.
Participants: Paula
Time frame: 5 years

Action 9.4: Continuous monitoring of the health of the managed population.
Output: Health of managed population monitored

Participants: Paula
Time frame: Starts with the translocation (continuous)

Action 9.5: Make an evaluation of the health of domestic animals in the villages within the Landscape Unit.
Output: Report on the health of domestic animals in the villages within the Landscape Unit with management recommendations.
Participants: Paula
Time frame: 4 years

Action 9.6: Study pathogens that could be transmitted by the African snails (in particular the incidence of* Angiostrongylus *species) within the Landscape Unit.
Output: Report on the pathogens that could be transmitted by the African snails (in particular the incidence of *Angiostrongylus* species) within the Landscape Unit.
Participants: Paula
Time frame: 5 years

Problem 8:

Lack of engagement of the community, government and non-government agencies, and the private sector with socio-environmental issues, which hampers the implementation of the program for the conservation of the species and its habitat.

10 Goal:

Consolidate a long-term environmental education program.

Action 10.1: Workshop for planning of the socio-environmental conservation action associated with the BFLT's Environmental Education Program (EEP).
Output: Workshop and action plan of the BFLT's EEP.
Participants: Guadalupe, Maria das Graças and Alexandre
Time frame: 1 year

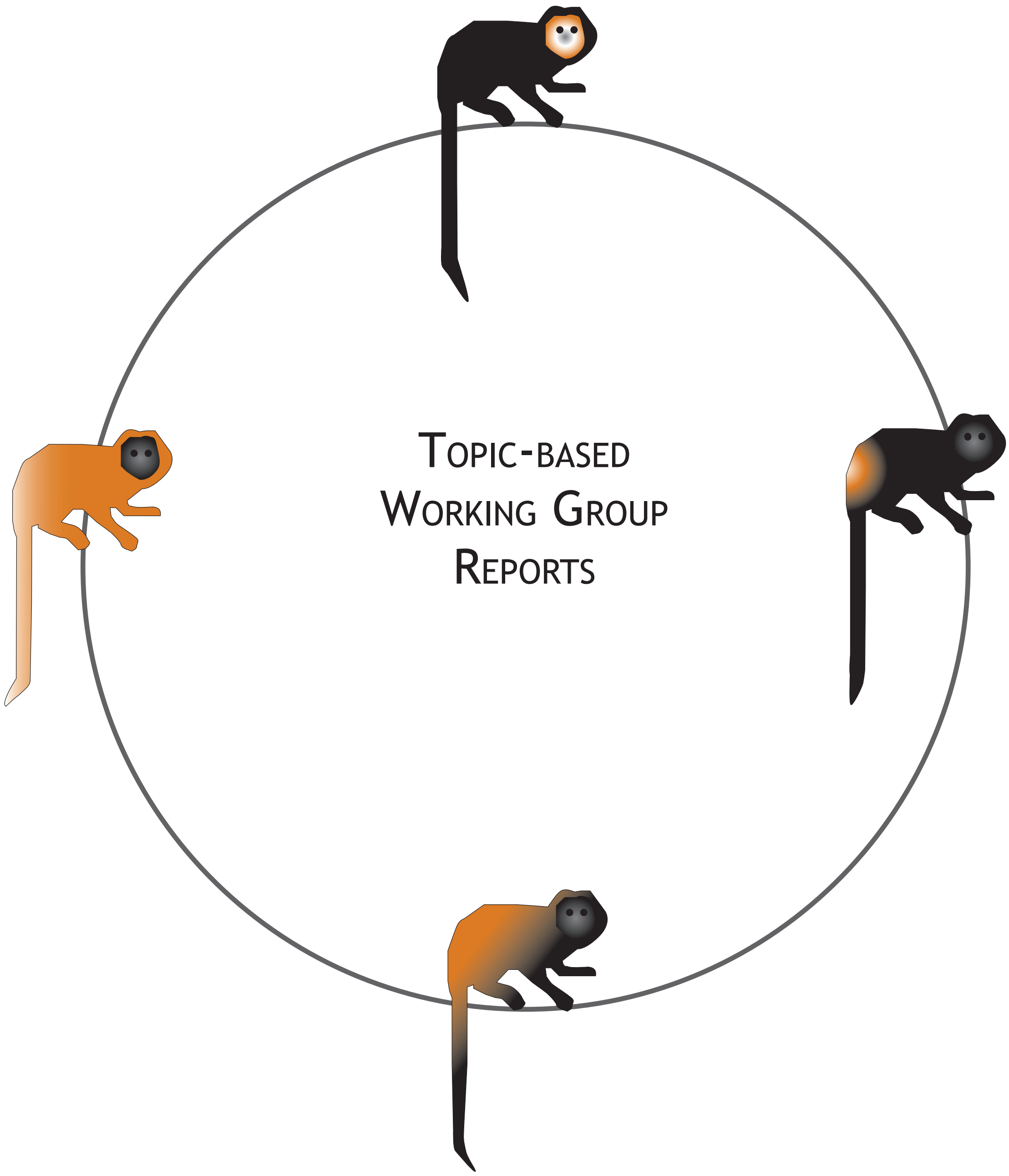
Action 10.2: Identify strategies for inter and intra-institutional communication involved in the Conservation Program within the Landscape Unit.
Output: Communication strategies defined
Participants: Selma and Maria da Graças
Time frame: Start win 1 year (continuous)

Action 10.3: Introduce environmental conservation practices into the regional planning of institutions involved on the Landscape Unit, including several social stakeholders.
Output: Introduction of at least one environmental conservation practice into the regional planning of institutions involved on the Landscape Unit.
Participants: Humberto and Guadalupe
Time frame: Immediate and continuous

Action 10.4: Systematize socio-environmental information on the Landscape Unit to inform the EEP.
Output: Socio-environmental diagnosis
Participants: Selma and Guadalupe
Time frame: 10 months

Action 10.5: Training of local socio-environmental agents to consolidation of the EEP.
Output: Local socio-environmental agents trained
Participants: Selma and Natanael
Time frame: Immediate and continuous

Topic-based Working Group Reports



Regional landscape planning, socioeconomic aspects and education

Facilitator- Gracinha
Recorder- Rodrigo Bacellar
Time-keeper- Beto
Flip Chart- Patricia Mie
Presenter- Paula Procopio

After deciding on roles, we divided the time by suggesting one hour each issue (landscape, socioeconomics, and education)

Problems - Landscape issues

- **lack of landscape consolidation**
- **habitat reduction**
- **inefficient fiscalization/ control**
- **geographic isolation of species**
- **anthropogenic pressure**
- **information and methods not integrated into a single GIS system**
- **lack of effective protected areas (UC, RL, APP)**

Goals:

The units of the landscape for each species defined

An efficient and comparable GIS system, integrated for each species and across species is implemented

The rate of habitat reduction is diminished and connectivity increased

An increase of protected areas is implemented.

Actions:

1.1 Define the priority areas for management and conservation:
Responsible: Becky Raboy (MLCD), Paula & Rosan (MLD), Lucia (MLCP), Christiana (MLP)
Time frame: 3 years
Product: Prioritya areas defined
Collaborating institutions: NGOs, local partners, public agencies

1.2 Do a cost-benefit analysis to prioritize areas (value to conservation, amount of threat):
Responsible: Carlos Eduardo (MLCD), Carlos Ruiz (MLD), Lucia (MLCP), Christiana (MLP)
Time frame: 3 yrs
Product: Analytical report
Collaborating institutions: NGOs local partners, public agencies

2.1 Do capacity building for technical staff to implement and integrate the institutional GIS

Responsible: Becky (MLCD), Marcio (MLD), Lucia (MLCP), Cristiana (MLP)
Time frame: 2 years
Product: at least one technical staff person from each species trained
Collaborating institutions: NGOs, researchers, public agencies

3.1 Quantify the actual area of habitat:
Responsible: Becky (MLCD), Marcio (MLD), Lucia (MLCP), Cristiana (MLP)
Time frame: 2 years
Product: area of habitat quantified
Collaborating institutions: NGOs and researchers

3.2 Estimate rate of reduction of habitat:
Responsible: Becky (MLCD), Marcio (MLD), Lucia (MLCP), Cristiana (MLP)
Time frame: continue each 2 years
Product: rate of habitat reduction known
Collaborating institutions: NGOs and researchers

3.3 Identify and map causes of habitat reduction:
Responsible: Becky (MLCD), Marcio (MLD), Lucia (MLCP), Cristiana (MLP)
Time frame: continue each 2 years
Product: causes of habitat reduction identified and mapped
Collaborating institutions: NGOs and researchers

3.4 Diagnose the weaknesses in the system of fiscalization:
Responsible: Saturnino (MLCD), Denise (MLD), Selma (MLCP), Andreia (MLP)
Time frame: 2 years
Product: Diagnosis completed
Collaborating institutions: NGOs and public institutions of the 3 spheres (Federal, State and municipal)

3.5 Develop an integrated plan of fiscalization:
Responsible: Saturnino (MLCD), Denise (MLD), Selma (MLCP), Andreia (MLP)
Time frame: 3 years
Product: Plan developed
Collaborating institutions: NGOs, communities, public institutions of 3 spheres (Federal, State and municipal)

4.1 Identify potential areas to create new Conservation Units (CUs):
Responsible: Saturnino (MLCD), Rosan and Marcio (MLD), Lucia (MLCP), Christiana (MLP)
Time frame: 3 years
Product: Areas for potential CUs identified
Collaborating institutions: NGOs, stakeholders, collaborators, IBAMA

4.2 Create new public CUs (resources from environmental compensation and others):
Responsible: Saturnino (MLCD), Rodrigo (MLD), Selma (MLCP), Wilson (MLP)
Time frame: 10 years
Product: CUs created
Collaborating institutions: IBAMA and other public institutions

4.3 Implement the already existing CUs:
Responsible: Saturnino (MLCD), Rodrigo (MLD), Selma (MLCP), Wilson (MLP)
Time frame: 10 yrs
Product: CUs implemented
Collaborating institutions: appropriate administrative agency and stakeholders

4.4 Survey of areas of permanent preservation (APPs) and legal reserves (RL):
Responsible: Saturnino (MLCD), Rosan and Marcio (MLD), Lucia (MLCP), Jeferson (MLP)
Time frame: 4 years
Product: APP and RL surveys completed
Collaborating institutions: NGOs, public powers, landowners, and local stakeholders

4.5 Stimulate the restoration of existing APPs and RLs:

Responsible: Saturnino (MLCD), Rosan & Ines (MLD), Lucia (MLCP), Christiana (MLP)
Time frame: continuous
Product: areas restored
Collaborating institutions: NGOs, landowners, SEMA, records office (registry office), Public Ministry

4.6 Stimulate the administration of a mosaic of CUs:
Responsible: Saturnino (MLCD), Rodrigo (MLD), Selma (MLCP), Wilson (MLP)
Time frame: continuing
Product: Mosaic of CUs created and effective
Collaborating institutions: appropriate administrative agencies, NGOs, council of UCs, DAP/MMA

4.7 Stimulate the creation and implementation of RPPNs:
Responsible: Carlos Eduardo (MLCD), Rosan (MLD), Selma (MLCP), Andreia (MLP)
Time frame: continuous
Product: RPPNs created and implemented
Collaborating institutions: NGOs, landowners, RPPN Association, state agency, IBAMA

Problems - Socio-Economic Issues

- **Lack of alternative sources of income**
- **Public policies aren't directed to sustainable development**
- **Conventional (modern) agriculture is incompatible with conservation**
- **Lack of formal technical capacity for conservation**
- **Loss of cultural characteristics of communities**
- **Economic instruments are not used to give value to environmental services**
- **Emphasis is on assistance (subsidies, money) vs sustainability in the long term**
- **There is much pressure on natural resources (hunting, animal traffic, and other forms of exploitation**

Goals:

1. Reduce the pressure on natural resources

Actions:

1.1 Stimulate and implement a project to evaluate environmental services
Responsible: Saturnino (MLCD), Rodrigo (MLD), Selma (MLCP), Wilson (MLP)
Time frame: by 2008
Product: At least one project implemented in each Landscape Unit
Collaborating institutions: NGOs, researchers, landowners, committee of watershed, boards, public

agencies

1.2 Have periodic meetings with local actors to discuss public policy
Responsible: Carlos Eduardo (MLCD), Inês (MLD), Selma (MLCP), Andréia (MLP)
Time frame: realização anual
Product: One meeting per year in each Landscape Unit
Collaborating institutions: NGOs, researchers, landowners, committee of watershed, boards, public agencies

1.3 Form a network to exchange experiences in agro-ecology within the 4 species
Responsible: Carlos Eduardo (MLCD), Inês (MLD), Beto (MLCP), Jeferson (MLP)
Time: by 2006
Product: network to exchange experience formed
Collaborating institutions: NGOs, Institutions of technical assistance, INCRA, public agencies

1.4 Stimulate the implementation of one sustainable economic practice within the landscape unit
Responsible: Carlos Eduardo (MLCD), Inês (MLD), Beto (MLCP), Jeferson (MLP)
Time: by 2006
Product: At least one economically sustainable practice implemented each year in each Landscape Unit
Collaborating institutions: NGOs, Institutions of technical assistance, INCRA, public agencies, communities, landowners

1.5 Participate in a tourism advisory board at an appropriate level
Responsible: Carlos Eduardo (MLCD), Rosan (MLD), Beto (MLCP), Andréia (MLP)
Time: by 2006
Product: At least one representative of each species group participates in a tourist Board
Collaborating institutions: NGOs, public agencies, associations

1.6 Develop and/or consolidate ecotourism iniciatives in the base community
Responsible: Carlos Eduardo (MLCD), Rosan (MLD), Beto (MLCP), Andréia (MLP)
Time: by 2006
Product: At least one initiative (road book, map, folder, diagnosis, operators) of ecotourism consolidated for each Landscape Unit
Collaborating institutions: NGOs, public agencies, associations, communities, SEBRAE, EMBRATUR

Problems - Education

- **Lack of environmental knowledge by local actors.**
- **Communities generally don’t recognize the importance of conservation**
- **Lack of sensitization to improve attitudes**
- **Lack of involvement of teachers**

Goals

1. **Increase and improve the source of local information that reaches people**
2. **Increase opportunities for capacity-building and sensitization**
3. **Incorporate Environmental Education into formal teaching**
4. **Increase exchange of experiences among the 4 species**

Actions

1.1 Diversify sources of and access to information
Responsible: Carlos (MLCD), Patrícia & Inês (MLD), Gracinha (MLCP), Gracinha (MLP)
Time: by 2006
Product: diversified sources of information are accessible
Collaborating institutions: NGOs, public agencies, researchers, communication vehicles (media)

2.1 Conduct campaigns to build awareness
Responsible: Carlos (MLCD), Patrícia e Inês (MLD), Gracinha (MLCP), Gracinha (MLP)
Time: by 2006
Product: Campaigns conducted
Collaborating institutions: NGOs, public agencies, researchers, communication vehicles (media)

3.1 Train technical staff formally in conservation
Responsible: Carlos (MLCD), Patrícia e Inês (MLD), Gracinha (MLCP), Gracinha (MLP)
Time: by 2006
Product: Technical staff trained in conservation
Collaborating institutions: NGOs, institutions of technical assistance, INCRA, public agencies

3.2 Augment means of communication (leaders, coordinators, managers)
Responsible: Carlos (MLCD), Patrícia & Inês (MLD), Gracinha (MLCP), Gracinha (MLP)
Time: by 2006
Product: Efficient communication
Collaborating institutions: NGOs, public agencies, researchers, communication vehicles, communities, leaders

4.1 Establish exchange of information among the 4 species
Responsible: Carlos (MLCD), Patrícia & Inês (MLD), Gracinha (MLCP), Gracinha (MLP)
Time: by 2006
Product: Network of communication established across the 4 species
Collaborating institutions: NGOs. Public agencies, researchers, communities

4.2 Improve the dissemination of research results to the communities
Responsible: Carlos (MLCD), Patrícia & Inês (MLD), Gracinha (MLCP), Gracinha (MLP)
Time: by 2006
Product: Research results made available
Collaborating institutions: NGOs, public agencies, researchers, media, communities

Metapopulation Management

Facilitator: James Dietz
Recorder: Cristiana Martins
Presenter: Rafael

Problem – Lack of a Metapopulation Management Planning Process

1) Goal: Define the parameters of the metapopulation (distribution and demography, genetics, health)

1.a. Demography and Geographic Distribution

Identification of the comprehensive metapopulation

Actions

Determine the total size and area of the metapopulation (Paula Procopio, Becky Raboy, Cristiana Martins)

Determine the number of populations and the limits of the populations within the metapopulation (Paula Procopio, Becky Raboy, Cristiana Martins)

Define which populations to include in the metapopulation based on:
- Genetic representation (rare alleles, local adaptation).
- Feasibility and costs
- Health of the population
- Probability of reproduction
- Public opinion

(Paula Procopio, Becky Raboy, Cristiana Martins)

Time frame: May 2006
Collaboraters: Paula Procopio, Becky Raboy, Cristiana Martins.
Product: PHVA action Plan, refined data to use in VORTEX and GIS, Report given at the 2006 ICCM meetings

1.b. Genetics

Characterize the genetic structure of the metapopulation (using microsatellite and mitochondrial

DNA as well as looking at new techniques and pedigree data).

Actions

Assemble the information on samples that already exist
(Dietz, Adriana, Cristiana, Fabiana, Rogério, Studbook keepers)
Time frame: December 2005
Product: List of the sampled populations

Assemble the current information available for pedigree
(Jennifer M., Studbook keepers)

Time frame: By the end of the PHVA
Products: List of the data that exists for creating pedigree

Define the populations that are of high priority to collect genetic material
(Adriana, Cristiana, Fabiana, Rogério, Fernando, Studbook keepers)
Time frame: December 2005
Product: List/map of the priority areas

Conduct genetic analysis
(Adriana, Cristiana, Fabiana, Rogério, Studbook keepers)
Time frame: 3 years
Product: A data bank containing the genetic characterization of the metapopulation

Use the obtained results to run and refine the VORTEX model
(Dietz, Adriana, Cristiana, Fabiana, Rogério, Fernando, Studbook keepers)
Time frame: 4 years
Product: Report with an action plan

1.c) Population Health

Evaluate the health of the populations and its interference with the viability of the metapopulation through long-term monitoring.

Actions

Characterize the principle infectious agents that have real or potential risk to the metapopulation
(Paula, Rafael, Pissinatti)
Time frame: August 2005
Product: List of the relevant infectious agents

Implement alternative diagnostic techniques that are more specific, sensitive, and less expensive
(Paula, Rafael, Pissinatti);
Time frame: Implemented in 4 years, then continued
Product: Effective utilization of the new techniques

Make a registry of the institutions and the researchers that can serve as a reference to conduct these diagnostic exams
(Paula, Rafael, Pissinatti, Monica)
Time frame: Implemented in 2 years, continuous
Products: List of the institutions/researchers formally committed to the intergration in the process

To support the commitment of the different stakeholders involved in conservation projects to the extent that they relate to medical sanitary processes
(Paula, Rafael, Pissinatti)
Time frame: Immediatly and continuous
Product: An increase in the information about health (as compared to the data from 1997-2005)

Initiate inter-institutional exchange
(Paula, Rafael, Pissinatti, Monica)
Time frame: Continuous
Product: An increase in the number of organizations involved

Collaborate in management actions by providing information on health
(Paula, Rafael, Pissinatti)
Time frame: Continuous
Products: Effectively incorporating health data in actions plans
Collaboradors: Universities, Research Institutes, NGOs, Ministério da Agricultura, Ministério da Saúde

2) Goal: Define strategies/techniques for metapopulation management

2.a. Facilitating Movement
Use and refine techniques for moving animals between populations within the metapopulation

Actions

Define which populations need to be connected and investigate connecting populations with forest corridors and/or "stepping stones"
(Cristiana Martins, Jennifer Mickelberg, Becky Raboy, Adriana).
Time frame: December 2005 for those areas that have already been genetically characterized, continuous
Product: GIS map with the corridors

Determine and implement animal movements necessary based on the model VORTEX and other analysis
(Jon Ballou, Kristin, Cristiana Martins, Alexandre Amaral)
Time frame: 2006
Product: recommendation for movement and action plan

Initiate and expand projects in order to refine and investigate new techniques for reintroduction and translocation
(Ben Beck, Cristiana Martins, Andreia Martins, Paula Procopio).
Time frame: 2006
Product: Proposal to test new techniques submitted to ICCM

Coordinate the permitting process for movement of animals out of CPB
(Monica, Juliana).
Time frame: December 2005
Product: Reduction in the time to receive permits (two months)

2.b.Collection of Data

Actions

Collaborate on the structure of a database integrated with GIS for the four species of lion tamarin
(Rafael Monteiro, Adriano Paglia, Fernando Passos, Carlos Ruiz, Marcio Schmidt).
Time frame: December 2005
Product: A database structure submitted for review

Compile, systematize, and provide biological information for each of the four species
(Adriano Paglia, Fernando Passos, Marcio Schmidt, Cristiana Martins, Rafael Monteiro, Carlos Ruiz)
(For Example: Number of groups, total abundance, density, distribution, dispersal age and probability, pedigrees home range, habitat use, causes of loss, age specific mortalities, reproductive period, age at first reproduction, reproductive parameters, parental experience, habitat quality (diet, tree holes, predation), behavior, data collection on supplemented groups)
Time frame: 2007
Product: data bank implemented and operational

Analyze data bank to identify areas where information is lacking and initiate research projects that fill in these areas
(Fernando Passos, Cristiana Martins, Becky Raboy, Jennifer Mickelberg, Carlos Ruiz).
Time frame: 2007
Product: Priority list of research needed and proposals submitted to the ICCM

Define criteria to evaluate the results of reintroduction, translocation, and other techniques of metapopulation management
(Jennifer Mickelberg, Carlos Ruiz).
Time frame: January 2006
Product: Draft of criterion submitted for review by ICCM

3)Goal: Obtaining human and financial resources

Convince the managers of the LTBF to give priority to metapopulation actions including all four species over the next five years
(Bengt Holst, Devra Kleiman, Jon Ballou).
Time frame: By the end of the 2005 ICCM meetings
Product: An agreement.

Examine the possibilty of developing collaborative proposals to raise money from NGOs and governmental agencies
(Species coordinators)
Time frame: Have a conversation between the four species coordinators during the 2005 ICCM meetings.
Product: At least one collaborative proposal

Identify possible funders both nationally and internationally and develop a strategy to fundraise for all four species.
(Lou Ann Dietz).
Time frame: Continuous
Product: List of funders

Identify and train additional professionals to help implement the metapopulation plan for all four species.
(All the teams).
Time frame: Continuous
Product: number of professionals identified and trained

Develop outlines for courses on: Reintroduction and Translocation techniques, Conservation Medicine, Conservation Genetics
(Ben, Rafael, Adriana)
Time frame: December 2005 to develop course outline
Product: Proposal of the program outline submitted for review

Interinstitutional Cooperation and Communication

Participants: Leandro, Kristel, Denise, Sinara, Karla, Lou Ann, Guadalupe, David, Marcelo, Antônio, Marcio, Joao

Facilitator: Karla Paranhos
Reporter: Kristel De Vleeschouwer, Lou Ann Dietz
Presenter: Leandro Jerusalinsky

Problem 1: Slowness of the research permit process

- **Review by the Committee**
- **Lack of guidance about the process for obtaining permits**
- **Inefficient flow of steps in the process to issue permits**
- **Lack of involvement of the official reviewers in the process of conservation of the lion tamarins**
- **Guidance for researchers**
- **Lack of institutional memory regarding procedures**
- **Lack of well-defined criteria for the review of applications**
- **Feedback from the researchers to the agencies issuing permits**
- **The lack of definition of rules and procedures between IBAMA & CGEN delays obtaining permits for genetic studies**

Goal 1.1. Integration between reviewers and researchers

Actions (in priority order)

Develop and make widely available terms of reference for guiding the procedures for issuing research permits.
Resp: IBAMA (David), IF (Márcio Port), Sinara (AMLD), IPÊ (Karla), IESB (Kristel)
Product: Terms of reference finalized and dissiminated
Time frame: 1 ano
Resources: for a meeting

Conduct meetings between representatives of the Committee (ICCM) with the Directors of: DIREC/ Ibama, DIFAP/Ibama e COTEC-IF/SP
Resp: Committee (Onildo)
Produto: reuniões realizadas
Colaborator: Márcio Port (IF/SP)
Time frame: immediately

Promote visits of the analysts to the sites where the research is being carried out and of the researchers to IBAMA (Headquarters and decentralized units)
Resp: Committee/IBAMA (Onildo), AMLD (Denise), IPÊ (Karla), IESB (Kristel)

Product: number of visits in both directions
Time frame: immediately and continuously

Stimulate and facilitate the participation of the analysts (who review the proposals for lion tamarins) in events related to conservation of the species.
Product: Number of events with participation by the analysts
Resp: Committee/IBAMA (Onildo), AMLD (Denise), IPÊ (Karla), IESB (Kristel)
Time frame: immediately and continuously

Goal 1.2. Strategies to facilitate obtaining permits for genetic studies

Actions (in priority order):

Stimulate a concensus between IBAMA & CGEN clarifying the flowchart for legal requirements for genetic research with lion tamarins.
Product: Consensus between CGEN & IBAMA on the flowchart for legal requirements
Resp: A Commission of Committee Members (Carlos Ruiz)
Collaborator: IBAMA/Committee (Onildo)
Time frame: immediately

Propose a genome bank for lion tamarins
Product: Guidelines for establishment and management of the genome bank
Resp: CPB (Leandro), Adriana Grativol, Jim Dietz, Cristiane Saddy
Time frame: 1 year (to present at the 2006 Committee meeting)

Problem 2: Insufficient coordinated inter- and intra-institutional actions

Lack of communication among the parties involved

Lack of coordinated actions

Lack of coordination among policies of different sectors

Sectoral policies give little importance to environmental issues

Lack of communication and cooperation among NGOs

Other institutions are not involved in conservation of lion tamarins

Lack of incentives for interinstitutional partnerships

Lack of continuous and effective communication mechanisms

Lack of definition of roles, interests and priorities resulting in interinstitutional conflicts and loss of potentiality for conservation

Lack of involvement of foreign zoos

Goal 2.1 Influence regional public policies to support the programs for conservation of lion tamarins

Action:

Identify and participate strategically in forums for regional planning integrating conservation of lion tamarins in their agendas
Product: Number of forums for regional planning with agendas including conservation of lion tamarins
Resp: regional IBAMA (João/SP, Guadalupe/PR, Rodrigo Bacelar/RJ, Saturnino/BA), IF/SP (Márcio Port, Andréia), AMLD (Denise), IPÊ (Karla), IESB (Kristel)
Time frame: begin immediately and continually

Goal 2.2. Effective and continuous communication among the diverse institutions involved in the conservation of lion tamarins

Actions (in priority order):

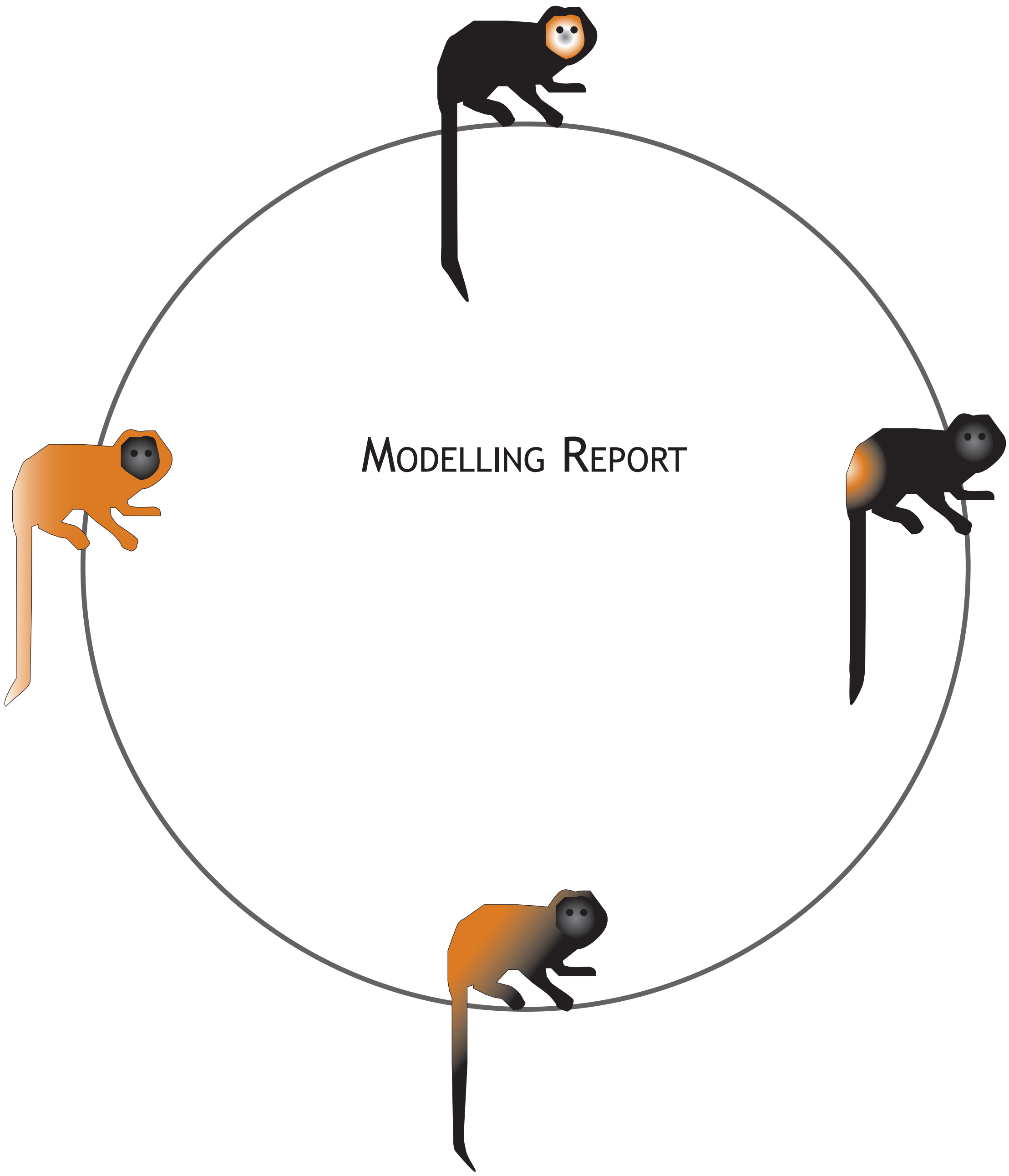
Promote meetings among stakeholders for each species to resolve conflicts, define roles and interests and common objectives with the goal of reinforcing actions
Resp: caissara – Guadalupe, chrysopygus – Gracinha, chrysomelas – Kristel, rosalia – Sinara, Márcio Port (IF/SP)
Product: Meetings held
Time frame: immediately and continuing

Develop a communication plan for the lion tamarin agenda
Product: the completed plan agreed by developers and collaborators
Resp: IESB (Kristel), AMLD (Denise/Sinara), IPÊ (Karla)
Collaborators: Governmental organizations
Time frame: present at the 2006 Committee meeting
Resources: to be identified with potential sources

Formalize partnerships to stimulate actions for conservation of lion tamarins
Product: Number of formalized partnerships
Resp: regional IBAMA (João/SP, Guadalupe/PR, Rodrigo Bacelar/RJ, Saturnino/BA), IF/SP (Márcio Port, Andréia), IBAMA Headquarters (Onildo), AMLD (Denise), IPÊ (Karla), IESB (Kristel)
Time frame: immediately and continually

Develop programs to involve foreign zoos in** in situ **by means of visits to the areas where lion tamarins occur
Product: a program for technical visits to all the areas where the lion tamarin species occur
Resp: Jennifer Mickelberg, Devra Kleiman, Bengt Holst, AMLD(Rosan), IESB (Kristel), IPÊ (Karla)
Time frame: 2 years (meeting of the Committee 2007)

MODELLING REPORT



Population Modelling Working Group

Working Group Participants

1. Kathy Traylor-Holzer (Conservation Breeding Specialist Group, SSC / IUCN)
2. Kristin Leus (Royal Zoological Society of Antwerp, CBSG Europe)
3. Jonathan D. Ballou (National Zoological Park, Smithsonian Institution)
4. Becky Raboy (National Zoological Park, Smithsonian Institution)

Introduction

The purpose of this chapter is to present the results of the simulation modelling that was conducted during the PHVA workshop to assist in evaluating the relative threats facing these populations, as well as to explore the potential effects of various management actions.

During the workshop, modellers worked closely with the each of the species working groups to understand the issues facing the species and determine what scenarios should be modelled to answer the kinds of questions of relevance to those working groups. KTH worked with the black lion tamarin (BLT) and black-faced lion tamarin (BFLT) working groups; KL worked with the golden-headed lion tamarin (GHLT) working group, and JDB worked with the golden lion tamarin (GLT) working group.

Model parameters used for this Lion Tamarin PHVA were derived primarily from extensive work by J. Dietz and A. Baker in the Poço das Antas Biological Reserve studying golden lion tamarins (Baker and Dietz 1996; Baker *et al*. 1993; Baker *et al*. 2002; Dietz and Baker 1993; Dietz and Baker, unpublished data; Dietz *et al*. 1997). This work, which began in 1984 and is still ongoing, provides a 21-year database that has been entered into the SPARKS studbook software (ISIS, 2005) in a standardized format. From these databases, vital rates were calculated for reproductive and survival parameters, inbreeding effects, environmental variances, density-dependent predation effects and mating systems. Additional data for golden-headed lion tamarins were taken from studies by Raboy and Dietz (Raboy 2002; Raboy and Dietz 2004; Raboy and Dietz, unpublished data) and Kristel de Vleeschouwer (unpublished data) working in the Una Biological Reserve in Bahia from 1991 to the present. Density estimates for each of the four species were species specific unless otherwise noted, compiled from data available from each of the lion tamarin research sites and/or census studies.

Vortex Simulation Model

Computer modelling is a valuable and versatile tool for quantitatively assessing risk of decline and extinction of wildlife populations. Complex and interacting factors that influence population persistence and health can be explored, including natural and anthropogenic causes. Models can also be used to evaluate the effects of alternative management strategies to identify the most effective conservation actions for a population or species and to identify research needs. Such an evaluation of population persistence under current and varying conditions is commonly referred to as a population viability analysis (PVA).

The simulation software program *Vortex* (v9.56) was used to examine the viability of populations of four lion tamarin species in Brazil. *Vortex* is a Monte Carlo simulation of the effects of deterministic forces as well as demographic, environmental, and genetic stochastic events on wild populations. *Vortex* models population dynamics as discrete sequential events that occur according to defined probabilities. The program begins by creating individuals to form the starting population and stepping through life cycle events (e.g., births, deaths, dispersal, catastrophic events), typically on an annual basis. Events such as breeding success, litter size, sex at birth, and survival are determined based upon designated probabilities. Consequently, each run (iteration) of the model gives a different result. By running the model hundreds of times, it is possible to examine the probable outcome and range of possibilities. For a more detailed explanation of *Vortex* and its use in population viability analysis, see Lacy (1993, 2000) and Miller and Lacy (2005).

Vortex Baseline Model Parameters

A baseline "lion tamarin" *Vortex* model was developed for use during the workshop primarily from data from the GLT studies from Baker and Dietz (Baker and Dietz 1996; Baker *et al*. 1993; Baker *et*

al. 2002; Dietz and Baker 1993; Dietz and Baker, unpublished data; Dietz *et al*. 1997). These data provided annual estimates of many of the parameters needed in *Vortex*. Environmental variation was calculated by removing average demographic (binomial) variation from the total variation observed over the 21 years of the dataset.

Number of iterations: *500*
500 independent iterations were run for each scenario.

Number of years: *100*
As generation length for lion tamarins (see deterministic model results) is about 6 years, the model simulations ran over about 17 generations.

Extinction definition: *Only one sex remains*
Extinction is defined in the model as no animals of one or both sexes.

Number of populations:
This parameter was species-specific and is presented in the species sections in this chapter.

Initial population size (N):
Species-specific. Generally based on area of habitat being modelled divided by average density estimates observed for that species in that habitat.

Carrying capacity (K):
Species-specific. Generally based on area of habitat being modelled divided by average density estimates observed for that species in that habitat. Unless otherwise noted, initial population sizes were set at carrying capacity.

Dispersal among populations:
Species-specific.

Inbreeding depression: Yes
Lethal equivalents for golden lion tamarins were estimated during the 1997 PHVA (Ballou et al. 1997) as 4.07, 50% of which were lethal alleles and subject to purging. These values were used during this workshop as well.

Concordance between environmental variation in reproduction and survival: Yes
A positive correlation was observed in the 1997 PHVA.

Mating system: Long-term monogamy
While lion tamarins are not strictly monogamous (there may be one or two adult males in a family group, only one of which probably breeds; Baker et al. 1993), long-term monogamy probably represents their mating system better than any other model option, as these family groups remain together over several breeding seasons until one of the breeding adults is removed from the group (through aggression or death), replaced as a breeder within a group, or disperses.

Age of first offspring: 4 years (females); 4 years (males)
While tamarins can begin breeding younger than 4 years, it is at this age when the rates of reproduction begin to match those of fully breeding adults. In Vortex, only integers can be entered in this field.

Maximum age of reproduction: 16 years
Vortex assumes that animals can reproduce throughout their adult life and does not model reproductive senescence. Individuals are removed from the model after they pass the maximum age of reproduction. This is probably quite realistic for lion tamarins. The life-table analysis from SPARKS indicates that few animals survive beyond 16 years.

Maximum number of progeny per year: 5
While average litter size for lion tamarins is 2.1, they can give birth to up to two litters per year. Observed maximum number of offspring produced per year is 5. Below is the distribution of number

of offspring produced by females in one year used for GLTs, BLTs and BFLTs. Species-specific data were used for GHLTs (see GHLT Model Report section).

Annual # of offspring	Frequency
1	21%
2	58%
3	8%
4	12%
5	1%

Percent males at birth: 50%
No indication that sex ratio at birth is uneven.

Density-dependent reproduction: No
Reproduction was assumed to be density-independent in the model.

Percent adult females breeding: 73%
This is the average over the 21-year dataset. Environmental variation calculated as 9.4%

Percentage of adult males in the breeding pool: 100%
All adult males were considered to be potential breeders in this mating system – when a mating vacancy appears, a male from another group will fill it.

Mortality rates: see discussion below
Estimates of mortality rates are complicated by two factors: the question of what happens to dispersing animals, and how to include drastically different predation events observed in the population in recent years. These will be discussed in turn.

A. Incorporation of dispersal events into mortality rates:
Field studies documented both mortality events and dispersal events by sex and age. Mortality events included both direct observations of deaths (rare) as well as disappearances of animals not of dispersal age (older adults, young offspring). Dispersal events were animals of dispersal age (2 – 4 years) that left or disappeared from their natal groups. It was not always possible to observe the fate of dispersing animals (i.e. to document which breeding group the disperser joined) (Baker and Dietz 1996; Baker and Dietz, unpublished data; Baker et al. 2002). In limited cases, 'disappearances' could have actually represented a death rather than a dispersal event.

It is likely that some of the dispersals resulted in mortalities during the dispersal process, since vacancies in groups are rare, particularly in times of high density. Furthermore, data indicate that females are less likely to make it into groups than males. Thus, age- and sex-specific mortality rates are likely to be density dependent.

The following function was used for mortality rates:

When population size (N) < 50% of carrying capacity (K), mortality included 100% of the mortality events plus %50 of the dispersal events. This applied to both sexes.

For females:
When N >= 50% of capacity (K), mortality was modelled as a linear function starting at the above mortality (100% of mortality events + 50% dispersal events) and increased linearly to N = K with mortality included 100% of the mortality events plus 100% of the dispersal events.

For males:
When N >= 50% of capacity (K), mortality was modelled as a linear function starting at the above mortality (100% of mortality events + 50% dispersal events) and increased linearly to N = K with mortality included 100% of the mortality events plus 75% of the dispersal events.

Thus, mortality rates were constant below N = 50% K, but increased linearly to include 100%

dispersals for females and 75% dispersals for males at carrying capacity.

The above density-dependent functions were not applied to the first age class since their mortality rates are significantly different than other age classes.

Define:
Let M_0 = mortality rate in low density (N < 0.5K) = 100% mortality events + 50% dispersal events.
Example: M_0 = 0.130 (used in figure below)

Let $M_{f,D}$ = for females: mortality events including 100% of the dispersal events.
Example: $M_{f,D}$ = 0.191 (used in figure below for females)

Let $M_{m,D}$ = for males: mortality events including 75% of the dispersal events.
Example: $M_{m,D}$ = 0.174 (used in the figure below for males)

The functions used in Vortex are:

For females:
Mortality = Mf,0+((N>(K/2))*((Mf,D-Mf,0)/((K/2)+1))*(N-((K/2)+1)))

For males:
Mortality = Mm,0+((N>(K/2))*(.75*(Mm,D-Mm,0)/((K/2)+1))*(N-((K/2)+1)))

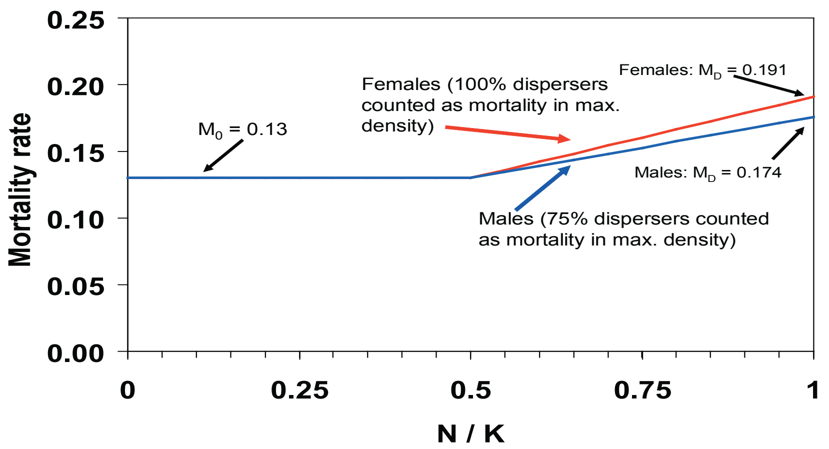


Figure 1. Example of the density- and sex-dependent mortality function used in modelling.

<u>B. Incorporation of predation events</u>
Predation has always been a source of mortality of lion tamarins. However, beginning in 1997, GLTs in Poço das Antas Reserve began to experience a series of significant predation events that lasted off and on for a number of years and which reduced the population size from about 320 to 200. These predators (possibly tayras) killed multiple individuals per predation event. Predation took place at or near tamarin nest holes (Dietz and Baker, in prep; Franklin *et al.* in press). In 2004-2005, such large-scale predation events have not been observed.

Discussions at the workshop suggested that the impact and character of predation events is probably different in different sized populations. In large populations predators probably are a stable part of the ecosystem and contribute to the background noise of average mortality rates. However, smaller populations are unlikely to be large enough to sustain a stable predator population. In these populations, predators may temporarily move in, increase the average mortality rate over a period of time, and then move out. This is hypothesized to explain what occurred in Poço das Antas with GLTs in the late 1990s and early 2000s: a relatively brief episode of intense predation. In very small populations such predation events are much more likely to cause the extinction of the entire

population. For example, if a population consisted of only one or two groups, these groups could be completely eliminated as a result of predation in a matter of days, causing the population to go extinct.

Thus, the impact of the predation events may be a function of population size. Predation rates were therefore incorporated into the model in different ways for different sized populations:

Large populations (area > 10,000ha): Mortality rates should exclude the high peaks in mortality rates observed in the Poço das Antas population in recent years. Mortality rates used were those from the 1997 PHVA, which pre-dates these predator events.

Medium populations (1,000ha < area < 10,000ha): This is the size of the Poço das Antas area. Mortality rates were calculated from data spanning the entire history of the project: 1984 – 2005, which include the periods of intense predation.

Small populations (area < 1,000ha): Predation should be treated as a significant catastrophe rather than part of normal mortality. High-peak predation mortality rates were about double those during pre-predation events. Thus, mortality in small populations was based on pre-predation mortality records (using those from the 1997 PHVA, which pre-dates these predator events), and a catastrophe (predation) was added with a frequency of 10% and a severity of 50% for survival.

The following tables give the sex- and age-specific M_0 and M_D values used in these formulas for different sized populations. All standard deviations for environmental variation were calculated from the full dataset and because of time constraints were treated as the same for all populations.

Table 1. Mortality parameters for medium-sized populations.

Sex	**Age (yrs)**	**M_0**	**M_D**	**SD due to environmental variation**
Females (f)	0	0.326	----	0.141
	1	0.130	0.191	0.078
	2	0.115	0.188	0*
	3	0.190	0.284	0.207
	Adult	0.104	0.128	0.077
Males (m)	0	0.319	----	0.140
	1	0.122	0.158	0*
	2	0.151	0.181	0.030
	3	0.154	0.183	0.095
	Adult	0.140	0.179	0.209

* All variation observed in this rate could be accounted for by demographic variance, which is automatically incorporated into the model.

Table 2. Mortality parameters for small and large populations (based on pre-1997 mortality rates).

Sex	**Age (yrs)**	**M_0**	**M_D**	**SD due to environmental variation**
Females (f)	0	0.328	----	0.087
	1	0.120	0.196	0.133
	2	0.128	0.245	0.076
	3	0.153	0.210	0*
	Adult	0.083	0.126	0.067
Males (m)	0	0.298	----	0.070
	1	0.126	0.159	0.099
	2	0.151	0.195	0*
	3	0.134	0.153	0.075
	Adult	0.089	0.125	0.082

* All variation observed in this rate could be accounted for by demographic variance, which is automatically incorporated into the model.

Number of catastrophes:
As mentioned above, predation was treated as a catastrophe in small populations, with a frequency of 10% and a 50% reduction in survival; no effect on reproduction. Other catastrophes were added in species-specific cases.

Harvest: **Not included.**

Supplementation: **Not included.**

Baseline Model Results

Deterministic Output
The demographic rates (reproduction, mortality and catastrophes) included in the baseline model can be used to calculate deterministic characteristics of the model population. These values reflect the biology of the population in the absence of stochastic fluctuations (both demographic and environmental variation), inbreeding depression, limitation of mates, and immigration/emigration. It is valuable to examine deterministic growth rates (lambda, generation lengths, and age structure) to assess whether they appear realistic for the species and population being modelled.

Table 3. Deterministic results for lion tamarin baseline model.

Parameter	Medium-sized populations	Large and small populations
Lambda	1.109	1.127
Generation length (yrs)	7.5	7.9
% living to 10 years of age	< 10%	< 10%

The values in Table 3 indicate populations with the potential to grow about 11-13% per year, and with generation lengths and age structures that are representative of what is known about lion tamarin biology. The parameters in the model are producing reasonable results.

NOTE: Species-specific rates of catastrophes and any changes in other parameters will change these results. This baseline model was subsequently modified by each population modeller and working group with respect to population size, catastrophes and other parameters as noted to develop species-specific lion tamarin models. This enabled the projections of the future viability of these populations and the ability to explore the impacts of various management strategies.

Golden Lion Tamarin Population Model

Introduction

The modelling for the golden lion tamarins (GLTs), *Leontopithecus rosalia*, focused on the maintenance of a viable metapopulation for the species. During the 1997 PHVA (Ballou *et al*. 1997), the management goal set for this species was to establish and manage a series of populations (a metapopulation) that collectively retained 98% of its genetic variation and had a 98% chance of surviving for 100 years given the threats that were known to exist at that time. These goals were retained for this workshop.

The current GLT metapopulation consists of 18 separate populations, which are for the most part genetically isolated from each other. These populations range in size and area from one family group in less than 145ha, to as large as 385 animals in an area of 6,835ha (Poço das Antas and surrounding areas). Sizes and estimated numbers of tamarins in each are shown in Table 4. The map of these 18 fragments is shown in Figure 2.

Table 4. Population size and area estimates for 18 GLT populations.

Population	Est. # GLTs	Area (ha)	Population Size*
V	8	147	S
RV	200	1740	M
BE	17	252	S
I	200	4517	M
A	80	498	S
B	200	1453	M
SJ	0?	579	S
SQ	50	582	S
MA	40	859	S
EME	15	926	S
SAQ	8	158	S
CAB	0?	225	S
SOB	0?	209	S
PDA	385	6835	M
CAM	0?	1776	M
U	200	3798	M
BEN	9	173	S
SER	75	9028	M

* Small, Medium or Large population as defined in the baseline model.

The fundamental questions posed to the modellers by the GLT working group were:

1) Does achieving a population of 2,500 tamarins in a metapopulation (a goal defined during the 1990 PHVA) achieve the goal of 98% gene retention and 98% survival for 100 years?

2) What is the likely viability of each of the existing populations as isolated populations within a metapopulation?

3) For non-viable populations that are considered valuable, what does it take to sustain them using translocations from larger viable populations?

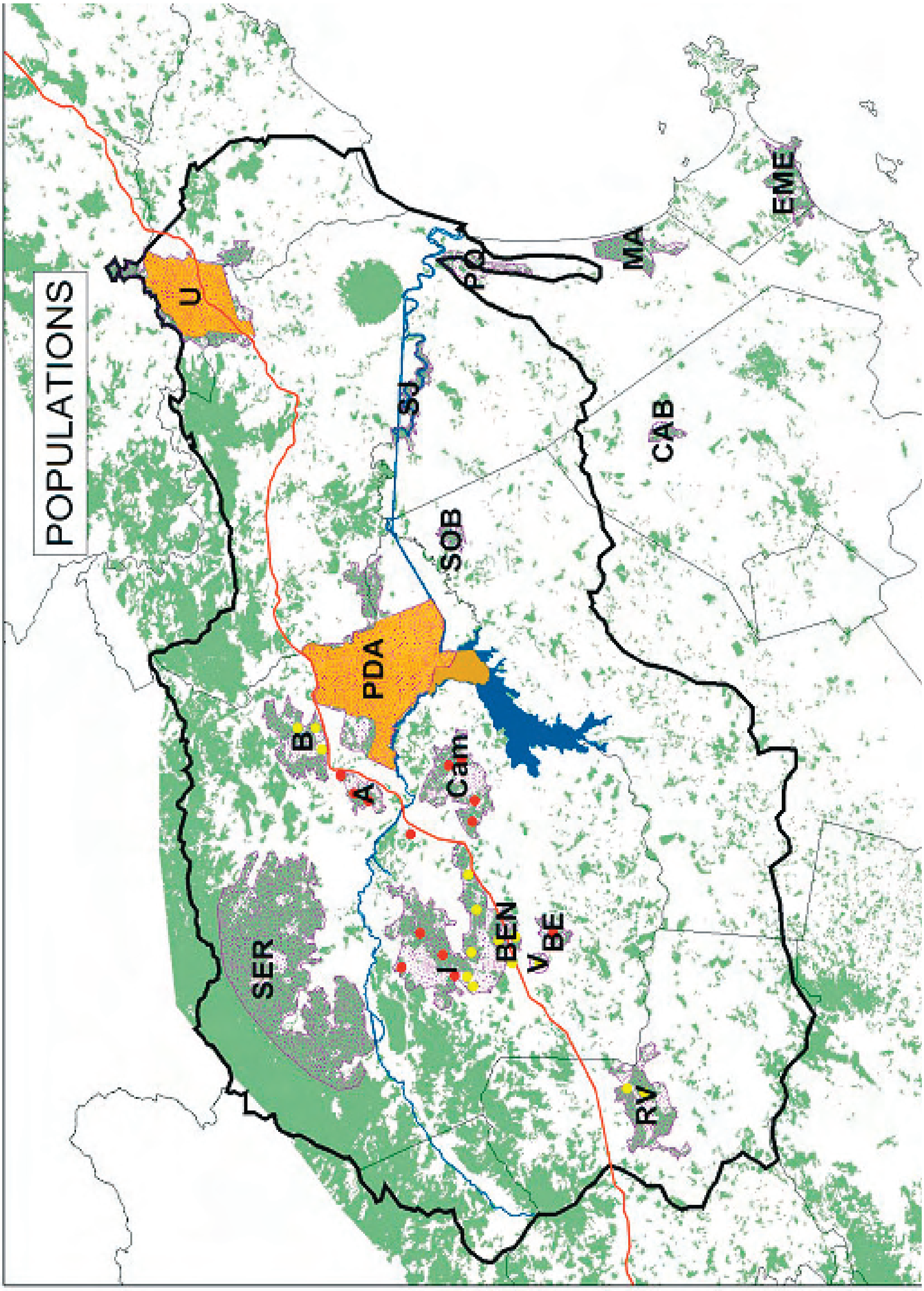


Figure 2. Map showing the 18 populations of golden lion tamarins

GLT *Vortex* Model Parameters
The GLT *Vortex* model used the baseline parameters in all cases with the addition of three catastrophes (described below). Table 4 shows which populations were identified as Small or Medium (there were no Large populations) for purposes of assigning baseline parameters. Additional species-specific parameters are also defined below.

<u>*Number of catastrophes:*</u>
The GLT model includes predation for small populations as described in the baseline model, as well as two other catastrophes:

Fire: Fires reduce habitat and threaten animals if they are trapped in small areas. Fires are not uncommon in the dry grassy areas around and in some of the habitats, and often are associated with lightning and sparks from trains. The IBAMA GIS Database on Fire Events from 1998 to 2004 (7 years) was used to identify the location of fires within the GLT range. The number of years where fires occurred in, or bordering, GLT populated habitats were counted and divided by 7 to give a frequency of occurrence. Five areas experienced fires during those years. The populations and probability of fire occurring based on this 7-year sample is given in the table below. These annual probabilities were entered as the frequency of occurrence for the fire catastrophe; severity was recorded as a 0.5% reduction in survival (survival multiplier 0.995).

Population	# of years out of 7 with fires detected in or bordering habitat	Annual probability of a fire occurring
SOB	3	0.43
SJ	2	0.28
RV	1	0.14
PDA	5	0.71
U	2	0.28

Train accidents: Train tracks cut through two of the reserves (Poço das Antas – PDA and Fazenda União – U). Within the ADA (management region that includes the GLT habitats), there have been 4 recorded train accidents over the last 21 years. This is a 19% chance (4/21) per year. GIS was used to determine what proportion of the track travelled through GLT habitat: of the total length of track in the ADA, 15% occurs in PDA, 10% in U, and 10% in CAM. Thus:

(15% x 19%) = 2.8% chance per year of accident in PDA
(10% x 19%) = 1.9% chance per year of accident in U; and
(10% x 19%) = 1.9% chance per year of accident in CAM.

The accident that is most likely to cause a catastrophe would be a localized explosion and toxic material spill. In these cases, only areas directly adjacent to the tracks would be affected. Most of the length of the tracks in Poço das Antas are in open grassy areas, not adjacent to habitat where tamarins are like to establish territories. The severity for PDA was chosen to be a multiplier of 0.99. In União (U), the severity was 0.96 because the tracks are surrounded by a larger area of occupied habitat. CAM currently does not have any resident GLTs.

Current estimates of population size were used as carrying capacities for all populations.

Scenario 1: Viability of *N* = 2500 Population (Name: “2025 Viable”)

What is the probability of survival, and gene retention, in a population of N = 2500 for 100 years?

The 1990 PHVA (Seal *et al*. 1990) set a goal to establish a population size of 2,500 tamarins by the year 2025. Although this goal was subsequently revisited during the 1997 PHVA, it still is being used in some situations. This scenario was modelled to determine if this earlier goal is compatible with the 1997 goal of establishing a metapopulation with 98% retention of genetic diversity and 98% chance of surviving for 100 years.

Vortex Parameters
The baseline parameters were used with the above modifications. A single population was modelled with N and K (carrying capacity) set at 2500. Parameters for a Large Population were used.

Results
The probability of survival for 100 years was 100%, and 99.9% of the genetic diversity was retained.

Summary
This confirmed that the two goals were compatible for a single population, or a metapopulation with enough movement of animals among populations to resemble a single population.

Scenario 2: Viability of Isolated Populations (Name: "Now - No Migration")

What is the viability of each of the 18 isolated populations?
Without metapopulation management (translocations, reintroductions), how viable are the current populations in the current habitats?

Vortex Parameters
Baseline parameters were used according to the size of each population. N = K was set at the population size estimates in Table 4.

Results
The probability of each of the populations surviving for 100 years is shown in Figure 3. The five largest populations (PDA, U, RV, I and B) all have almost 100% chance of surviving. The SERRA population has over 96% persistence. All of the remaining populations, with sizes N < 100, have less than 50% chance of surviving for 100 years.

Summary
Only 6 of the 18 populations are viable as isolated populations.

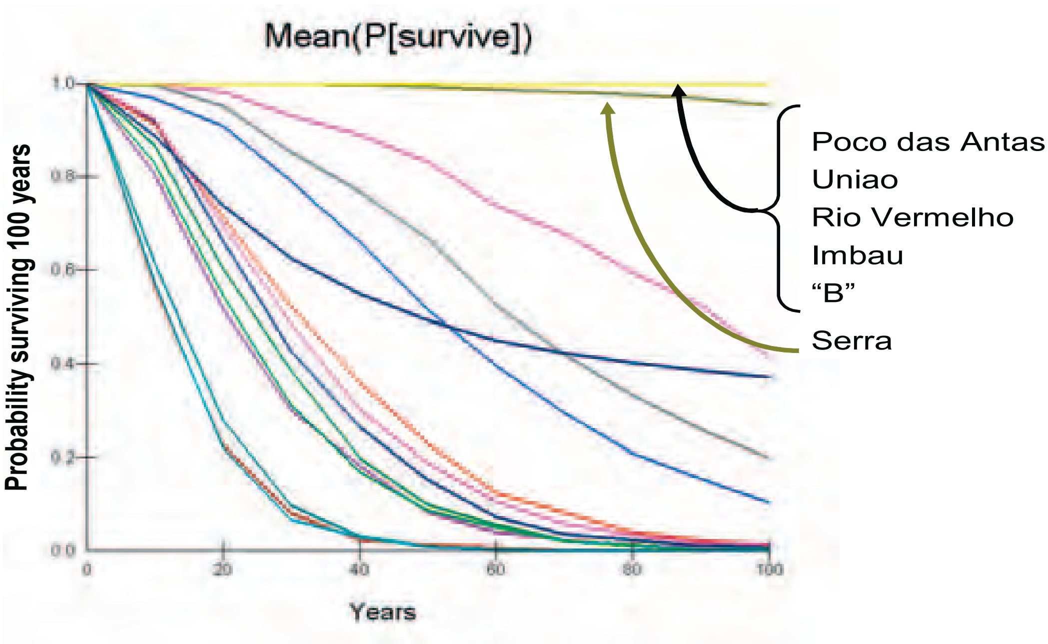


Figure 3. Probability of persistence over 100 years for each of 18 isolated GLT populations.

Scenario 3: Costs of Maintaining Non-Viable Populations

Do the viable populations have enough reproductive capacity to supply animals for translocations to non-viable populations?

Only 6 of the 18 populations can be considered viable for the longer-term. This raises the question of the value of the additional populations. Populations under dire threat could be translocated to other available habitats or populations, as was done to form the translocation population in Fazenda União Biological Reserve. However, there may be many reasons to keep non-viable populations in existence where they are: politics, ecotourism, protection of unique habitats, GLTs serving as an umbrella species for other biodiversity, and corridor building.

Figure 4 zooms in on the area of five of the six viable populations from Figure 2. Five of the smaller, non-viable, populations or habitats (V, BE, BEN, CAM and A) are spaced among 4 of the viable populations. Retaining these small populations and expanding them to connect to the larger populations would potentially provide a corridor joining the larger populations. This area would then become central core habitat for GLTs. However, these corridor populations should be maintained, both to protect them and to make them attractive to other migrating tamarins.

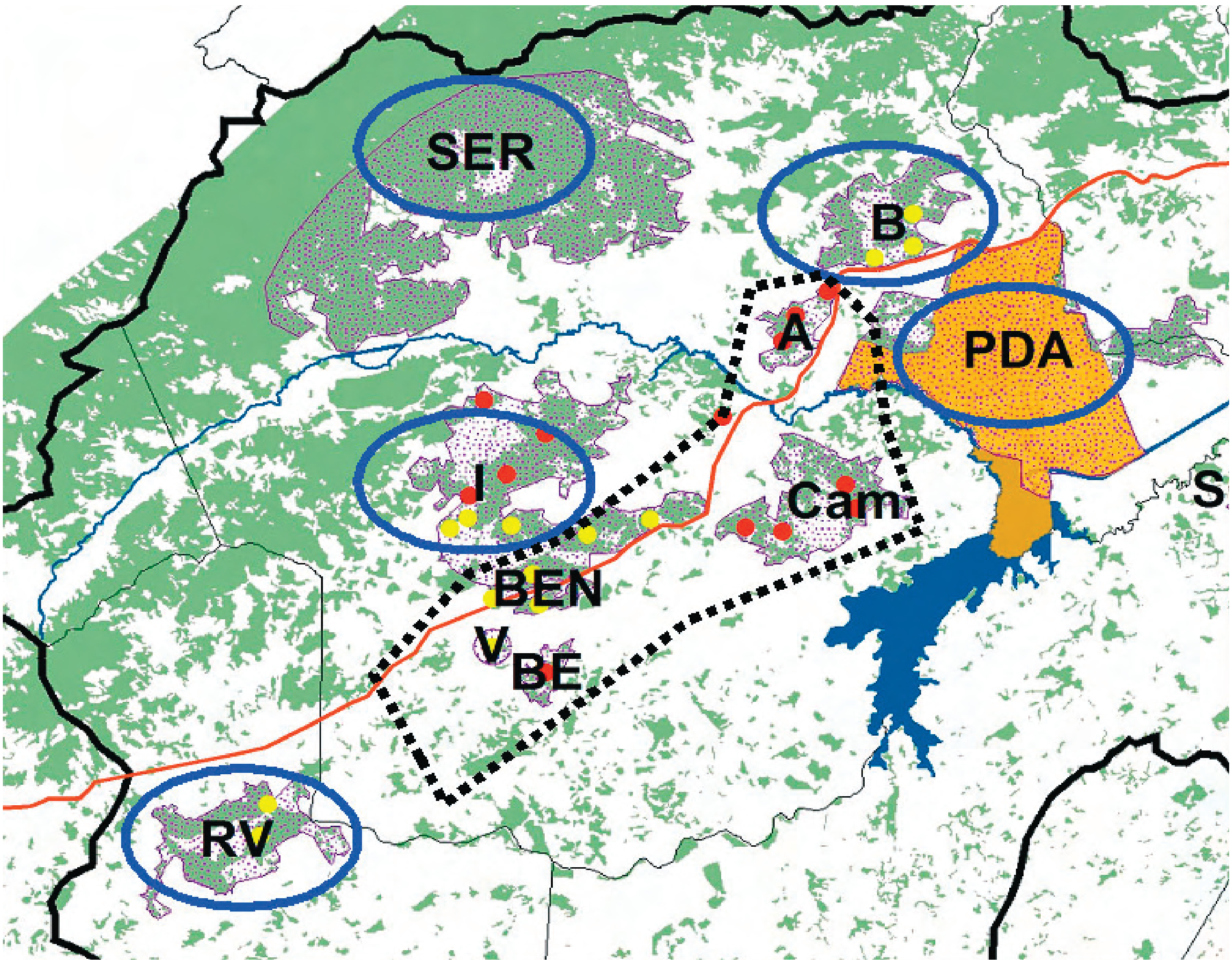


Figure 4. Map depicting core area for golden lion tamarins proposed in Scenario 3, consisting of 5 viable and 5 smaller populations.

Do the larger populations have the surplus needed to keep these smaller corridor populations viable until a functional corridor can be developed?

This question was examined by setting up a metapopulation in *Vortex* consisting of the five larger populations in the area (RV, SER, I, B and PDA) as well as the five smaller populations (V, BE, BEN, CAM, A) in that area. Migration (managed translocation) was allowed only from the large to the small populations. However, migration would not be needed unless: 1) a small population had gone extinct; or 2) a small population had become inbred enough to warrant "new blood" (average inbreeding coefficient >= 0.10 = average relationship in population half brother/sister). Furthermore, animals would not be removed from a large population if, for whatever reason, the population has become too small ($N < 0.5K$).

Vortex Parameters

Initial population sizes: *N* from table above

Carrying capacity: $K = N$ from table above for those with $N > 0$. For CAM, *K* was estimated to be the area (225ha) multiplied by the density of GLTs in PDA (0.14 GLTs/ha) = 31 GLTs.

Dispersal: Within this area, there were 5 "source" populations, and 5 smaller populations. Since it was unreasonable to have all 5 source populations simultaneously colonize an extinct or small inbred population, each small population was linked to a specific source population. Dispersal rates between specific source and sink populations was 5%. SERRA was the source for Pop A; PDA was the source for CAM; I was the source for BEN; RV was the source for V; and B was the source for BE. Thus, when the conditions were met (source population above 50% of capacity and small population extinct or greater than 10% average inbreeding) 5% of the source population migrated to the small population. At capacity, this amounted to one or two groups of GLTs for most populations. GLTs of both sexes aged 2 to 4 were the dispersers. Survival during migration was set at 75%.

The function that modified dispersal if the conditions were met was:

=D*((II(PP)>10)OR(NN(PP)=0))*(N/K>0.5)

D = dispersal rate
II(PP) = average inbreeding coefficient (in%) (II) of the recipient population (PP) of a dispersing individual
NN(PP)= the population size (NN) of the recipient population (PP) of a dispersing individual

Results

The 5 sink populations were maintained throughout the 100 years (Figure 5) and the probabilities of extinction for the 5 source populations increased slightly from 0% to between 2% and 4% - indicating that these source populations were capable of providing the dispersal needed to maintain the smaller populations with only slight cost. Unfortunately, *Vortex* does not provide output that allows users to determine how many dispersers were needed to maintain these smaller populations, nor how often dispersal was needed to either recolonize an extinct population or reduce inbreeding in a population whose average inbreeding coefficient was greater than 10%. So while the results suggest that the large most likely can support the small populations, we cannot estimate the logistical costs of doing so.

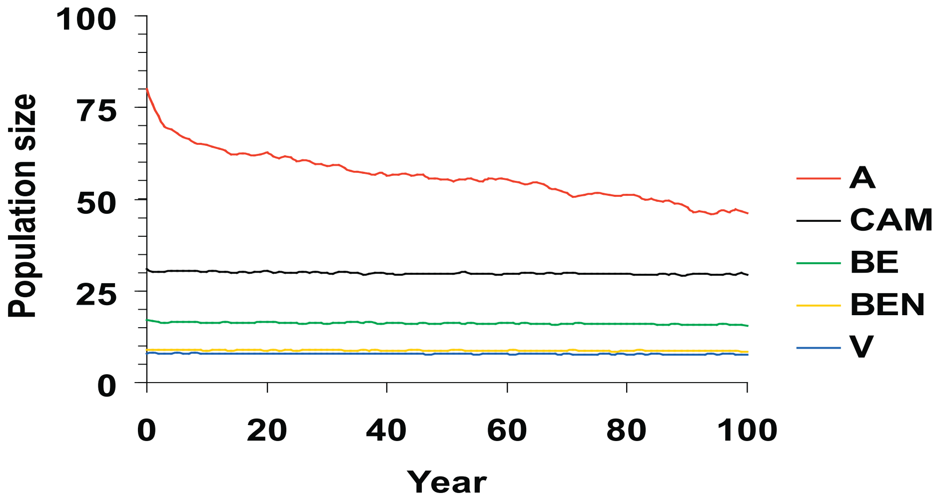


Figure 5. Mean population size over 100 years for each of 5 small sink GLT populations under managed translocation in Scenario 3.

Scenario 4: Dispersal Capabilities of Populations of Different Sizes

How much removal can different sized populations sustain before their viability is significantly affected?

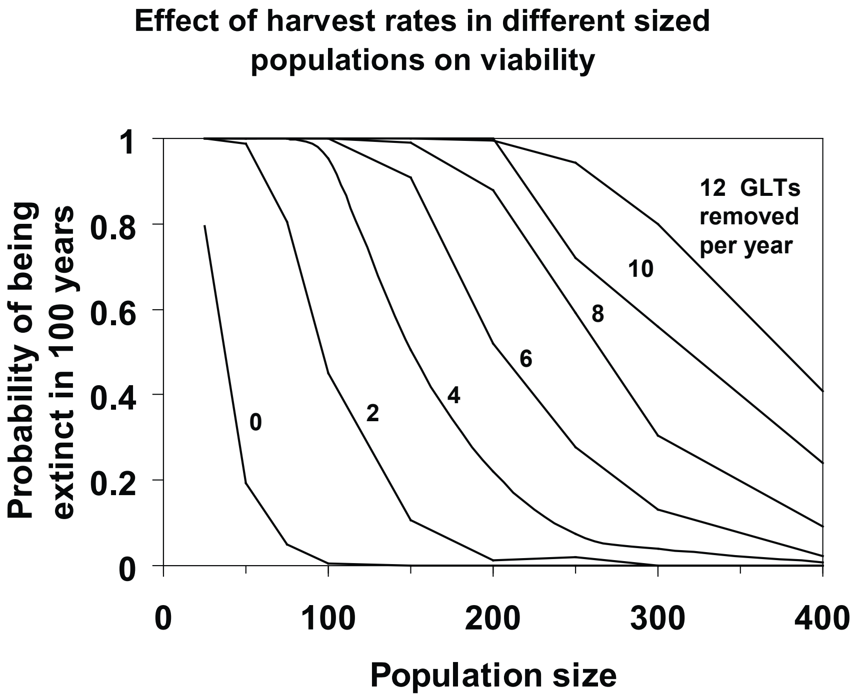
In metapopulation management planning, it would be useful to know how much harvesting a population can withstand before it affects viability. To explore this, a number of populations of sizes ranging from 25 to 400 animals were modelled with harvest rates varying from 2 animals per year up to 12 per year.

Vortex Parameters

Parameters for medium-sized populations were used for all population sizes. Initial population sizes were: 25, 50, 75, 100, 150, 200, 250, 300 and 400. Carrying capacities were set at initial population sizes. Harvest rates of: 0, 2, 4, 6, 8, 10 and 12 (equal sex ratios) were applied to each of the populations. All parameters except for these three (initial size, K and harvest) were identical across populations.

Results

Population sizes below about 200 cannot sustain a removal rate above about 2 GLTs per year, populations sizes about 300 may be able to sustain removal rates of up to 4 or 5 GLTs per year, and populations of size 400 may be able to sustain up to 6 or 7 removals per year (about one group on average) (Figure 6).



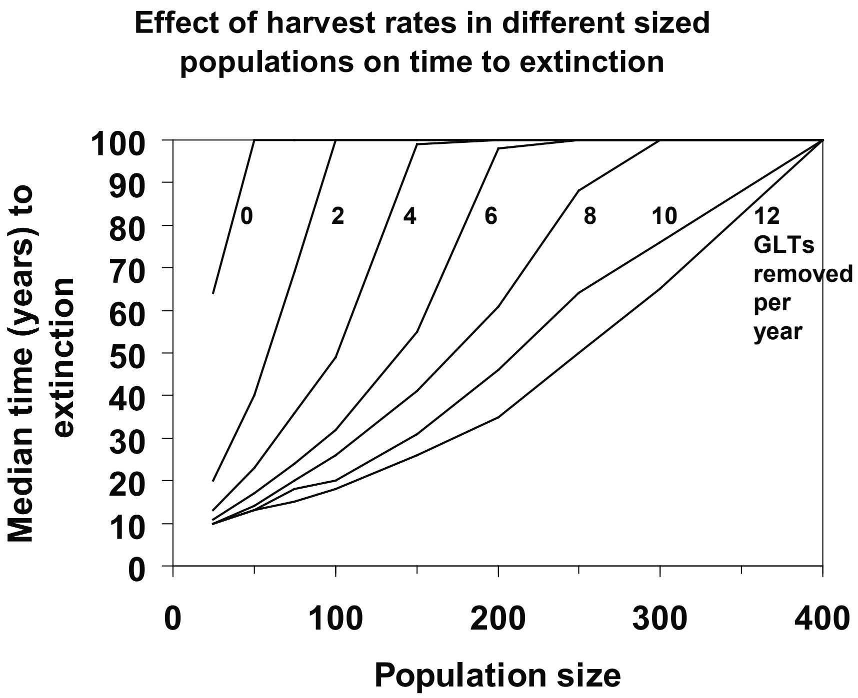


Figure 6. Population viability (measured by probability of extinction in 100 years and median time to extinction) for different sized populations with varying rates of harvest

Golden-Headed Lion Tamarin Population Model

Introduction

The golden-headed lion tamarin has a geographic range that is considerably larger than that of the other three species: 19,462 km^2 in total. The area is largely situated in the southeastern corner of the State of Bahia (19,043 km^2) and with a tiny corner (419 km^2) in the extreme northeast (the Rio Jequitinhonha valley) of the State of Minas Gerais (Pinto and Rylands 1997; Rylands *et al*. 2002).

A 1991/1993 survey estimated the total population size of wild GHLTs to be considerably larger than that of the other three species: more than 6,000, and possibly up to 15,500 individuals (Pinto and Rylands 1997). Also in contrast to the other lion tamarin species, the GHLTs still occur in most parts of their original range. However, the forest in this region has been and is being cleared at an alarming rate and the little that remains is highly fragmented (Figure 7). Without effective conservation measures, it is fully expected that in a short space of time the GHLTs will face critical conditions similar to those of the other lion tamarin species.

The western part of the GHLT range is characterised by highly seasonal, inland semi-deciduous tropical rainforest and the eastern part by lowland coastal evergreen tropical rainforest lacking in seasonality. The largest areas of remaining habitat are located in the east along a stretch of the Atlantic coast between the Rio de Contas in the north and the Rio Pardo in the south. Elsewhere the forest is divided into a myriad of tiny forest fragments, especially in the western area of the distribution range (see Figure 7). For example, the project "Conexão Mico-Leão" (CML) currently being conducted has already identified more than 8000 fragments, of which only 784 were larger than 40 ha (Raboy et al, unpublished data). 40 ha is the smallest published home range size for GHLTs (Rylands 1989), and thus it is considered the minimum home range for one group of GHLTs for the CML models. It is known that a significant part of the home range of GHLT groups can consist of 'cabruca', a system of growing cacao whereby only the understory of the forest is cleared and the cacao trees are planted in the shade of natural forest trees (Raboy et al, 2004). As is illustrated on Figure 7, cabruca is an important "forest type" in the eastern part of the GHLT's range. However, it is as yet unknown if GHLT groups can subsist entirely within cabruca. Moreover, management styles and forest structure vary widely across different types of cabrucas, and thus GHLTs may not use them all alike. Based on the currently available information, it is believed that cabruca likely would make suitable forest corridors.

Specific information about the location, size and characteristics of suitable forest fragments, and the occurrence of lion tamarins within these fragments, is still being gathered by the projects "Conexão Mico-Leão" (CML) (Smithsonian Institution) and BioBrasil (Royal Zoological Society of Antwerp). Because CML also aims to conduct a much more lengthy, detailed and complex Population Viability Analysis of the metapopulation within the distribution area of the species, using a combination of various PVA and spatial modelling packages, the GHLT working group of this PHVA decided to concentrate the Vortex modelling during the PHVA on the Una Biological Reserve and its vicinity. This is also the area where most biological information on the species has so far been gathered, and the area that contains the largest amount of projected habitat for the GHLTs. Considering the difference in habitat between the eastern (wet forest) and western (mesophytic forest) part of the distribution area of the species, it is not unreasonable to assume that a number of the reproduction and survival parameters may well differ significantly between the regions. This illustrates the importance of studies to be carried out in the western part of the geographic range, such as the one recently started by C. Guidorizzi in Limoeiro, Itapetinga (Instituto de Estudos Socio-Ambientais do Sul da Bahia).

Analyses carried out during previous PHVAs (Seal *et al*. 1990, Lacy *et al*. 1997) suggested that the Una Biological Reserve was too small to support a viable population of GHLTs from a genetic point of view (during the 1997 PHVA, a viable population was defined as having at least 98% probability of survival and retaining at least 98% of gene diversity after 100 years). However, since then, more of the decreed surface area of the reserve has been effectively included in the reserve, the chances for further degradation of areas within the reserve are much smaller and continued scientific research projects in the reserve have produced better and alternative estimates of average territory size and densities. This population model was designed to re-investigate the viability of the golden-headed lion tamarin (GHLT) (*Leontopithecus chrysomelas*) population in, and in the vicinity of, the Una Biological Reserve in Bahia.

Currently, the potential is being investigated to expand the area of the Una Biological Reserve to include the areas marked in yellow on Figure 9, as part of the activities for the conservation and restoration of the "Corredor Central da Mata Atlântica". Further, during the opening presentations of the PHVA, the Instituto de Estudos Socioambientais do Sul da Bahia (IESB), announced that IESB and its partners are already involved in plans, discussions and applications for the creation of two new "Unidades de Conservação (UC,s)", conservation units, within the range of the GHLTs: Serra do Baixão (~32,089 ha according to GIS) and Serra das Lontras (~8015 ha according to GIS) (Figure 10). This latter area already contains a private reserve (RPPN), in the municipality of Arataca.

The fundamental questions posed to the modellers by the GHLT working group were:

1) What is the current potential of the only Biological Reserve containing this species, the Una Biological Reserve, to achieve the goal of at least 98% of gene diversity retention and 98% probability of survival for 100 years?

2) What would be the effect of the proposed expansion of the Una Biological Reserve on the potential for gene retention and probability of survival for 100 years?

3) What is the likely viability of populations in two areas currently under consideration for the creation of additional conservation units: Serra do Baixão and Serra das Lontras and what could be their importance to the gene retention and viability of the metapopulation

GHLT *Vortex* Model Parameters

For the most part, the GHLT *Vortex* model used the baseline lion tamarin model parameters, where possible adapted to reflect golden-headed lion tamarin specific information taken from studies by Raboy and Dietz (Dietz *et al*. 1996; Raboy 2002; Raboy and Dietz 2004; Raboy *et al*. 2004) and De Vleeschouwer (unpubl. data) working in the Una Biological Reserve in Bahia from 1991 to the present. Input values used in the GHLT model that are different from the general baseline lion tamarin model are described below.

<u>*Number of iterations:*</u> *500 or 250*
500 independent iterations were run for each scenario, except for the scenarios with more than one population (Scenario 5 below) for which 250 iterations were run (due to running time per iteration).

<u>*Number of Populations:*</u> *depending on the scenario 1-3 populations*

The three populations:

<u>1. Una Biological Reserve:</u>
The original decreed area of the Una Biolgical Reserve was 11,400 ha. Currently 9,881 ha have been effectively included in the reserve. This represents an increase of 2,822 ha from 7,059 ha in 1997. Undertaking actions to ensure inclusion of the remaining 4341 ha was an important recommendation from the 1997 Lion Tamarin PHVA (Lacy *et al*. 1997). The remaining 1519 ha are in the final stages of acquisition and their addition seems fairly guaranteed in the short term. It was therefore decided to consider Una Biological Reserve to be 11400 ha in size for the modelling.

Adjacent to the Una Biolgical Reserve lies the "Ecoparque de Una", a 383 ha private reserve or RPPN (Reserva Particular do Patrimônio Natural) active in ecotourism (Figure 8). It was decided to model the Una Biological Reserve and the Ecoparque de Una as one population as there is plenty of gene flow between them and densities appear at the moment not so different between the regions (see also N and K below). In the various scenarios, the term "<u>Una today</u>" refers to the full decreed surface area of Una Biological Reserve plus the Ecoparque de Una.

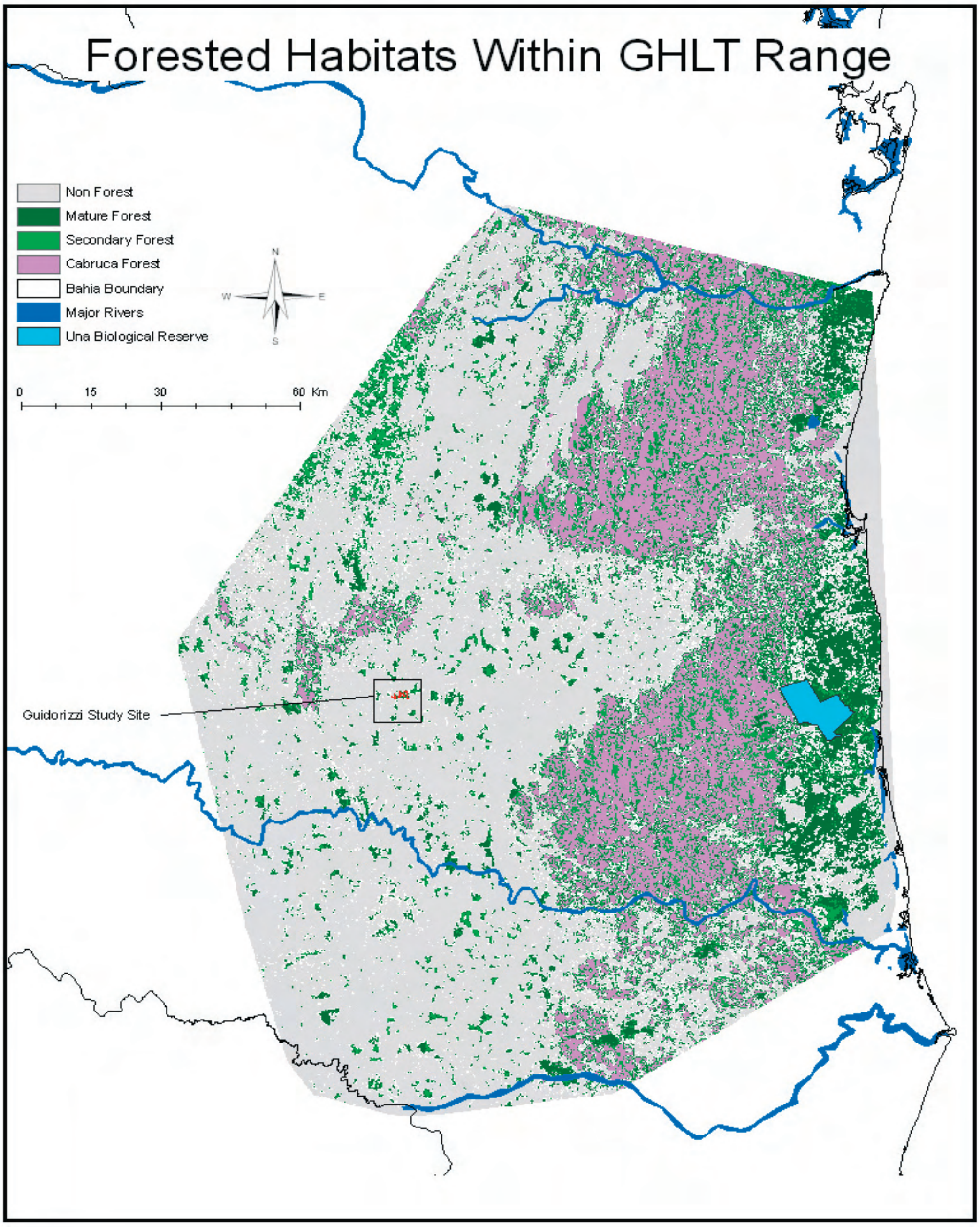


Figure 7. Forested areas within the GHLT range. (Credit)

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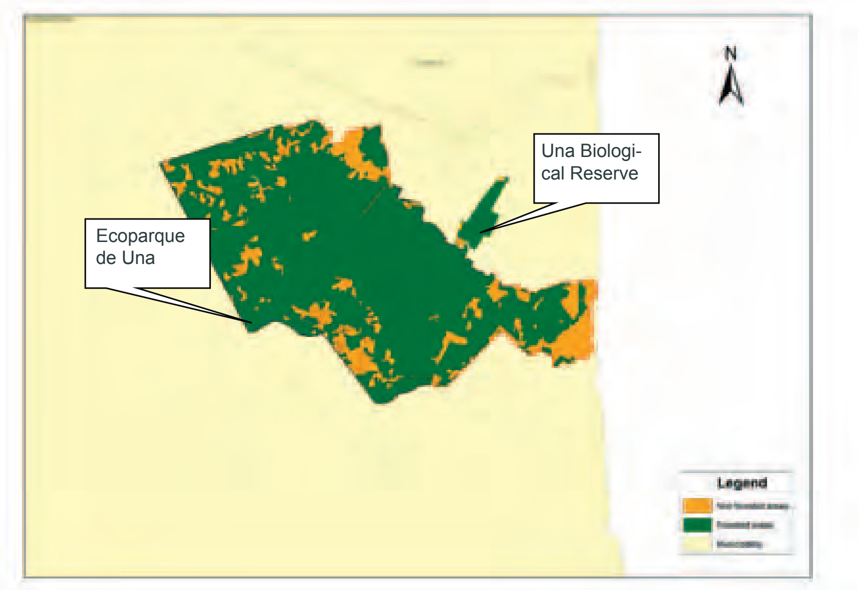


Figure 8. Una Biological Reserve and the RPPN “Ecoparque de Una” Note that this map already includes the proposed expansion area – see Figure 9 for difference between current area and proposed expanded area. (Credit)

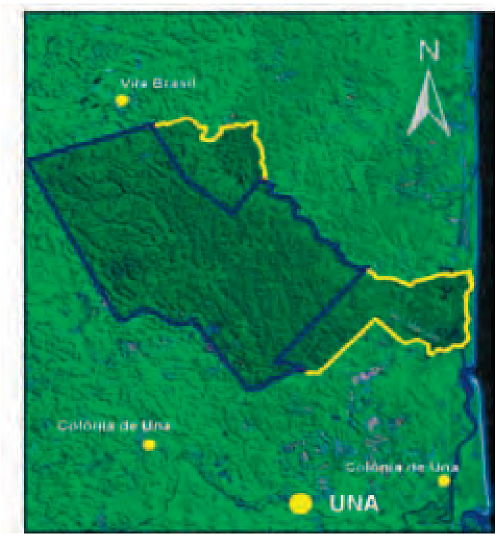


Figure 9. Proposed expansion of Una Biological Reserve (Credit)

2. + 3. Serra do Baixão and Serra das Lontras

During the opening presentations of the PHVA, the Instituto de Estudos Socioambientais do Sul da Bahia (IESB), announced that IESB and its partners are already involved in plans, discussions and applications for the creation of two new “Unidades de Conservação (UC,s)”, conservation units, within the range of the GHLTs: Serra do Baixão (~32,089 ha according to GIS) and Serra das Lontras (~8015 ha according to GIS) (Figure 10). This latter area already contains a private reserve (RPPN), in the municipality of Arataca. For some model scenarios these areas were added as extra populations, in order to test the potential effect of the creation of these new UC’s on the probability of survival of the population(s) of GHLTs.

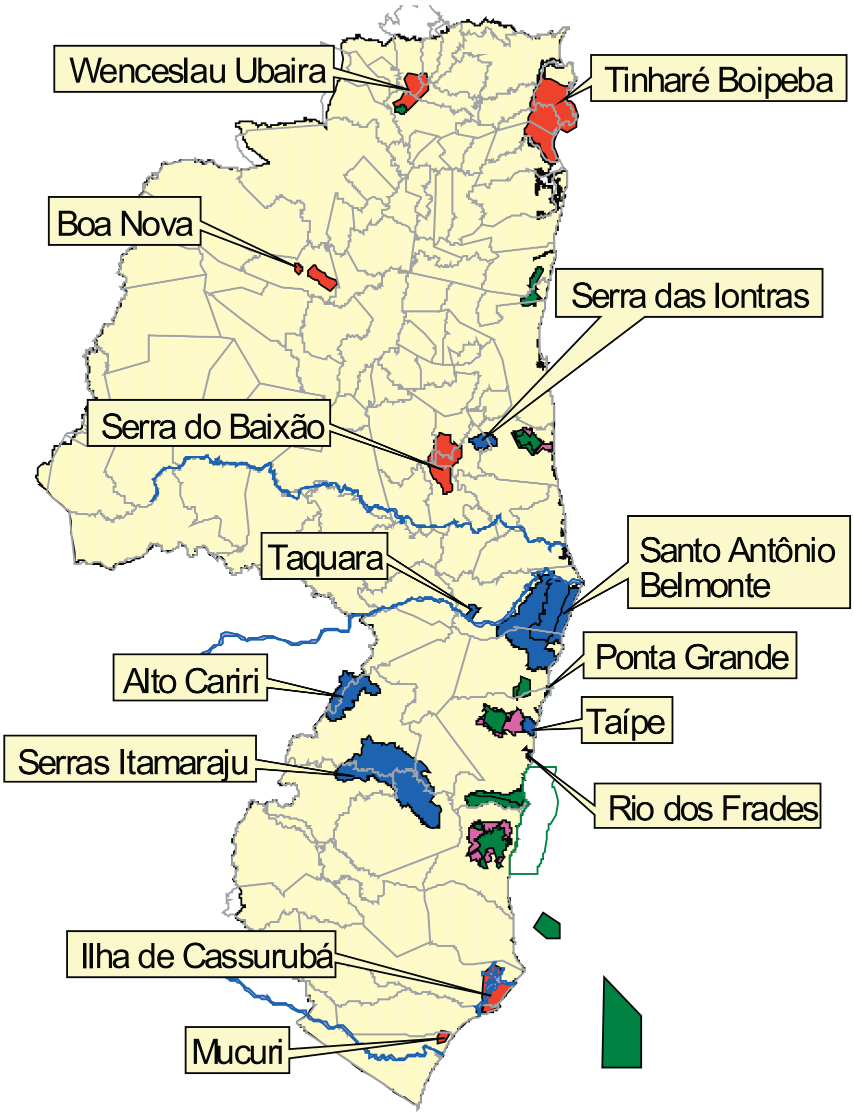


Figure 10. Proposed new Conservation Units ("Unidades de Conservação") in Bahia; including Serra do Baixão and Serra das Lontras within the geographic range of GHLTs (IESB, June 2005)

Initial Population Size (N): 1016
The current density of GHLTs at the study site Maruim in Una Biological Reserve (non degraded habitat) is 0.10 GHLTs/ha (Raboy and Dietz, unpublished data). In Maruim, the territory size has gradually decreased over the years from 135 in 98-99 to 58 ha in 04-05. In 1997 the density in Maruim was 1 GHLT/18.8 ha or 0.053 GHLT/ha.

At the study site Piedade in Una Biological Reserve (degraded habitat) the current mean territory size is 45 ha, which with mean of 5 animals per group gives 0.11 GHLT/ha. However, this does not take into account possible overlap between territories (De Vleeschouwer, unpublished data). The density used during the 1997 PHVA was 1 GHLT/13.9 ha or 0.07 (the value for GLTs in PDA in degraded forest and also GHLTs in a degraded forest fragment as by Rylands (1989)).

The situation in the Ecoparque is thought to be similar to that in Maruim (good forest and GHLTs are known to be there, although not known how many).

As all of these figures are based on small sample sizes, it was decided to assume for 0.1 GHLT/ha for the whole of the reserve and the Ecoparque in the baseline model. In any case, it was felt that the degraded habitat will have regenerated in about two to three generations, resulting in a situation that is likely similar to Maruim today.

Table 5 shows how this density estimate was applied to the different regions to derive initial population size and carrying capacity. With the aid of GIS the total amount of forested area in the reserve was determined. To determine the initial population size, the current forested area was multiplied by the density.

Carrying capacity:
GHLT working group participants indicated that in the Una Biological Reserve it was observed that, in 23 years, pasture regenerated to a forest type suitable to completely support lion tamarins, and indistinguishable from the rest of the forest in Maruim. However, it is not the case. Not all current non-forested areas are completely bold pasture – they are in various stages of regeneration. The workshop participants felt that after 15 years the regenerated forest is already in a form that it can serve as part of a home range, if there is also better forest available. As the habitat is degraded rather than deforested completely, better forest is available also. It was therefore suggested that for the baseline the carrying capacity at year 0 of the run should be the current N and after 15 years should be the value for when all is forested – with a gradual, 0.93% annual increase of K between 0 and 15 years.

Table 5. Determination of the initial population size (N) and the current and future (in 15 years, when the whole reserve is forested) carrying capacity (K), based on the surface area of the Una Biological Reserve + the Ecoparque as measured by GIS, and the proportion of this area that is currently forested.

	Total Size decreed (ha)	Total size of decreed area as measured by GIS (ha)	Non-forested area in 2005 (ha)	Forested area in 2005 (ha)	Density	N	K current	K when all is forest
Una	11400	11187.81	1377.07	9810.74	0.1 /ha	981	981	1118
Ecoparque	383	382.27	29.37	352.90	0.1 /ha	35	35	38
TOTAL = “Una today”	11783	11570.08	1406.44	10163.64	0.1 /ha	1016	1016	1156

Dispersal among populations:
Scenario specific

Maximum number of progeny per year: 4
GHLTs can have 1-2 offspring per litter, and can give birth to up to two litters per year. For the baseline model data from Raboy and Dietz (unpublished data) at the Maruim study site in the Una Biological Reserve were used (Table 6).

Table 6. Frequency distribution of number of offspring per female per year for GHLTs.

Offspring / female GHLT/ year	Frequency
1	37%
2	54%
3	1%
4	8%

Mortality rates: all populations modelled are medium-sized populations
See baseline lion tamarin model parameters.

Because Una Biological Reserve and the areas with vegetation in Serra do Baixão are not much over 10.000 ha, it was decided to model them (as well as Serra das Lontras) as medium-sized populations.

Mortality data for GHLTs were available from Raboy and Dietz (unpublished data) for GHLTs (Table 7).

Table 7. Age specific mortality for GHLTs based on data from Raboy and Dietz.

Age Class	Number at Risk	Mortality dispersal=death	Mortality only confirmed deaths
0-1	46	0.326	0.326
1-2	24	0.238	0.027
2-3	12	0.095	0
3-4	6	0.250	0
4+	84	0.091	0.048

The largest difference with the GLT mortality data (which are based on a larger sample size and a larger time frame), is the mortality in age class 2-3. For GLTs this was, for the two sexes combined, 20% (standard error 3.5). The GHLT rate therefore falls out with the window of 20% +/- 2 x standard error.

However, the 9.5% mortality in the age class 2-3 for GHLTs is based on an N of only 12 animals ¤ just one more animal dead/disappeared in that age class would have increased to mortality to the level in GLTs. It was therefore felt that it would be more prudent to use the GLT mortality data for GHLTs as well.

Catastrophes: disease outbreak (survival severity factor 0.75; frequency 2% or 3%)

The GHLT working group felt that fire was no longer a substantial risk for the Una Biological Reserve, but disease is. Through communication with R. Monteiro during the workshop, it was felt that a disease outbreak should be modelled with both a frequency of 2% and 3% whereby it causes ¼ of the population to go extinct (severity factor of 0.75). For the baseline scenario, a 2% frequency was chosen as is this is the less severe scenario of the two.

Deterministic output of baseline GHLT model

Because GHLT specific frequencies of offspring per female per year were used, the deterministic characteristics of the GHLT baseline model differ slightly from these of the overall lion tamarin baseline model (Table 8). More specifically, the GHLT specific model results in a slightly lower growth rate. However, this still falls within normal levels for lion tamarin biology and the parameters in the GHLT model produce reasonable results.

Table 8. Deterministic results for the GHLT baseline model in comparison to the general lion tamarin baseline model.

Parameter	Medium sized GHLT population	Medium sized general lion tamarind population
Lamba	1,086	1.109
Generation length (yrs)	7.7	7.5
% living to 10 years of age	<10%	<10%

Scenario 1: Viability of the population in Una Biological Reserve

What is the current potential of the Una Biological Reserve, to achieve the goal of at least 98% of gene diversity retention and 98% probability of survival for 100 years?

During the 1997 PHVA, the goals set for the species in the wild was the retention of a minimum of 98% of gene diversity and a probability of survival of least 98% for 100 years. The workshop participants wished to re-investigate the ability of the only federal reserve for the species, the Una Biological Reserve, to safeguard the species according to these standards. On the one hand, more of the originally gazetted area of the reserve has been effectively included in the reserve, and on the other hand, updated data on

GLT and GHLT demographic parameters have led to a change in the input parameters of the Vortex model for the species (in comparison to the 1997 PHVA). This may well have an effect on the viability of the Una population of GHLTs.

Vortex scenario name
GHLT 2005 Baseline

Vortex Parameters
The baseline GHLT parameters were used.

Results
The probability of survival for 100 years was 100%, and 98.32% of gene diversity was retained, with an average population size after 100 years of 920.48 (SD 225.07).

Summary
Under conditions modelled in the baseline model, the Una Biological Reserve by itself appears to be able to safe guard the species with the current goals for viability (min 98% persistence and min 98% gene diversity retained after 100 years). However, the population size after 100 years is relatively small and all these GHLTs would be in the proverbial "one basket" and therefore vulnerable to physical and/or socio-political catastrophes happening in or around the reserve.

Scenario 2: Viability of the population in an expanded Una Biological Reserve

What would be the effect of the proposed expansion of the Una Biological Reserve on the potential of gene retention and probability of survival for 100 years?
The potential is currently being investigated for the expansion of the Una Biological Reserve with the areas marked by the yellow lines in Figure 9. Workshop participants wished to investigate the effect this might have on the probability of existence and the potential for retention of gene diversity by the Una GHLT population.

Vortex scenario name
GHLT Una exp K current

Vortex Parameters
The baseline GHLT parameters were used with the following modifications (see also Table 9):
Initial population size is 1308
K at year 0 = 1308
K after 15 years (i.e. after forest regeneration) = 1580
Annual increase in K = 1,4% for 15 years

Table 9. Initial population size and carrying capacity of the GHLTs in Una Biological reserve (current and expanded), based on the current and future area covered by forest.

	Total Size	Forest	GHLT/ha	N	K current	K when all is forest
Una	11400	9810	0.1	981	981	1118
Ecoparque	383	352	0.1	35	35	38
Total = "Una today"	**11783**	**10162**		**1016**	**1016**	**1156**
Proposed addition to Una	4248	2927	0.1	292	292	424
Total = "Una expanded"	**16031**	**13089**		**1308**	**1308**	**1580**

Results

The probability of survival for 100 years was 100%, and 98.76% of gene diversity was retained, with an average population size after 100 years of 1243,77 (SD 313,05).

Summary

Expansion of the Una Biological reserve increases the amount of gene diversity that can be retained for 100 years, as well as the size of the population of GHLTs after 100 years, and in this light is certainly to be encouraged. The concern of "all eggs in one basket" when completely relying on the reserve for the safeguarding of the species however remains. In addition, it is currently not yet known if the western GHLT populations (living under very different ecological circumstances) are genetically substantially different from the populations in the east. If this would be the case, the Una Biological Reserve would only provide a safeguard for the gene pool typical for the eastern populations.

Scenario 3: Viability of the population in the Una Biological Reserve and an expanded Una Biological Reserve based on alternative density estimates

How sensitive is the outcome of the model for the Una Biological Reserve to uncertainties regarding the density of GHLTs in the reserve?

Vortex scenario names

See Table 10

Vortex Parameters

The baseline GHLT parameters were used with the following modifications:

As was indicated in the GHLT Vortex Model Parameters section, the average territory size at the study site Maruim in the Una Biological Reserve has changed over time. The density currently observed is the highest density observed. It was therefore considered prudent to also test the effect of two lower density levels:

<u>Mean density 0.067 GHLT/ha:</u>
Calculated from the average home range in Maruim (over all study years) = 96 ha; and the average of the average size of each group studied over all years studied = 6.43 (from studies by Raboy and Dietz (Dietz *et al.* 1996; Raboy, 2002; Raboy and Dietz 2004, Raboy et al, 2004)).

<u>Low density 0.053 GHLT/ha:</u>
Based on the low density used in the 1997 PHVA report based on the data from Maruim at that time = 0.053 GHLT /ha.

Scenarios were run both with and without concurrent adaptations of K (i.e. leaving the carrying capacity at the high level according to a maximum achievable density of 0.1 GHLT/ha, or lowering K to follow the mean or low density modelled).
Scenarios were run for the Una Biological Reserve in its current form, as well as when expanded.

Table 10. Initial population sizes and carrying capacities used in the various Vortex scenarios run to evaluate the influence of different GHLT density estimates on the viability of the GHLT population in the Una Biological Reserve (current and expanded).

Vortex scenario name	Una	GHLT density	N	K current	K when all is forest
GHLT 2005 Baseline	Today	High 0.1/ha	1016	1016	1156
GHLT Una dens Mean	Today	Mean 0.067/ha	680	1016	1156
GHLT Una dens Low	Today	Low 0.053/ha	538	1016	1156
GHLT Una dens mean K mean	Today	Mean	680	680	775
GHLT Una dens low K low	Today	Low	538	538	613
GHLT Una exp K current	Expanded	High 0.1/ha	1308	1308	1580

GHLT Una exp dens Mean	Expanded	Mean 0.067/ha	877	1308	1580
GHLT Una exp dens Low	Expanded	Low 0,053/ha	693	1308	1580
GHLT Una exp dens mean K mean	Expanded	Mean	877	877	1059
GHLT Una exp dens low K low	Expanded	Low	693	693	838

Results

As long as the carrying capacity K is left set at the high level used for the baseline model (based on the high density of GHLTs currently observed in Maruim and Piedade), lower density estimates (and concurrent lower initial population sizes) do not influence the viability of the GHLT population in Una. Both in its current state and when expanded, the Una Biological Reserve can harbour a GHLT population with a zero probability of extinction and a minimum of 98% of gene diversity retained after 100 years (Table 11). The stochastic growth rate of at least 3% for each of these scenarios allows the population in most of the iterations to relatively quickly climb to carrying capacity and results in a population large enough to withstand the current deterministic and stochastic threats modelled.

When carrying capacity is set according to the density estimate used, the Una Biological Reserve in its current state is not able to harbour a viable population of GHLTs in terms of gene diversity, as for both scenarios, the gene diversity retained after 100 years just drops below the threshold of 98%. When carrying capacity is set to follow that lowest density estimate used the population also has a 0.2% probability of extinction (which still falls below the threshold level of 2%). An expanded Una Biological Reserve is able to harbour a viable population of GHLTs at medium density estimate and concurrent carrying capacity; but not at low density and concurrent carrying capacity. In the latter case gene diversity retained after 100 years drops below the 98% threshold.

Table 11. Effect of alternative density estimates on the viability of the population in the Una Biological Reserve in both its current form and when expanded.

Scenario	stoc-r	SD(r)	PE	N-extant	SD(Next)	GeneDiv	SD(GD)
K stays at high baseline level							
Una current size							
GHLT 2005 baseline	0.032	0.168	0	920.48	225.07	0.9832	0.0031
GHLT Una dens mean	0.032	0.167	0	917.29	236.30	0.9826	0.0042
GHLT Una dens low	0.033	0.168	0	925.59	227.75	0.9827	0.0033
Una expanded							
GHLT Una exp K current	0.032	0.168	0	1243.77	313.05	0.9876	0.0026
GHLT Una exp dens mean	0.033	0.167	0	1235.94	322.85	0.9873	0.0038
GHLT Una exp dens low	0.033	0.167	0	1273.74	311.39	0.9869	0.0032
K decreased according to density used							
Una current size							
GHLT Una dens mean K mean	0.029	0.168	0	601.22	160.35	0.9748	0.0052
GHLT Una dens low K low	0.028	0.170	0.002	474.16	133.84	0.9682	0.0095
Una expanded							
GHLT Una exp dens mean K mean	0.031	0.168	0	831.06	213.52	0.9811	0.0101
GHLT Una exp dens low K low	0.030	0.169	0	659.75	172.90	0.9764	0.0138

Summary

Both the Maruim and Piedade research sites in the Una Biological Reserve are currently observing a GHLT density of about 0.1 GHLT/ha, the highest density so far observed. This high density therefore definitely is possible, but the question remains whether it is obtainable throughout the reserve and can be sustained over the long term. Considering that the high density is currently observed in both degraded and good quality habitat, it may not be too unreasonable to assume that this density can be obtained throughout the reserve (the forest regeneration is dealt with in the gradual increase of K over 15 years). Whether this density can be sustained over the long term remains a question however.

Expanding the Una Biological Reserve would provide an extra buffer against an overestimation of the GHLT density over the long term – only if the lowest density so far observed were to be close to the average density achieved over the long term, would the population in the expanded reserve no longer be viable according to our criteria set for viability. The workshop participants considered this last scenario to be unlikely.

Scenario 4: Viability of the population in the Una Biological Reserve and an expanded Una Biological Reserve with more frequent and/or more severe disease outbreak scenarios

Workshop participants considered disease to be an important catastrophic threat to GHLTs, but at this moment, no information is available on the likely frequency and severity of catastrophic disease outbreaks. ***Therefore, effects of more frequent (3% probability of occurrence in stead of 2%) and/or more severe (severity factor 0.5 for survival in stead of 0.75 = survival reduced by 50% in stead of 25%) disease outbreaks were modelled.***

Vortex scenario names
See Table 12.

Vortex Parameters
The baseline GHLT parameters were used with the following modifications.

Table 12. Initial population sizes, carrying capacities and disease frequencies and severities used in the various Vortex scenarios run to evaluate the influence of disease frequency and severity on the viability of the GHLT population in Una Biological Reserve (current and expanded).

Dens high: initial population size based on GHLT density of 0.1GHLT/ha
Dens mean: initial population size based on GHLT density of 0.067/ha
K cur: Carrying capacity based on high density estimate
K mean: Carrying capacity based on mean density estimate
2% or 3%: frequency of disease outbreak
surv 75 or surv 50: severity factor for survivorship (0.75 or 0.50)

Vortex scenario name	Una	N	K current	K when all is forest	Disease Freq. (%)	Survival severity factor
GHLT 2005 Baseline copy 1	Today	1016	1016	1156	2	0.75
GHLT Una dens mean K mean dis 2% surv 75	Today	680	680	775	2	0.75
GHLT Una dens high K cur dis 2% surv 50	Today	1016	1016	1156	2	0.50
GHLT Una dens mean K mean dis 2% surv 50	Today	680	680	775	2	0.50
GHLT Una dens high K cur dis 3% surv 75	Today	1016	1016	1156	3	0.75
GHLT Una dens mean K mean dis 3% surv 75	Today	680	680	775	3	0.75
GHLT Una dens high K cur dis 3% surv 50	Today	1016	1016	1156	3	0.50
GHLT Una dens mean K mean dis 3% surv 50	Today	680	680	775	3	0.50
GHLT Una exp K current copy 1	Expanded	1308	1308	1580	2	0.75
GHLT Una exp dens mean K mean dis 2% surv 75	Expanded	877	877	1059	2	0.75
GHLT Una exp dens high K cur dis 2% surv 50	Expanded	1308	1308	1580	2	0.50

GHLT Una exp dens mean K mean dis 2% surv 50	Expanded	877	877	1059	2	0.50
GHLT Una exp dens high K cur dis 3% surv 75	Expanded	1308	1308	1580	3	0.75
GHLT Una exp dens mean K mean dis 3% surv 75	Expanded	877	877	1059	3	0.75
GHLT Una exp dens high K cur dis 3% surv 50	Expanded	1308	1308	1580	3	0.50
GHLT Una exp dens mean K mean dis 3% surv 50	Expanded	877	877	1059	3	0.50

Results

Table 13. Effect of alternative frequencies and effects on survival of disease outbreak on the viability of the population in the Una Biological Reserve in both its current form and when expanded.

Dens high: initial population size based on GHLT density of 0.1GHLT/ha
Dens mean: initial population size based on GHLT density of 0.067/ha
K cur: Carrying capacity based on high density estimate
K mean: Carrying capacity based on mean density estimate
2% or 3%: frequency of disease outbreak
surv 75 or surv 50: severity factor for survivorship (0.75 or 0.50)

Scenario	stoc-r	SD(r)	PE	N-extant	SD(Next)	GeneDiv	SD(GD)
K at high baseline level							
Una current size							
GHLT 2005 baseline - Copy 1 2% surv 75	0.031	0.168	0	925.33	231.95	0.9831	0.0073
GHLT Una dens high K cur dis 2% surv 50	0.026	0.188	0.002	849.51	275.79	0.9808	0.0076
GHLT Una dens high K cur dis 3% surv 75	0.028	0.171	0	885.50	247.32	0.9827	0.0038
GHLT Una dens high K cur dis 3% surv 50	0.020	0.202	0.004	785.82	312.91	0.9766	0.0201
Una expanded							
GHLT Una exp K current - Copy 1 2% surv 75	0.031	0.168	0	1245.15	333.76	0.9875	0.0035
GHLT Una exp dens high K cur dis 2% surv 50	0.026	0.188	0	1159.15	397.31	0.9854	0.0094
GHLT Una exp dens high K cur dis 3% surv 75	0.029	0.170	0	1248.38	327.11	0.9874	0.0026
GHLT Una exp dens high K cur dis 3% surv 50	0.021	0.201	0.002	1075.34	427.49	0.9830	0.0129
K according to medium density							
Una current size							
GHLT Una dens mean K mean dis 2% surv 75%	0.030	0.168	0	613.01	159.24	0.9751	0.0055
GHLT Una dens mean K mean dis 2% surv 50%	0.024	0.191	0.004	563.07	189.80	0.9707	0.0117
GHLT Una dens mean K mean dis 3% surv 75%	0.028	0.171	0	611.89	161.81	0.9737	0.0114
GHLT Una dens mean K mean dis 3% surv 50%	0.019	0.201	0.002	494.29	227.60	0.9630	0.0482
Una expanded							
GHLT Una exp dens mean K mean dis2% surv 75	0.031	0.168	0	848.28	220.51	0.9816	0.0047
GHLT Una exp dens mean K mean dis2% surv 50	0.026	0.190	0	774.37	266.90	0.9782	0.0093
GHLT Una exp dens mean K mean dis3% surv 75	0.029	0.170	0	829.79	227.57	0.9811	0.0038
GHLT Una exp dens mean K mean dis3% surv 50	0.022	0.201	0	741.07	285.80	0.9753	0.0137

When carrying capacity is set to the high level used in the base line scenario (derived from a density of 0.1 GHLT/ha), Una Biological Reserve, even with its current size, is able to harbour a viable population of GHLTs under all disease scenarios, except the worst: a 3% probability of occurrence and a reduction in survival of 50%. In that case, gene diversity just drops below the set threshold of 98% after 100 years. An expanded Una Biological Reserve is however able to withstand all disease scenarios, including the worst. (Table 13)

In the event that the current high density should not be sustainable in the long term, or applicable to whole reserve, and the average future carrying capacity is more like the mean density observed over time at the study site Maruim, Una Biological Reserve, in its current state is vulnerable to disease outbreaks, both under baseline conditions and (of course) more severe conditions. An expanded Una Biological Reserve is not affected by more frequent disease outbreaks, but is affected by more severe disease catastrophes (gene diversity retained drops below the 98% threshold).

None of the scenarios tested had a probability of extinction higher than 0.4%.

Summary

In the event that the current observed high density of GHLTs would not be obtainable in the whole reserve, or sustainable for the long term, the GHLT population in the Una Biological Reserve at its current state would no longer be viable under the more frequent and severe disease scenarios modelled. An expanded Una Biological Reserve provides a buffer to more frequent disease outbreaks but not more severe ones. It remains wise to establish/secure at least one more viable population of GHLTs in another area.

Scenario 5: Viability of the populations in Serra do Baixão and Serra das Lontras and their importance to gene retention and viability of the metapopulation

As was explained in the input parameter section, two areas are currently being considered for the creation of new Unidades de Conservação (UC,s)", conservation units, within the range of the GHLTs: Serra do Baixão (SDB) and Serra das Lontras (SDL) (see Figure 10 for location). As GHLTs are known to be present in these areas, the workshop participants wished to investigate their potential to act as valuable populations within a metapopulation (thereby not relying on only one protected area/population to safeguard the species).

Judging by maps of the area (e.g. Figure 10), SDB, SDL and Una Biological Reserve are currently connected by mostly cabruca, interspersed with small, remnant fragments of secondary forest. However, this apparent interconnectivity needs to be evaluated on the ground. For example, not all cabruca types are equally suitable for GHLTs and the location of, and surface area covered by, the different types in between and around SDB, SDL and Una Biological Reserve is at present insufficiently known. GHLTs are known to be present in at least some areas of SDL and likely also in some areas of SDB, but nothing is known about their occurrence in interconnecting areas. As such, current dispersal rates, or the potential for natural dispersal of GHLTs between the three areas remain unknown for now.

Vortex scenario names

Una exp 3 pop dens high K cur dis 2% surv 75
Una exp 3 pop dens high K cur dis 3% surv 50
Una exp 3 pop dens mean K mean dis 2% surv 75
Una exp 3 pop dens mean K mean dis 3% surv 50

Vortex Parameters

The baseline GHLT parameters were used with the following modifications (Tables 14 & 15):

Both SDB and SDL are hilly/mountainous areas and since GHLTs mostly occur at altitudes below 400 m, only the lower lying areas will be potentially suitable for the species (Table 14).

Table 14. Total area with vegetation (all and <400 m altitude) within Serra das Lontras and Serra do Baixão.

	Total Size (ha)	Area with vegetation (not just forest) (ha)	Vegetation < 400 m (ha)
Serra das Lontras	8015	7942	1668
Serra do Baixão	32089	26918	13782

No future increase in carrying capacity was modelled for SDL and SDB because the current population size was calculated based on the GHLT density in the Una Biological Reserve (high and medium) and the total area with vegetation (of any kind, since details on vegetation types were not available) below 400 m. The Una Biological Reserve was modelled in its expanded form. Two different disease scenarios were modelled, the baseline scenario and the worst case scenario (3% frequency and 50% reduction in survival).

No gene flow was modelled between the three populations to explore the viability of each of the populations as isolated populations within a metapopulation (and because of lack of information on dispersal rates/potential). 250 iterations were run for each scenario.

Table 15. Initial population sizes, carrying capacities and disease frequencies and severities used in the various Vortex scenarios run to evaluate the viability of the populations in Una Biological Reserve (when expanded), Serra do Baixão (SDB) and Serra das Lontras (SDL) and their importance to gene retention and viability of the metapopulation. No dispersal between populations was modelled.

Dens high: initial population size based on GHLT density of 0.1GHLT/ha
Dens mean: initial population size based on GHLT density of 0.067/ha
K cur: Carrying capacity based on high density estimate
K mean: Carrying capacity based on mean density estimate
2% or 3%: frequency of disease outbreak
surv 75 or surv 50: severity factor for survivorship (0.75 or 0.50)

Vortex scenario name	Population	N	K current	K when all is forest	Disease Freq.%	Disease Survival severity factor
Una exp 3 pop dens high K cur dis 2% surv 75	Una	1308	1308	1580	2	0.75
	SDL	166	166	/	2	0.75
	SDB	1378	1378	/	2	0.75
Una exp 3 pop dens high K cur dis 3% surv 50	Una	1308	1308	1580	3	0.50
	SDL	166	166	/	3	0.50
	SDB	1378	1378	/	3	0.50
Una exp 3 pop dens mean K mean dis 2% surv 75	Una	877	877	1059	2	0.75
	SDL	111	111	/	2	0.75
	SDB	923	923	/	2	0.75
Una exp 3 pop dens mean K mean dis 3% surv 50	Una	877	877	1059	3	0.50
	SDL	111	111	/	3	0.50
	SDB	923	923	/	3	0.50

Results

The Una and SDB populations as well as the metapopulation had a zero probability of extinction in all scenarios. SDL on the other hand had a probability of extinction between about 1 and 27% and was particularly vulnerable to a higher disease risk and severity (see Figure 11). In addition, the SDL stochastic growth rate under the worst case disease scenario was only 0.3% for the high density estimate and -0.3% for the mean density estimate.

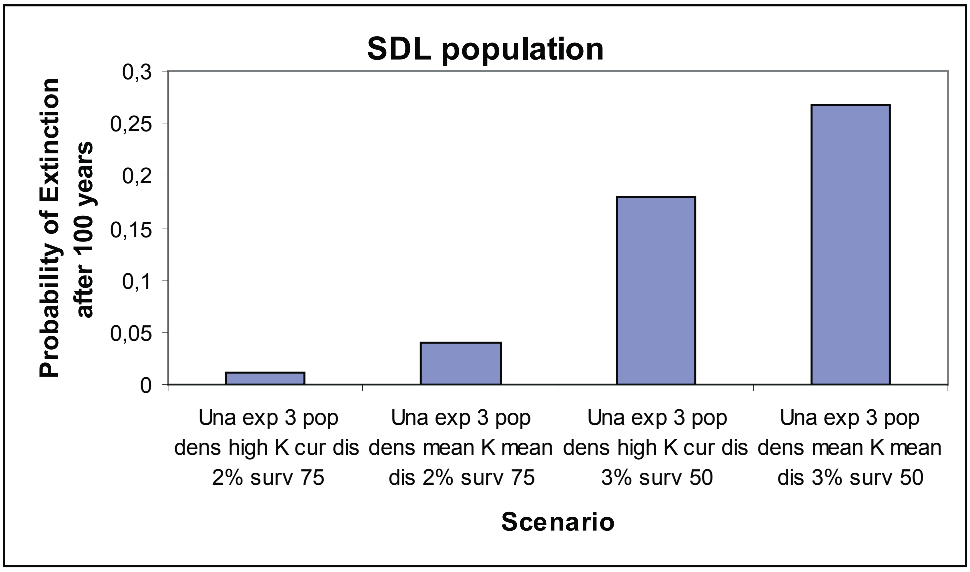


Figure 11. Probability of extinction for the population of GHLTs in Serra das Lontras (SDL), under different GHLT density estimates and disease outbreak frequencies and severities.

Dens high: initial population size based on GHLT density of 0.1GHLT/ha
Dens mean: initial population size based on GHLT density of 0.067/ha
K cur: Carrying capacity based on high density estimate
K mean: Carrying capacity based on mean density estimate
2% or 3%: frequency of disease outbreak
surv 75 or surv 50: severity factor for survivorship (0.75 or 0.50)

The Una and SDB populations were able to retain at least 98% of gene diversity after 100 years, except for the worst case scenario (population size and carrying capacity based on mean density estimate and worst case disease scenario) in which case it dipped just below the set threshold of 98% (Figure 12). The metapopulation was able to retain at least 98% of gene diversity after 100 years in all scenarios. The SDL population on the other hand was only able to retain between 78% and 88% of gene diversity and as such stays far below the set threshold in all scenarios. Therefore, even in scenarios with a relatively low probability of extinction, this population will be in a significantly impoverished genetic state after 100 year (with an average level of inbreeding of 22-12%, roughly corresponding to an average relatedness of full sibs to aunt/nephew-uncle/niece).

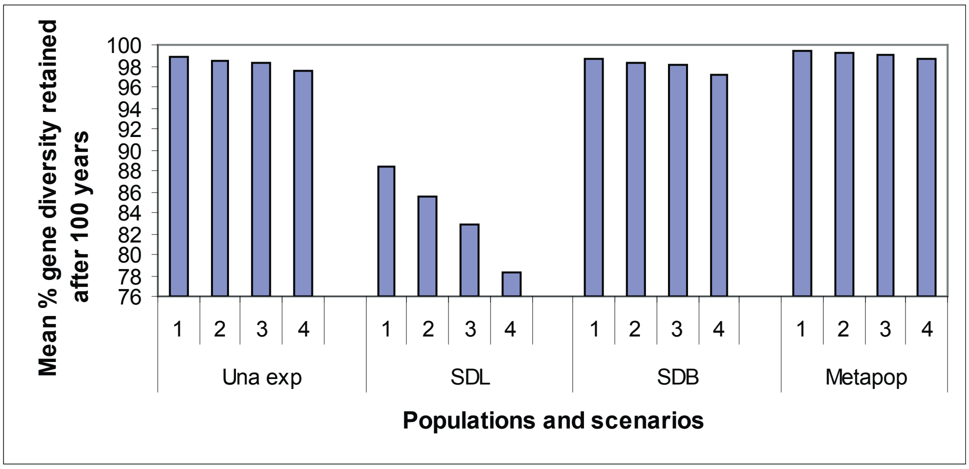


Figure 12. Mean % of gene diversity retained after 100 years in the expanded Una Biological Reserve, Serra das Lontras (SDL), Serra do Baixão (SDB) and the metapopulation under different GHLT density estimates and disease outbreak frequencies and severities (no dispersal between populations).
Scenarios:
1: Una exp 3 pop dens high K cur dis 2% surv 75
2: Una exp 3 pop dens high K cur dis 3% surv 50
3: Una exp 3 pop dens mean K mean dis 2% surv 75
4: Una exp 3 pop dens mean K mean dis 3% surv 50
Dens high: initial population size based on GHLT density of 0.1GHLT/ha
Dens mean: initial population size based on GHLT density of 0.067/ha
K cur: Carrying capacity based on high density estimate
K mean: Carrying capacity based on mean density estimate
2% or 3%: frequency of disease outbreak
surv 75 or surv 50: severity factor for survivorship (0.75 or 0.50)

As a metapopulation, the three areas together harboured an average of 2560 (in the best case scenario) to 1415 (in the worst case scenario) GHLTs after 100 years (Figure 13). Not surprisingly in light of the above results for probability of extinction and retention of gene diversity, by far most of these individuals live in Una Biological Reserve or SDB, with only very small numbers (or no animals at all) in SDL.

Summary

SDB appears to hold the potential to provide a solid backup GHLT population (for the population in the Una Biological Reserve), that can in itself remain self sustaining. Even under the worst scenario modelled, probability for extinction within 100 years remains zero and 97% of gene diversity can be retained after 100 years. The creation of an extra UC in this area would therefore be beneficial to the conservation of GHLTs. As an isolated area, SDL does not have this potential (significant probability of extinction and genetic impoverishment).
However:

1. Depending on the degree of connectivity and rate of natural dispersal between the three areas monitored, the SDL area may be an important stepping stone/link between the populations of Una and SDB. On the other hand, it may also serve as a sink that may endanger the viability of the Una and/or SDB populations. It is therefore recommended that the apparent interconnectivity between the three areas, the presence of GHLTs in and between the areas, and the current dispersal rates, or the potential for natural dispersal, between the areas is evaluated on the ground.
2. It is likely that not the whole of the SDB and SDL areas will be included into the new UCs. In addition, not all current or future vegetation types below 400 meter may be suitable for GHLTs. Purely from the viewpoint of GHLT conservation, it would be important to include as big a proportion of the <400 meter altitude area as possible into the new UCs, and/or to encourage and maintain suitable forms of cabruca in the lower lying areas outside the proposed UCs, as well as in the areas between the Una Biological Reserve, SDL and SDB. .

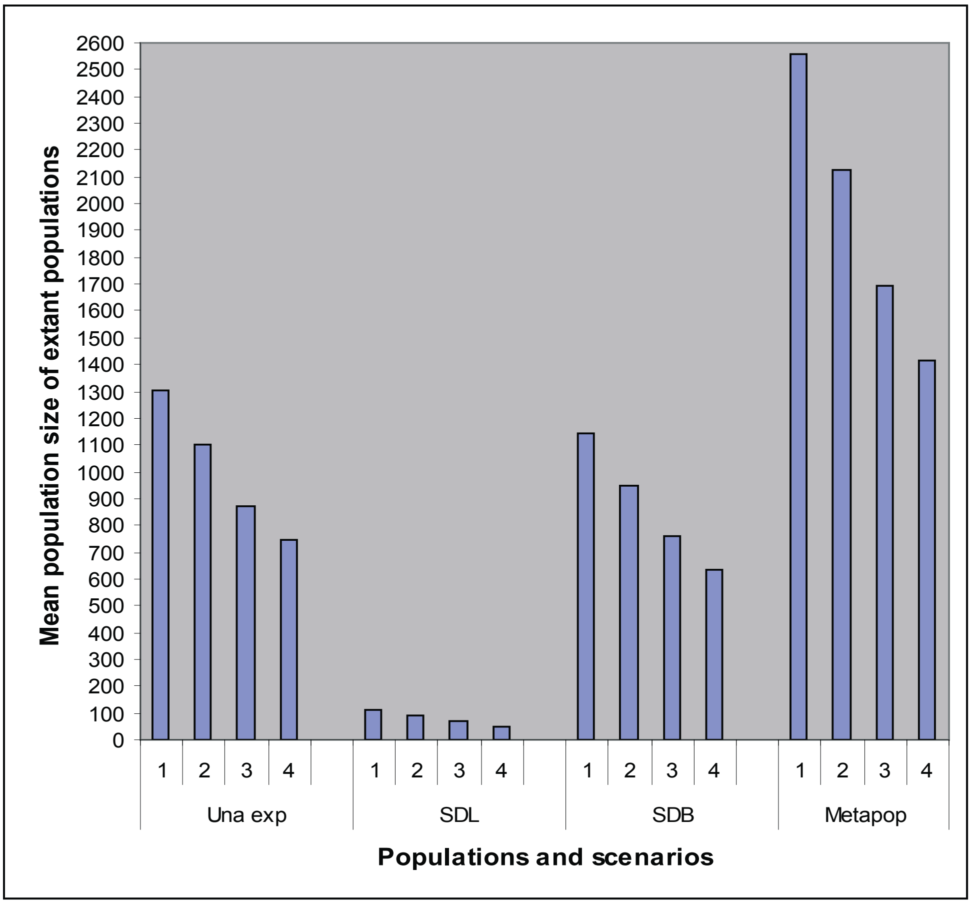


Figure 13. Mean population size at the end of 100 years in the expanded Una Biological Reserve, Serra das Lontras (SDL), Serra do Baixão (SDB) and the metapopulation under different GHLT density estimates and disease outbreak frequencies and severities (no dispersal between populations).
Scenarios:
1: Una exp 3 pop dens high K cur dis 2% surv 75
2: Una exp 3 pop dens high K cur dis 3% surv 50
3: Una exp 3 pop dens mean K mean dis 2% surv 75
4: Una exp 3 pop dens mean K mean dis 3% surv 50

Dens high: initial population size based on GHLT density of 0.1GHLT/ha
Dens mean: initial population size based on GHLT density of 0.067/ha
K cur: Carrying capacity based on high density estimate
K mean: Carrying capacity based on mean density estimate
2% or 3%: frequency of disease outbreak
surv 75 or surv 50: severity factor for survivorship (0.75 or 0.50)

Summary of GHLT Model Results

The successful inclusion of the remaining gazetted areas in the Una Biological Reserve has been/is instrumental for the viability of the GHLT population in the reserve. In contrast to the situation during the 1997 PHVA, the current Una Biological Reserve, under the baseline conditions modelled, does appears to be able to harbour a viable (min 98% persistence and min 98% gene diversity retained after 100 years) population of the species.

Further expansion of the Una Biological Reserve as proposed would increases the amount of gene diversity that can be retained for 100 years, as well as the size of the population of GHLTs after 100 years. In addition, an expanded Una Biological Reserve would provide an extra buffer against an overestimation of the GHLT density over the long term. As such, this proposed expansion is to be encouraged.

In the event that the current observed high density of GHLTs would not be obtainable in the whole reserve, or sustainable for the long term, the GHLT population in the Una Biological Reserve at its current state would no longer be viable under the more frequent and severe disease scenarios modelled. An expanded Una Biological Reserve provides a buffer to more frequent disease outbreaks, but not more severe ones.

To buffer against more severe disease outbreaks, and in order not to have all GHLTs in the proverbial “one basket” it would be advisable to have at least one other substantial GHLT population in another area.

SDB appears to hold the potential to provide a solid backup GHLT population. Even under the worst scenario modelled, probability for extinction within 100 years remains zero and 97% of gene diversity can be retained after 100 years. As an isolated area, SDL does not have this potential. Further work is needed to investigate whether SDL can function as an important stepping stone between SDB and Una, or rather works as a sink.

From the viewpoint of GHLT conservation, it would be important to include as large a proportion of the <400 meter altitude area as possible into the new UCs in SDB and SDL, and/or to encourage and maintain suitable forms of cabruca in the lower lying areas outside the proposed UCs, as well as in the areas between Una Biological Reserve, SDL and SDB.

It is currently not yet known if the western GHLT populations (living under very different ecological circumstances) are genetically and substantially different from the populations in the east. If this would be the case, the Una Biological Reserve, SDB and SDL would only provide a safeguard for the gene pool and natural history strategies typical for the eastern populations.

Black Lion Tamarin Population Model

Introduction

The black lion tamarin (BLT), *Leontopithecus chrysopygus*, is the only lion tamarin species that occurs inland in the Atlantic forests. One large population inhabits Morro do Diablo State Park in western São Paulo state, with an additional 10 small, fragmented populations scattered to the south and east (see Figure 14 for distribution map). The development of forest corridors is underway in the west to connect isolated populations. Perez-Sweeney (2002) observed genetic differences between the western populations and the central/eastern populations and recommended managing these populations separately. Carrying capacity was estimated based on census data of 0.033 individuals/ha for most populations (Paranhos, pers. comm.); 0.01 individuals/ha was used for Caetetus (Passos, 1997) (Table 16). Most populations were estimated at carrying capacity (all except Mosquito and Caetetus). The Diablo population was modelled as a Large population (see model description), two were considered as Small populations, and the remainder were modelled as Medium populations.

Table 16. Estimated population size and carrying capacity for current and potential BLT habitats.

Population	Est. # BLTs	Est. K	Area (ha)	Population size*
West				
Diabo	1131	1131	34,000	Large
Tucano	47	47	1458	Medium
Ponte Branca	41	41	1276	Medium
Santa Maria	15	15	467	Small
Santa Monica	15	15	457	Small
East				
Mosquito	11	45	1385	Medium
Caetetus	23	37	2282	Medium
Rio Claro	45	45	1360	Medium
Angatuba	77	77	2305	Medium
Buri	134	134	3998	Medium
*Paranapiacaba***	*300*	*300*	*100,000*	*Medium*

* Small, Medium or Large population as defined in the baseline model. ** Potential population (unk. density)

The BLT Working Group identified the following questions to be addressed by the model:

1) What is the projected viability of the metapopulation, comprised of 10 isolated individual populations?

2) What is the viability of the western metapopulation and of the eastern metapopulation when considered separately?

3) How does connectivity among the four small western populations affect their long-term viability?

4) How would the presence of a BLT population in the Serra de Paranapiacaba area affect metapopulation and eastern population viability? How does viability differ if this population is isolated vs. connected to the Buri populations via corridors?

5) How might an increase or decrease in carrying capacity affect population viability?

6) Is translocation among existing BLT populations beneficial to individual population and metapopulation viability?

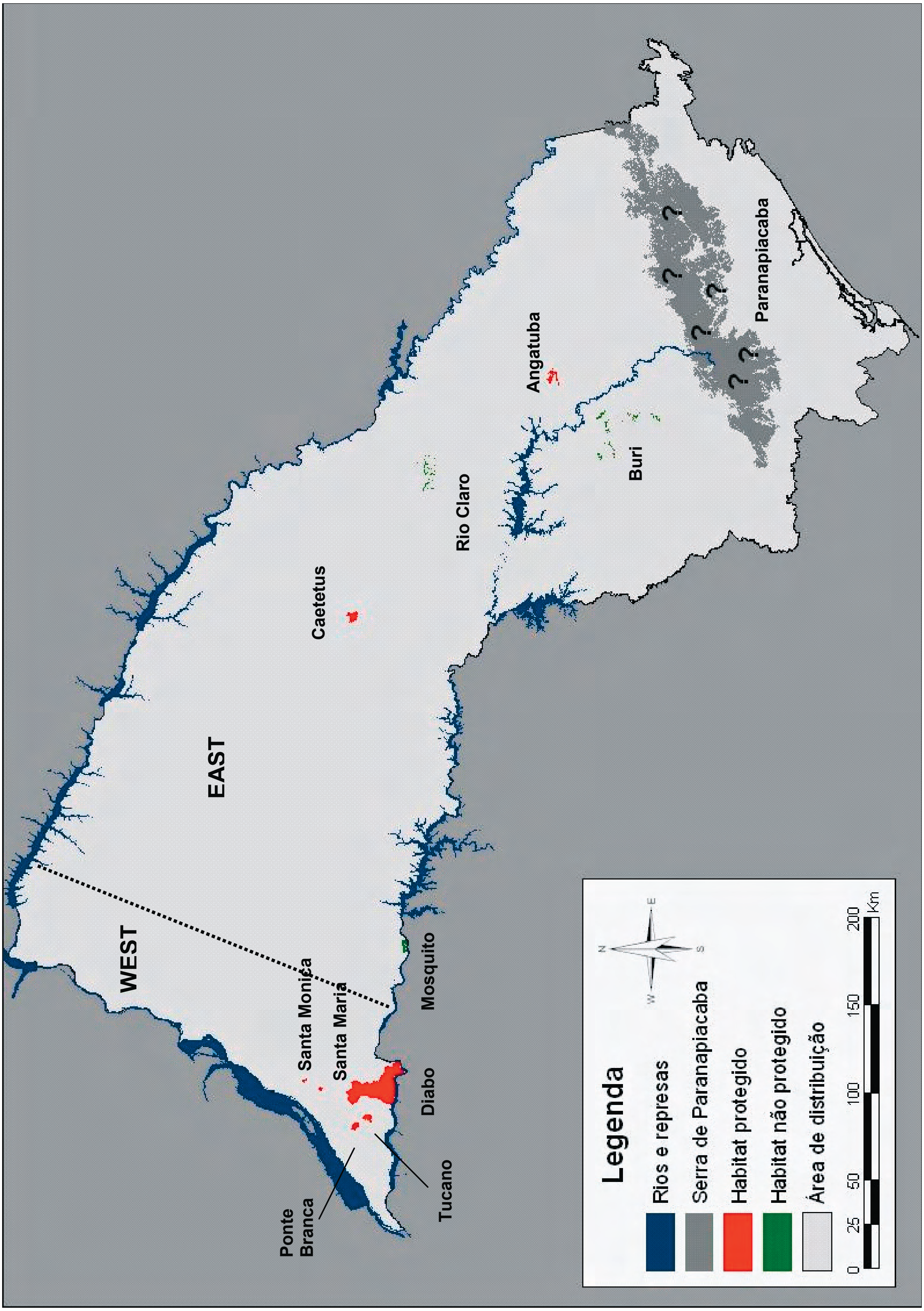


Figure 14. Map depicting current and potential habitat for black lion tamarins.

BLT *Vortex* Model Parameters

Vortex v9.60 was used to model BLT populations. For the most part, the BLT *Vortex* model used the baseline parameters for Small, Medium and Large populations, as appropriate. Two catastrophes were added to all scenarios, in addition to the Meso-Predator catastrophe for Small populations. Anticipated habitat loss was included for five areas in the central/eastern region (see below for details). Most scenarios included 10 known populations, 5 in the west and 5 in the east. A potential BLT population may exist in Serra de Paranapiacaba to the southeast; this population was included only in Scenarios 4 and 6.

Number of catastrophes:
The BLT model includes the following three catastrophes, which were modelled as occurring independently (locally) for each population:

	Disease	Fire	Meso-Predator*
Probability of occurrence	1%	5%	10%
Severity factor (multiplier) for reproduction	1.0	1.0	1.0
Severity factor (multiplier) for survival	0.5	0.9	0.5

* Small populations only (Santa Maria and Santa Monica)

Habitat loss:
Habitat loss is anticipated for areas in the eastern portion of BLT range and was incorporated into the BLT baseline model as a decline in carrying capacity. These 5 areas (Mosquito, Caetetus, Rio Claro, Angatuba and Buri) were modelled as losing 0.3% of its current area per year for the next 20 years, resulting in a total loss of 6% of carrying capacity for each area.

Scenario 1: Viability of Current BLT Metapopulation

What is the projected viability of the metapopulation, comprised of 10 isolated individual populations?

The management goal set by workshop participants in 1997 and again in 2005 is to manage a metapopulation that collectively retains 98% of its gene diversity with no more than 2% risk of extinction for 100 years. At the 1997 PHVA workshop the viability of the BLT metapopulation was evaluated based on 7 isolated populations (1 large population in Diabo and 6 smaller populations, with a total N = 927 and K = 1306) and with the addition of 18-32 smaller forest fragments managed through translocation. In all cases the metapopulation was not projected to meet the management goal; although extinction risk was low (PE = 1.7% for the 7 isolated populations model), only about 96% gene diversity was retained over 100 years (Ballou *et al.* 1998).

Since that time several translocations have occurred, and new estimates of BLT population size and occurrence are available. The *Vortex* model was used to reassess the viability of the current BLT metapopulation based on these new estimates.

Vortex Parameters

The baseline model included the 10 known populations listed in Table 16 (N = 1539, K = 1587) but did not include the potential population in Paranapiacaba. These populations were modelled as isolated populations with no connectivity among forest patches.

Results

Model results based on the best estimates of population size and carrying capacity indicate that the BLT metapopulation has little to no risk of extinction over the next 100 years and retains 98.8% of its gene diversity, thereby meeting current management goals. Metapopulation viability is dependent upon the large population in Diabo (PE = 0, GD = 98.5%). The next largest population, Buri (K = 134), has a low probability of extinction but loses substantial genetic variation (GD = 85%). Other individual populations are much smaller (< 100), experience low or even negative growth rates, lose significant levels of genetic variation (GD = 54% - 73%), and are at much higher risk of extinction (Figure 15).

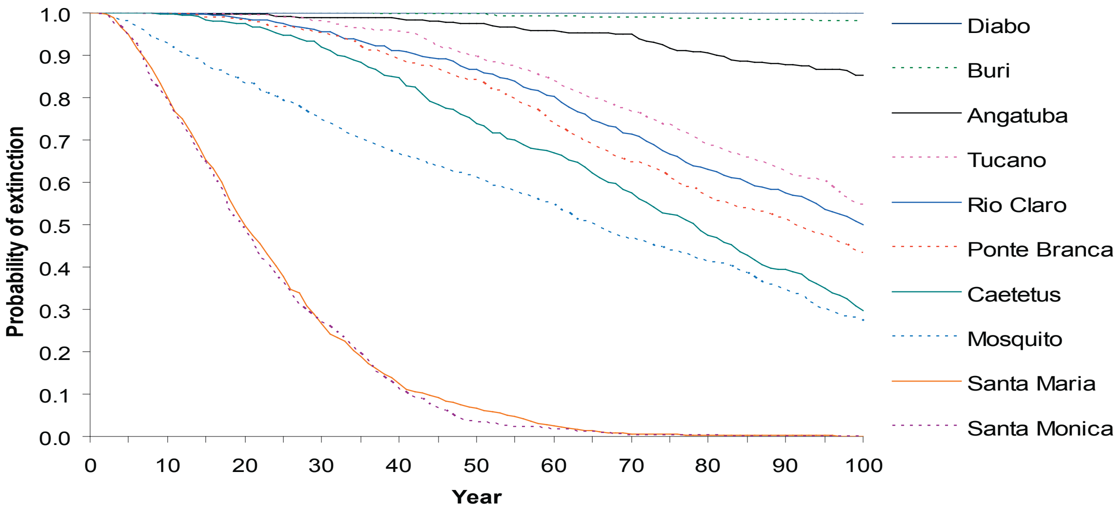


Figure 15. Probability of extinction of isolated individual BLT populations over 100 years (legend indicates order of lines on graph).

Summary

Using the current population estimates, the BLT metapopulation is projected to meet the management goal of retaining 98% gene diversity and having at least 98% probability of persistence over 100 years, with no translocations or additional corridors. Most populations are small and are likely to be lost over time. Although the Buri population appears to be at little risk of extinction in the model, primarily due to size, Buri does not represent one population but a small metapopulation of potentially connected fragments (see Figure 14) and is likely at higher risk of extinction and loss of genetic diversity than projected by the model. The population in Diabo represents the only large and relatively secure population for BLTs, and the viability of this species likely depends upon this population.

Scenario 2: Genetic Distinction between West and East Populations

What is the viability of the western metapopulation and of the eastern metapopulation when considered separately?

There is some evidence that black lion tamarin populations in the western portion of the species' range (Pontal region) are genetically distinct from central and eastern populations (Perez-Sweeney 2002). Is each of these two metapopulations viable if managed separately?

Vortex Parameters

Scenarios were run for the West metapopulation (5 populations, with N = K = 1222) and the East metapopulation (5 populations, with N = 290, K = 338), with no connectivity among populations.

Results

Long-term projections for the West metapopulation are quite good, with PE = 0, GD = 98.6% and a mean population size of 1090 tamarins after 100 years, which meets management goals. The Diabo population has essentially these same projections, while the remaining 4 populations have a high risk of extinction.

As modelled, the East metapopulation also is likely to persist (PE = 0), but retains less gene diversity (90.6%) and has a smaller total population size (N = 151). All five populations have some risk of extinction. Three populations (Mosquito, Caetetus, and Rio Claro) have a high risk of extinction and lose significant genetic variation, while the Angatuba and Buri populations have lower risk (14% and 3%, respectively) and retain more genetic diversity (74% and 85%, respectively) (see Table 17 for complete results for Scenarios 1-5).

Summary
If further investigation warrants the separate management of West and East BLT populations, the western BLT taxon has a high probability of persistence due to the viability of the Diabo population; other population fragments in the west may likely be lost. The eastern BLT taxon is less secure. No individual population is large enough for long-term viability, and the model projections for the Buri population may be overly optimistic given the fragmented nature of this population. Model results suggest that the East metapopulation is likely to persist and retain > 90% gene diversity, but these results should be viewed with caution.

Scenario 3: Impact of Forest Corridors on West Population

How does connectivity among the four small western populations affect their long-term viability?
When isolated, the 4 smaller western populations (those outside of Diabo) have low or negative growth rates, high probabilities of extinction and become highly inbred. Efforts are currently underway to develop habitat corridors to connect these populations to each other and with Diabo. How might the development of such corridors affect the viability of these 4 smaller populations?

Vortex Parameters
Dispersal among populations was modelled for tamarins of both sexes from 3 to 6 years, with 50% mortality occurring during dispersal. Corridors were modelled as shown in Figure 16, using the following annual dispersal rates (expressed as percents):

Source population	Recipient population				
	Diabo	Tucano	Ponte Branca	Santa Maria	Santa Monica
Diabo		2.0	--	2.0	--
Tucano	2.0		2.0	--	--
Ponte Branca	--	2.0		--	--
Santa Maria	2.0	--	--		2.0
Santa Monica	--	--	--	2.0	

Figure 16. Map depicting habitat cooridors modelled for the West black lion tamarin metapopulation.

Results
At the level of connectivity modelled, the creation of corridors has a significant effect on the viability of the 4 smaller populations, with little negative impact upon BLTs in Diabo. All 4 populations have essentially no risk of extinction and maintain population sizes near carrying capacity with levels of gene diversity above 90% (Table 17). Metapopulation viability remains high but relatively unchanged (PE = 0%, N = 1116, GD = 98.5%).

Summary
The creation of corridors to allow dispersal of BLTs out of Diabo and into the adjacent smaller habitat patches has the potential to allow the persistence of BLTs in these patches. Without immigration through natural dispersal or through translocation, these small populations are not likely to survive. Movement of animals can provide both demographic and genetic augmentation to these populations. Given the parameters used in the model and the estimated size of the Diabo population, connections to the small populations do not appear to act as sinks to such an extent that they jeopardize the viability of BLTs in Diabo. Modifications to the dispersing age and sex classes, rate of dispersal, and mortality during dispersal may lead to different conclusions.

Scenario 4: Impact of BLT Population in Paranapiacaba

How would the presence of a BLT population in the Serra de Paranapiacaba area affect metapopulation and eastern population viability? How does viability differ if this population is isolated vs. connected to the Buri populations via corridors?
Serra de Paranapiacaba represents a large area of potential tamarin habitat in the southeastern region of São Paulo State (Figure 14). There is some evidence of BLTs in this area, but no information was available at the PHVA workshop regarding population size or carrying capacity. If BLTs inhabit this area or were established there via translocation, how might this additional population affect the viability of the eastern metapopulation? How might a corridor between Paranapiacaba and the Buri population increase the viability of BLTs in Buri?

Vortex Parameters
Scenarios were developed that included an additional BLT population in Paranapiacaba (N = K = 300) to evaluate the effect on the East metapopulation and the entire species metapopulation. The model was run both with Paranapiacaba as an isolated population and with a corridor allowing dispersal between Buri and Paranapiacaba (3-6 year olds of both sexes, 2% annual probability of dispersal, 50% mortality during dispersal).

Results
Paranapiacaba could potentially represent the largest and most viable eastern BLT population, with PE = 0, N = 248 and GD = 93.6%.The addition of the Paranapiacaba population increases the viability of the East metapopulation by more than doubling mean population size and increasing gene diversity retention over 100 years to 96%. Viability of the species metapopulation (West and East combined) remains high, with a slightly larger mean population size. As modelled, the creation of a dispersal corridor between Buri and Paranapiacaba increases the viability of the Buri population without detrimental effects to BLTs in Paranapiacaba (Table 17).

Summary
The existence and management of a BLT population in Paranapiacaba could be of significant value to the conservation of the eastern metapopulation if West and East populations are managed separately; this is true even without corridors connecting Paranapiacaba to other habitat patches. This population represents the second largest potential BLT population and could serve as a secondary back-up population if unforeseen threats jeopardize the population in Diabo.

Scenario 5: Changes in Carrying Capacity

How might an increase or decrease in carrying capacity affect population viability?
Several factors could change in the future that could affect population size and/or carrying capacity of forest patches for BLTs. Habitat loss through deforestation or conversion, or changes in habitat quality due to impacts by humans or invasive species, could decrease carrying capacity. Other management actions might be able to increase habitat area and/or quality, leading to an increase in carrying capacity. Therefore, it would be valuable to know how population size affects BLT population viability.

Vortex Parameters
Single isolated populations of varying size were modelled, from N = 25 to N = 1500, to assess the impact on measures of population viability.

Results
Populations of 150 have a low probability of extinction (2.2%) but lose significant genetic variation (GD = 87%). A population of 250 fares better (PE = 0.2%, GD = 92%), and population sizes of 500 or more resulted in no risk of extinction and GD > 96%. More than 750 tamarins are needed in a single population (or metapopulation with sufficient connectivity to act as a single population) to meet the management goal of at least 98% chance of persistence and 98% retention of gene diversity (Figure 17).

Summary
Populations of fewer than 150 tamarins are not likely to persist without some form of supplementation. Populations of at least 250-500 tamarins are needed to maintain high levels of gene diversity with little risk of extinction. Currently, only the population in Diabo, and possibly a population in Paranapiacaba, meet these requirements for population size. These model results can help managers to prioritize efforts to expand carrying capacity and/or prevent habitat loss for those patches that are most realistically viable and contributed to metapopulation viability.

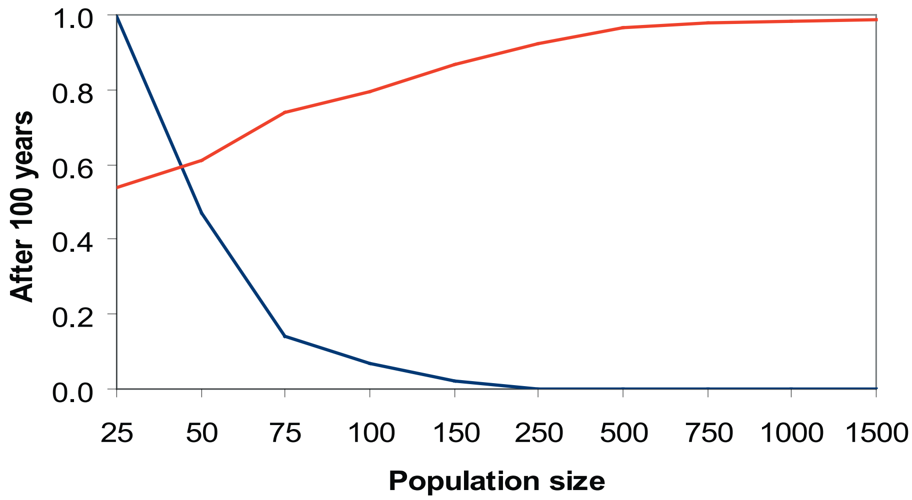


Figure 17. Probability of extinction / gene diversity retained over 100 years for isolated populations of varying size.

Scenario 6: Impacts of Translocation

Is translocation among existing BLT populations beneficial to individual population and metapopulation viability?
There are several relatively small populations in the central and eastern portion of BLT range that are too far apart to be connected by habitat corridors. These populations, however, could be supplemented through translocation. Several translocation scenarios were suggested by the BLT Working Group to be explored through the *Vortex* model.

Vortex Parameters
Translocation was modelled as the transfer of a number of "groups" from one population to another, with each group consisting of 1 adult pair (1 male, 1 female) and 1 2-year-old pair (1 male, 1 female). In *Vortex*, these individuals are chosen randomly from the population and do not represent breeding pairs and their offspring, which is the transfer unit that would likely be used in actual translocations. Therefore, *Vortex* simulates translocation demographically but likely overestimates the genetic contribution of translocation by transferring non-family members within each group.

For each translocation scenario, a total of 5 translocation events were modelled, each of which occurred in a different year. Each event involved the transfer of 3 groups (12 tamarins) during a specific year, for a total of 60 tamarins moved from one population to another over 5 different years of translocation. Unless otherwise noted, these 5 translocations occurred in Years 1-5 in the model. Mortality during translocation was set at 18.5%, and translocations were not made into saturated habitat. Five different translocation options were explored; model inputs and results are discussed below and are presented in Table 18.

Translocations to Mosquito
Two different source populations were considered for translocations to Mosquito: Diabo as a sole source, and Diabo (2 translocations) and Buri (3 translocations) as a dual source. Translocations over the first 5 years improve population size, growth, and probability of persistence, but still do not lead to a long-term viable population (PE = 47%) and have no effect on metapopulation viability. Diabo is a large population that can withstand the short-term loss of 60 individuals with no long-term negative effects; the significantly smaller Buri population is less able to recover from the loss of 36 tamarins over 3 years, leading to an increase of risk of extinction from 2% to 10%. If Buri were used as a source population due to logistical, genetic or other concerns, care should be taken not to remove too many animals in a short time period to avoid negative impacts on the Buri population.

The impact of translocations, upon both the source and the recipient populations, is influenced by the timing of those transfers. Translocations can boost genetic variation through the addition of unrelated individuals, but gene diversity will then again decline; therefore, periodic translocations may have greater positive effects on population status at Year 100. Five translocations from Diabo to Mosquito were modelled over 90 years (translocation event at Years 10, 30, 50, 70, 90) and compared to the same number of translocations over Years 1-5. Population viability for Mosquito improved dramatically, increasing mean population size and gene diversity, and reducing the risk of extinction to 2%. A similar benefit would be expected from other large source populations such as Buri or Paranapiacaba. Periodic translocations over time have the potential to produce significantly greater benefits than several immediate translocation events followed by population isolation.

Caetetus Expansion/Translocations
Two management scenarios were considered for the augmentation of the Caetetus population. It may be possible to expand the habitat and therefore carrying capacity from 37 to 110 tamarins. Second, translocations were considered from either Diabo or Rio Claro. All combinations of these management options were evaluated.

Expansion of habitat (carrying capacity) in Caetetus may significantly improve the viability of a BLT population in this area, increasing population size 11-fold and reducing the risk of extinction from 70% to 18%. In the absence of habitat expansion, translocation has little impact on the Caetetus population, as the population is too small for long-term viability. If the carrying capacity can be increased, however, translocations can provide a genetic boost and help the population to grow quickly to fill the additional habitat, resulting in larger mean population size, increased retention of gene diversity, and lower risk of extinction (Table 18). All scenarios modelled have little impact on the metapopulation or Diabo as a source population. Rio Claro (K=45), however, does not have enough animals to provide large numbers for translocation within a short time period, and caution should be used before removing animals for translocation.

Rio Claro Expansion/Translocation
Similar to the scenarios for Caetetus, two management scenarios were considered for augmentation of the Rio Claro population. It may be possible to expand the carrying capacity of this area from 45 to 66

tamarins. Second, translocations were considered from either Diabo or Paranapiacaba. All combinations of these management options were evaluated.

Expansion of habitat (carrying capacity) in Rio Claro may improve the viability of a BLT population in this area, increasing population size and reducing the risk of extinction from 50% to 24%. Unlike Caetetus, short-term translocations (Years 1-5) provide relatively little benefit to Rio Claro even with an increase in K, in part because there is less opportunity for the population to expand. If, however, the same 5 translocations were spread out over 90 years (1 translocation event each at Years 10, 30, 50, 70, 90), viability is greatly improved, with PE = 1% and GD = 85%. Translocations have no impact on the relatively large source populations in Diabo and Paranapiacaba or on species metapopulation viability.

Merging Angatuba and Buri

The BLT Working Group considered the possibility of joining the Buri and Angatuba populations, whether through habitat corridors or translocations, which would result in a total carrying capacity of 211 tamarins for a combined area. Merging these two populations results in a larger population in this area that has little risk of extinction (PE = 0.4%) and retains 90.7% gene diversity. This has little impact on the species metapopulation, but does slightly improve the viability of the eastern population if it is managed as a separate taxon, particularly in the absence of BLTs in Paranapiacaba.

Paranapiacaba as a Source Population

If a large BLT population exists in Paranapiacaba, it has the potential to be the best source population for translocations for the eastern taxon. Two translocation scenarios were modelled in which Paranapiacaba provided 3 BLT groups (1 translocation event) each year for 15 years, with 5 translocations each occurring to Buri, Angatuba and Rio Claro. Under immediate, short-term management, translocations occur each year (once every 3 years per area), while under long-term management, translocations occur once every 6 years (once every 18 years per area), as follows:

	Short-term	Long-term
Translocations to Buri:	*Years 1, 4, 7, 10, 13*	*Years 6, 24, 42, 60, 78*
Translocations to Angatuba:	*Years 2, 5, 8, 11, 14*	*Years 12, 30, 48, 66, 84*
Translocations to Rio Claro:	*Years 3, 6, 9, 12, 15*	*Years 18, 36, 54, 72, 90*

Each of these management scenarios results in the removal of 12 tamarins per year for 15 years, for a total of 180 tamarins removed from Paranapiacaba (60 to each population). As noted in earlier scenarios, immediate short-term translocations provide little long-term benefit to these populations with their current limited carrying capacity. In addition, Paranapiacaba cannot sustain such intense removals, with the risk of extinction increasing from essentially zero to 43%. If, however, the same number of removals are spread out over 90 years, all 3 recipient populations benefit in terms of population size, genetic diversity and risk of extinction, particularly Rio Claro, while the impact on Paranapiacaba is greatly reduced (Figure 18). Metapopulation viability is not affected by either translocation strategy.

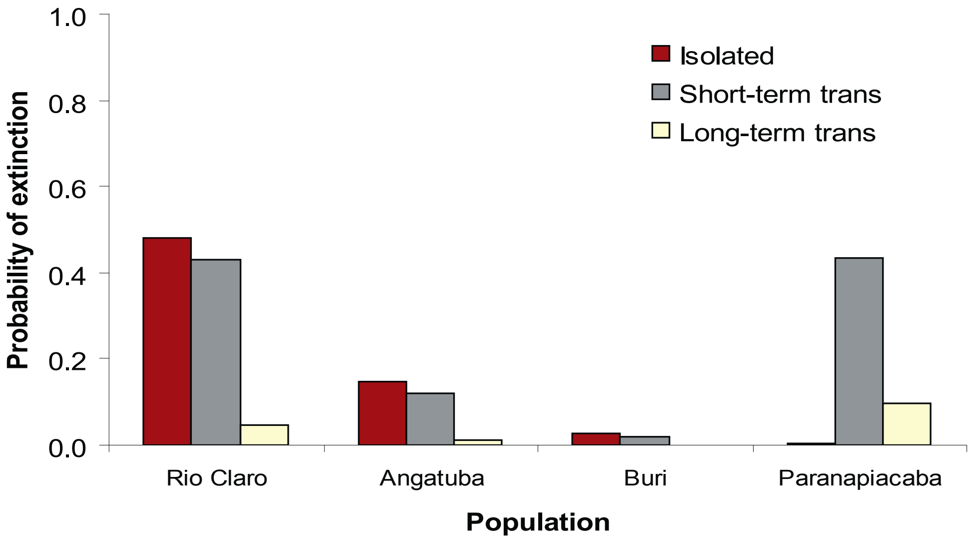


Figure 18. Probability of extinction after 100 years for each population with no translocations and with 5 translocations from Paranapiacaba to each of the other 3 populations over either 5 or 90 years.

Summary of Translocation Results

Population size is a critical factor in individual population viability. Translocation may provide demographic or genetic rescue to small populations, but does not improve the long-term viability of these populations without continued periodic supplementation. Translocation alone does not improve metapopulation viability, either for the eastern taxon or for the species as a whole. When combined with increased carrying capacity, however, translocation may provide substantial benefits to the recipient population and potentially to the metapopulation if these populations become large enough. If translocation is considered as a management strategy, care should be taken to minimize the risk to the source population. Source populations should be large, and removals should not be excessive over a short time period such that the source population cannot recover.

The translocation strategies modelled here assume the transfer of specific numbers of tamarins in certain age and sex classes, translocation mortality rates, breeding and survival rates of translocated individuals, and translocation intervals. Modification of these input values may have implications for translocation model results. Other factors (ecological, genetic, behavioral) may also be considered when developing a translocation strategy. Further detailed and comprehensive modelling efforts are recommended before undertaking translocations among black lion tamarin populations.

Summary of BLT Model Results

Using current population and carrying capacity estimates, the black lion tamarin metapopulation is projected to meet the management goal of retaining 98% gene diversity and having at least 98% probability of persistence over 100 years, with no translocations or additional corridors. Population size is a key factor affecting viability for individual populations, with populations of at least 250-500 tamarins needed to maintain high levels of gene diversity with little risk of extinction. Currently, the population in Diabo represents the only large and relatively secure population for BLTs, and the viability of this species may depend upon this population. Most other known populations are small and are likely to be lost over time without immigration of additional tamarins either through dispersal corridors or via translocation. The existence and management of a BLT population in Serra de Paranapiacaba could be of significant value to the conservation of the eastern metapopulation if West and East populations are managed separately; this is true even without corridors connecting Paranapiacaba to other habitat patches.

Connectivity of western populations through habitat corridors and periodic translocation efforts targeting eastern populations have the potential to maintain these populations through continued immigration of tamarins into these areas. The maintenance of small populations (<100 tamarins) is not likely to contribute to metapopulation viability, which is more dependent upon the preservation of the larger populations such as in Diabo, Paranapiacaba and possibly Buri and Angatuba. Preservation of smaller populations and their habitats, however, may be beneficial in protecting a matrix of forest patches and ecosystems and may enable them to function as backup “insurance” populations that may become important if unforeseen factors threaten the larger populations in the future. Efforts to substantially increase the carrying capacity of small populations to over 100 tamarins may provide greater benefits than translocation efforts alone. These model results should be viewed as preliminary, but may help to guide managers in prioritizing efforts to preserve or expand habitat and to consider corridors or translocation efforts for those patches that are most realistically viable and may contribute to metapopulation viability.

Table 17. Simulation results for BLT Scenarios 1 - 5 over 100 years (PE = probability of extinction; N = mean population size; GD = gene diversity; stochastic r; MTE = mean time to extinction in years).

Population	Scenario	PE	N	GD	Stoch. r	MTE
Metapopulation Viability						
Metapopulation	Baseline (isolated)	0	1236	0.988	0.051	--
	W/ Parana (isolated)	0	1479	0.990	0.051	--
	Corridor to Parana.	0	1479	0.990	0.050	
West Population						
Metapopulation	Isolated	0	1090	0.986	0.054	--
	With Corridors	0	1116	0.985	0.031	--
Diabo	Isolated	0	1067	0.985	0.056	--
	With Corridors	0	1004	0.985	0.026	--
Tucano	Isolated	0.446	14	0.608	0.005	68
	With Corridors	0	45	0.952	0.068	--
Ponte Branca	Isolated	0.544	9	0.569	0.000	62
	With Corridors	0	38	0.934	0.050	--
Santa Maria	Isolated	1.000	--	--	-0.028	24
	With Corridors	0	15	0.914	0.089	--
Santa Monica	Isolated	1.000	--	--	-0.035	22
	With Corridors	0.006	14	0.901	0.060	56
East Population						
Metapopulation	Isolated	0	151	0.906	0.026	--
	W/ Parana. (isolated)	0	394	0.961	0.036	--
	Corridor to Parana.	0	405	0.961	0.026	--
Mosquito	Isolated	0.670	7	0.528	0.002	47
	W/ Parana. (isolated)	0.744	5	0.533	-0.003	44
	Corridor to Parana.	0.732	5	0.534	-0.028	50
Caetetus	Isolated	0.664	5	0.521	-0.002	61
	W/ Parana. (isolated)	0.692	5	0.535	-0.002	57
	Corridor to Parana.	0.696	5	0.531	-0.041	59
Rio Claro	Isolated	0.530	10	0.606	0.002	68
	W/ Parana. (isolated)	0.520	10	0.584	0.001	64
	Corridor to Parana.	0.482	12	0.588	-0.004	66
Angatuba	Isolated	0.144	38	0.737	0.016	66
	W/ Parana. (isolated)	0.130	38	0.744	0.017	76
	Corridor to Parana.	0.154	37	0.737	-0.006	74
Buri	Isolated	0.032	91	0.852	0.029	74
	W/ Parana. (isolated)	0.020	88	0.845	0.028	73
	Corridor to Parana.	0	103	0.930	0.031	--
Paranapiacaba	W/ Parana. (isolated)	0	248	0.936	0.039	--
	Corridor to Parana.	0	242	0.944	0.026	--
Impact of Changes in Population Size / Carrying Capacity						
N = 25	Single population	0.994	0	0.539	-0.034	32
N = 50	Single population	0.472	14	0.610	0.003	68
N = 75	Single population	0.142	37	0.740	0.016	74
N = 100	Single population	0.068	61	0.794	0.023	77
N = 150	Single population	0.022	108	0.869	0.031	78
N = 250	Single population	0.002	195	0.922	0.038	86
N = 500	Single population	0	458	0.967	0.053	--
N = 750	Single population	0	697	0.978	0.055	--
N = 1000	Single population	0	927	0.983	0.054	--
N = 1500	Single population	0	1392	0.989	0.056	--

Table 18. Simulation results for BLT Scenario 6 over 100 years (PE = probability of extinction; N = mean population size; GD = gene diversity; stochastic r; MTE = mean time to extinction in years).

Population	Scenario	PE	N	GD	Stoch. r	MTE
Translocations to Mosquito						
Mosquito	Isolated	0.728	6	0.552	0.000	48
	From Diabo	0.470	12	0.609	0.027	69
	From Diabo and Buri	0.502	10	0.607	0.024	66
	From Diabo (90 yrs)	0.022	30	0.853	0.032	41
Effect on Buri	Isolated	0.020	93	0.853	0.027	67
	Trans to Mosquito	0.100	82	0.828	0.017	43
Expansion/Translocations to Caetetus						
Caetetus (K = 37)	Isolated	0.702	5	0.538	-0.003	61
	From Diabo	0.658	6	0.543	0.021	64
	From Rio Claro	0.640	6	0.531	0.021	65
Caetetus (K = 110)	Isolated	0.176	55	0.766	0.022	54
	From Diabo	0.036	69	0.818	0.038	77
	From Rio Claro	0.044	68	0.819	0.038	70
Effect on Rio Claro	Isolated	0.500	11	0.597	0.003	64
	Trans to Caetetus	0.956	1	0.610	-0.114	13
Expansion/Translocations to Rio Claro						
Rio Claro (K = 45)	Isolated	0.500	11	0.597	0.003	64
	From Diabo	0.472	12	0.592	0.017	68
	From Parana.	0.474	11	0.599	0.017	69
Rio Claro (K = 66)	Isolated	0.238	29	0.708	0.014	72
	From Diabo	0.188	30	0.712	0.024	70
	From Parana.	0.204	29	0.708	0.024	71
	From Parana (90 yrs)	0.012	45	0.851	0.030	60
Angatuba/Buri						
Angatuba	Isolated	0.146	38	0.726	0.016	70
Buri	Isolated	0.020	93	0.853	0.027	67
Angatuba/Buri	Merged	0.004	154	0.907	0.035	92
East metapop.	Isolated (w/o Paran.)	0	151	0.906	0.026	--
	Merged (w/o Paran.)	0.002	177	0.918	0.032	96
	Isolated (w/ Parana.)	0	394	0.961	0.036	--
	Merged (w/ Parana.)	0	425	0.964	0.039	--
Paranapiacaba as a Source						
Buri	Isolated	0.028	88	0.849	0.027	74
	From Parana.	0.018	92	0.856	0.034	74
	From Parana (90 yrs)	0	98	0.892	0.035	--
Angatuba	Isolated	0.146	39	0.747	0.017	71
	From Parana.	0.122	41	0.756	0.026	75
	From Parana (90 yrs)	0.010	52	0.848	0.031	72
Rio Claro	Isolated	0.480	11	0.578	0.002	64
	From Parana.	0.432	12	0.626	0.017	72
	From Parana (90 yrs)	0.046	28	0.829	0.026	66
Paranapiacaba	Isolated	0.002	248	0.935	0.038	88
	To 3 pops.	0.434	133	0.915	0.001	15
	To 3 pops. (90 yrs)	0.098	209	0.929	0.024	71

Black-Faced Lion Tamarin Population Model

Introduction

The black-faced lion tamarin (BFLT), *Leontopithecus caissara*, inhabits a small coastal region of Atlantic forest along the border of Sao Paulo and Parana States. Distribution of this species consists of a small mainland population and a nearby island population on Superagui, which was isolated from the mainland about 60 years ago by construction of the Varadouro Channel. Little information is known on the mainland population – at the time of the PHVA, only 11 individuals were known, all in the Ariri region. Satellite imagery was used to identify potential habitat on the mainland and estimate connectivity. Three populations (two mainland, one island) are estimated to currently exist, and potential areas for future translocation efforts were also identified (see Figure 19 for map of these areas). Estimates of current population size and carrying capacity are listed in Table 19 and were calculated based on information from the BFLT report compiled for the PHVA (carrying capacity calculations assume a home range of 255ha based on 4 groups on Superagui, 19% overlap and average group size of 5.12 animals) and subsequent discussions by the BFLT Working Group. All populations were considered as medium-sized populations for the purposes of model input values. Currently there are no captive populations of this species.

Table 19. Estimated population size and carrying capacity for current and potential BFLT habitats.

Population	Est. # BFLTs	Est. K	Area (ha)	Population size
Island				
Superagui	190	200*	11459	Medium
Mainland				
Ariri	105	156	6302	Medium
Rio dos Patos	50	74	2986	Medium
Potential sites				
Taquari	0	221	8911	Medium
Sebui	0	74	2972	Medium
East Ariri	0	50	2030	Medium

* Revised from initial estimate of 284.

The BFLT Working Group identified the following questions to be addressed by the model:

7) What is the projected viability of the estimated mainland and island populations and species metapopulation? How does viability differ using minimum, maximum and best guess estimates of current population size and carrying capacity?

8) How does connectivity of these populations affect their long-term viability?

9) How might reduction or loss of the Superagui island population affect species viability?

10) Can the Superagui population withstand the occasional loss of individual tamarins?

11) Is translocation among existing BFLT populations beneficial to species metapopulation viability?

12) Is translocation of BFLTs to potential unoccupied adjacent habitats beneficial to species metapopulation viability? How many translocations are needed to establish new viable populations?

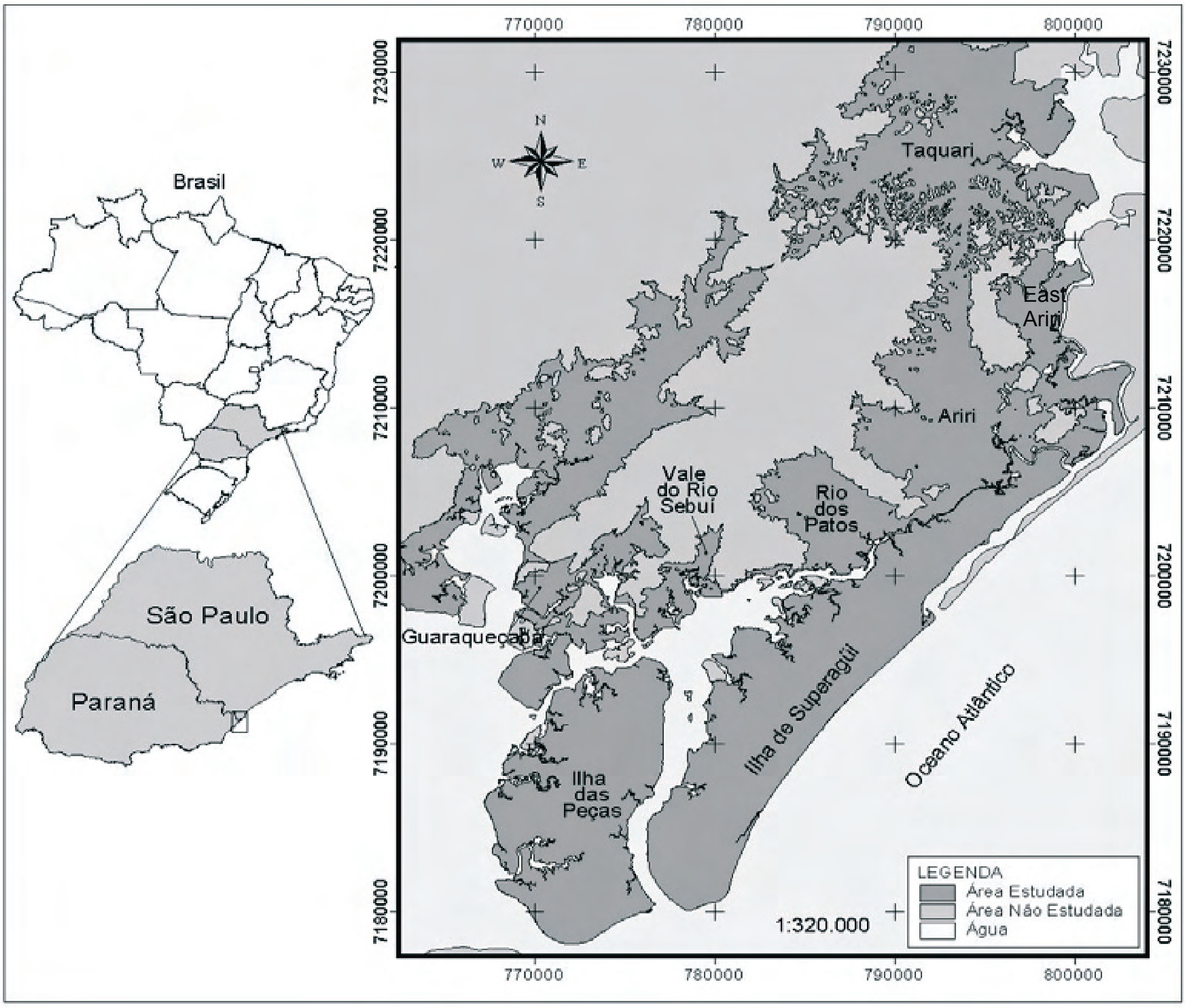


Figure 19. Map depicting current and potential habitat for black-faced lion tamarins.

BFLT *Vortex* Model Parameters

Vortex v9.60 was used to model BFLT populations. For the most part, the BFLT *Vortex* model used the baseline parameters for Medium populations. Two catastrophes were added to all scenarios, and dispersal rates were estimated among the mainland populations, both current and potential. Anticipated habitat loss was included for three areas (Ariri, Superagui and Taquari), and harvest (short-term) was included for Superagui (see below for details).

Number of catastrophes:
The BFLT model includes the following two catastrophes, which were modelled as occurring independently (locally) for each population:

	Disease	Fire
Probability of occurrence	1%	1%
Severity factor (multiplier) for reproduction	0.7	0.9
Severity factor (multiplier) for survival	0.5	0.7

Dispersal rates:
Dispersal among the mainland populations was modelled for 2- and 3-year-old tamarins of both sexes, with 50% mortality occurring during dispersal. The Superagui island population is isolated from all other populations. The following annual dispersal rates (expressed as percents) were used for adjacent tamarin habitats:

Source population	Recipient population				
	Ariri	Rio dos Patos	Taquari*	Sebui*	E Ariri*
Ariri		1.4	1.4	--	1.4
Rio dos Patos	2.9		--	2.9	--
Taquari*	1.0	--		--	1.0
Sebui*	--	2.9	--		--
E Ariri*	4.5	--	1.0	--	

* only used in Translocation scenarios, as appropriate

Habitat loss:
Habitat loss is anticipated for the Ariri and Taquari regions and on Superagui, and was incorporated into the BFLT baseline model as a decline in carrying capacity. Ariri was modelled as losing 1% of its current area per year for the next 15 years, resulting in a total loss of 15% of carrying capacity; nearby Taquari (potential BFLT habitat) was modelled as losing 1% for the next 20 years (total of 20% loss of current carrying capacity). Superagui was modelled as losing 0.05% of its current area per year for the next 40 years, resulting in a total loss of 2% of its carrying capacity.

Harvest:
The loss of BFLTs is believed to occur on Superagui, through hunting or other human-related deaths or removals, and is anticipated to continue over the next few years before it can be completely stopped. The baseline model incorporated the harvest of 1 adult male and 1 adult female BFLT each year for the next 5 years from Superagui.

Reproductive success:
Some reproductive data were available for the BFLT population on Superagui. Of 12 adult female tamarins captured in 2004, 7 (58%) had at least one infant. Of these, 6 (86%) had two offspring, and 1 (14%) had a single offspring. These data differ from the GLT values of 73% of females breeding. However, the GLT values are based upon 21 years of data, and the single year data for BFLTs fall within two standard deviations (based on EV) for percent of females breeding. Therefore, the values for GLT were used in these analyses. It should be noted, however, that changing the percent of females to 58% and revising annual production of offspring to 14% for 1 and 86% for 2 offspring results in a reduction of the deterministic growth rate from $r = 0.104$ to $r = 0.054$; this also would negatively impact stochastic growth rates and population viability.

Scenario 1: Viability of Current BFLT Metapopulation

What is the projected viability of the estimated mainland and island populations and species metapopulation? How does viability differ using minimum, maximum and best guess estimates of current population size and carrying capacity?

The management goal set by workshop participants for GLTs was to manage a metapopulation that collectively retained 98% of its gene diversity with no more than 2% risk of extinction for 100 years. Prior to this PHVA the viability of the BFLT metapopulation had not been assessed for its ability to achieve similar management goals. The paucity of data regarding the distribution and size of BFLT populations and the carrying capacity of the habitat make it more difficult to assess species viability. The BFLT Working Group provided maximum, minimum and best guess estimates for the size of each population; carrying capacity (K) for maximum and minimum scenarios were extrapolated proportionately from the best guess for K.

Vortex Parameters

Baseline input values were used for all scenarios, with the exception of changes to initial population size and carrying capacity as follows:

Population	Baseline (best guess)		Maximum		Minimum	
	Initial N	Initial K	Initial N	Initial K	Initial N	Initial K
Superagui	190	200	355	374	102	107
Ariri	105	156	195	291	56	84
Rio dos Patos	50	74	93	139	27	40
Metapopulation	345	430	643	804	185	231

Results

Model results based on the best guess estimates of population size indicate the BFLT metapopulation has little to no risk of extinction over the next 100 years (given the parameter estimates included in the model) and retains about 95% of its gene diversity. Each of the three individual populations have relatively low risk of extinction, with Rio dos Patos being most vulnerable (PE = 6%) and retaining the least gene diversity (GD = 81.4%). All populations show a positive stochastic growth rate of about 2 - 4% (see Table 21 for complete results for Scenarios 1 - 4).

The accuracy of population estimates and carrying capacity does have implications for long-term population viability. Although PE = 0 for the metapopulation even with minimum population estimates, the resulting mean population size is only about 20% of that using maximum estimates, and gene diversity retained ranges from 97.4% (maximum) to 88.5% (minimum). These trends are magnified for the individual populations; the viability of Rio dos Patos is particularly affected by population estimates, with PE ranging from 0.2% to 40% based on maximum vs. minimum estimates, respectively (see Figure 20).

Summary

Using the maximum population estimates, the BFLT metapopulation comes close to meeting the management goal set for GLTs of retaining 98% gene diversity and having at least 98% probability of persistence over 100 years (with no translocations). The best guess estimates for this species indicate a relatively viable metapopulation. Superagui is the largest and most secure of the three populations under all conditions, and Rio dos Patos is the most vulnerable, with a relatively high probability of extinction, population decline, and loss of gene diversity using minimum population estimates.

Uncertainty in Estimates of Reproductive Success

An alternative scenario was run using baseline input values but decreasing reproductive success using estimates for percent of females breeding and annual offspring distribution based on BFLT data from 2004. Table 21 illustrates the resulting reduction in population viability, particularly for Rio dos Patos. Although these values are based on only one year of data, this result emphasizes the importance of accurate estimates of these parameters for projecting long-term population viability.

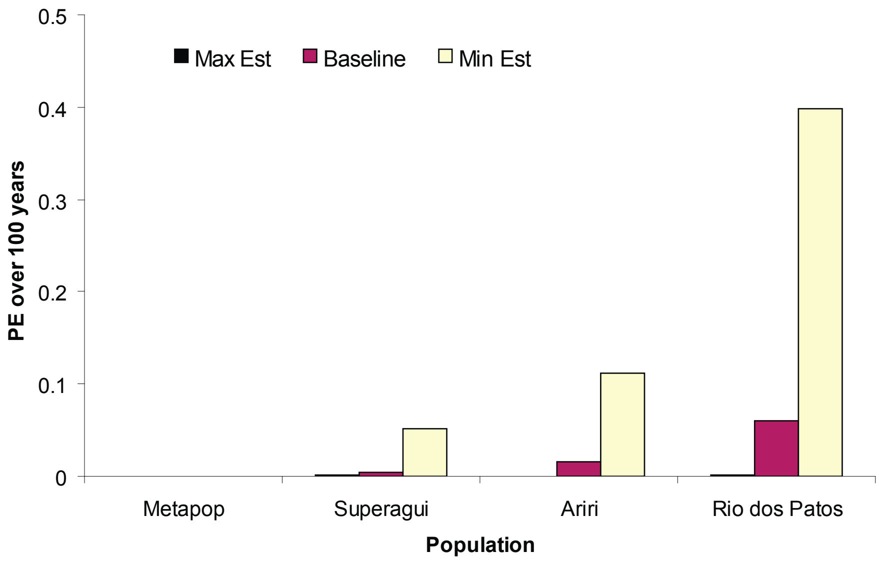


Figure 20. Probability of extinction for the BFLT metapopulation and individual populations using maximum, best guess and minimum population estimates.

Scenario 2: Effects of Dispersal Rates

How does connectivity of these populations affect their long-term viability?

The island population on Superagui is isolated from the two mainland populations. There is some connectivity of habitat between the Ariri and Rio dos Patos regions on the mainland; however, the actual degree of dispersal of BFLTs between these habitats is unknown.

Vortex Parameters

Three levels of dispersal were tested: baseline (best guess) estimates, higher degrees of dispersal (twice baseline estimates), and no dispersal (i.e., three isolated populations).

Results

Model results show no effect on metapopulation viability across the range of dispersal rates modelled. A slight effect was observed for the Ariri population. The population in Rio dos Patos is smaller and therefore benefits most from dispersal; when isolated, this population has a 15% chance of extinction over 100 years and retains only 74.2% gene diversity.

Summary

Connectivity may be important in maintaining smaller BFLT mainland populations, such as the one estimated for Rio dos Patos, but does not appear to be critical for species viability given the relatively large population on Superagui.

Scenario 3: Impact of Island Population on Species Viability

How might reduction or loss of the Superagui island population affect species viability?

Superagui is believed to support the largest population of BFLTs, but as an island population is vulnerable to changes in sea levels as well as other factors. How might the reduction or loss of this population affect the long-term viability of BFLTs?

Vortex Parameters
Scenarios were created to evaluate the importance of the Superagui population to species viability, as follows: 1) 37% reduction in habitat (modelled as N_{init} = K = 126), which could occur through sea encroachment or other factors; and 2) total loss of Superagui population.

Results
Reduction of habitat leads to a slightly higher risk of extinction (2.4% vs. 0.4%) and a greater loss of gene diversity (84.5% vs. 90.3%) due to decreased population size on Superagui. There is little effect on metapopulation viability with habitat reduction. Total loss of the Superagui population has a greater effect, primarily on population size (141 vs. 295 total tamarins) and corresponding reduction in gene diversity (89.7% vs. 94.9%). However, probability of species extinction is very low (0.8%), even with the loss of Superagui.

Summary
Given the input values used in the BFLT model, the Superagui population does not appear to be critical to the persistence of this species over the next 100 years. Loss of the island population, however, reduces BFLT numbers by over 50% and causes gene diversity to be lost more rapidly, making this species more vulnerable to extinction over longer time periods and/or in the face of additional threats not included in this model.

Scenario 4: Effects of Harvest on Superagui

Can the Superagui population withstand the occasional loss of individual tamarins?
Some BFLT groups are habituated to humans near the villages on Superagui, which may result in the occasional loss or death of tamarins. The baseline model includes the harvest of 1 adult male and 1 adult female each year for the next 5 years.

Vortex Parameters
Three additional scenarios were modelled: the loss of 2 adult males and 2 females per year and the loss of 3 adult males and 3 females per year over the next 5 years, as well as no loss of tamarins.

Results
There was no significant change in any of the measures of population viability for either the metapopulation or the Superagui population over the range of losses modelled.

Summary
The short-term loss of up to 6 adult tamarins per year is not expected to affect population viability, as the positive growth rate allows the population to quickly recover. Figure 21 illustrates the increased rate of population decline under higher rates of loss for the first 5 years; after harvest is eliminated starting at Year 6, the population recovers in about 15 years. Continued removal of individuals over time, however, may possibly have adverse effects.

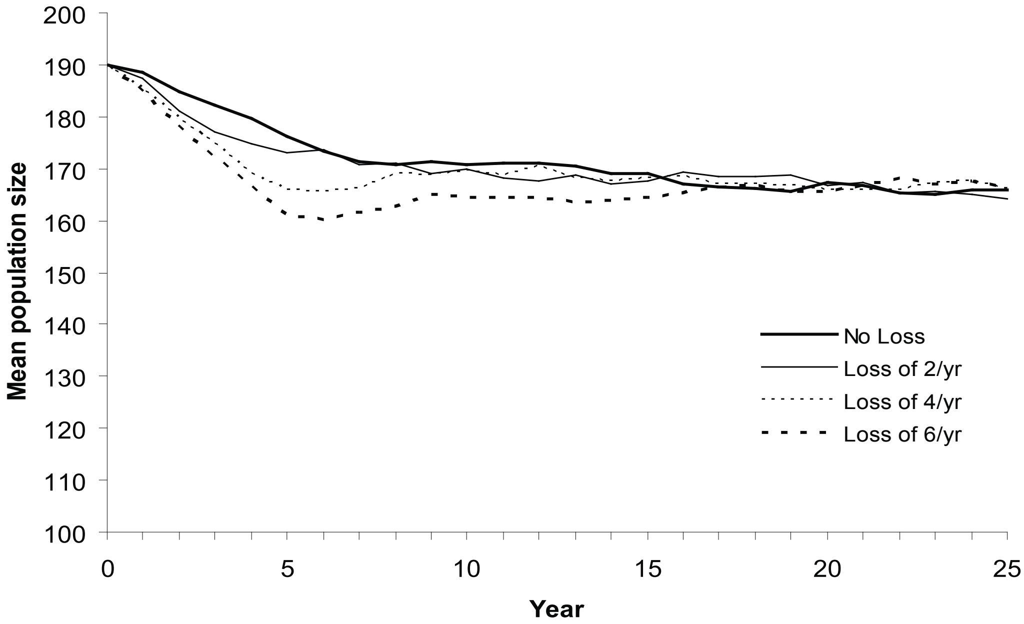


Figure 21. Mean population size for BFLTs on Superagui under various harvest rates for the first five years.

Scenario 5: Impacts of Translocation Among Populations

Is translocation among existing BFLT populations beneficial to species metapopulation viability?

There is limited connectivity between Ariri and Rio dos Patos, and no connectivity between these mainland populations and Superagui. Translocation of BFLTs among these areas was investigated for its potential to slow the loss of gene diversity, reduce inbreeding, and reduce the risk of extinction in individual populations as well as the species metapopulation.

Vortex Parameters

Translocation was modelled as the transfer of 1 adult pair (1 male, 1 female) and 1 2-year-old pair (1 male, 1 female) from one population to another. In *Vortex*, these individuals are chosen randomly from the population and do not represent breeding pairs and their offspring, which is the transfer unit that would likely be used in actual translocations. Therefore, *Vortex* simulates translocation demographically but likely overestimates the genetic contribution of translocation by transferring non-family members. Mortality during translocation was set at 18.5%, and translocations were not made into saturated habitat.

The impact of translocations is dependent upon both the number of groups transferred and the timing of those transfers. Translocations can boost genetic variation through the addition of unrelated individuals, but gene diversity will then again decline; therefore, later translocations may have a greater effect on population status at Year 100. These variables were tested by modelling translocation at Years 25, 50 or 75, with each translocation involving 1 or 3 groups. The source – recipient populations were defined as follows:

Source	Recipient
Rio dos Patos	Ariri
Superagui	Rio dos Patos
Ariri	Superagui

Results

Translocation of 1 to 3 groups of BFLTs as modelled had no noticeable effect on mean population size or probability of extinction over 100 years for any of the individual tamarin populations or the metapopulation as a whole. There were some modest genetic effects observed, with greater impacts with more and later translocations as expected. Only Rio dos Patos (the smallest population) benefited from one-time translocation, with an increase in gene diversity and decrease in average inbreeding. All populations showed lower inbreeding levels with multiple translocations, with later translations being more effective (Table 20).

Table 20. Mean inbreeding coefficient after 100 years for each BFLT population and metapopulation under various translocation strategies.

Scenario	Superagui	Ariri	Rio dos Patos	Metapop
No Translocation	0.0820	0.1081	0.1514	0.1000
1 Trans @ Y25	0.0846	0.1055	0.1482	0.1004
1 Trans @ Y50	0.0811	0.1040	0.1428	0.0975
1 Trans @ Y75	0.0818	0.1091	0.1343	0.0969
3 Trans @ Y25	0.0801	0.1039	0.1415	0.0965
3 Trans @ Y50	0.0762	0.0989	0.1304	0.0901
3 Trans @ Y75	0.0729	0.0979	0.1135	0.0856

Summary
Occasional translocations among existing populations may be beneficial in reducing inbreeding levels within small populations. This benefit will be dependent upon a variety of factors, including the timing of such translocations, the reproductive success of the translocated animals, and the level of relatedness among translocated individuals and between source – recipient populations. There is no substantial benefit to the species metapopulation over 100 years with those translocation scenarios tested with the *Vortex* model.

Scenario 6: Impacts of Translocation to Unoccupied Areas

Is translocation of BFLT to potential unoccupied adjacent habitats beneficial to species metapopulation viability? How many translocations are needed to establish new viable populations?
Three areas of potential BFLT habitat were identified that are adjacent to existing BFLT mainland populations – Taquari, Sebui and East Ariri (see Figure 19). How might expansion of BFLT distribution to these areas impact species viability, and how many translocations might be needed to establish BFLTs in these areas?

Vortex Parameters
Each translocation event was modelled as the transfer of 1 adult pair and 1 pair of 2-year-olds as described in Scenario 5. Translocations to a new area occurred over 4, 6, 8 or 10 consecutive years, with the first half of translocated groups coming from Ariri and the second half from Superagui. Therefore, new areas were stocked with between 16 to 40 BFLTs. No further translocations took place after the initial establishment of the population. Mortality during translocation was modelled as 18.5%, and translocations were not made into saturated habitat. Translocations were modelled separately for each of the three potential BFLT habitats; additional scenarios were also developed for translocations into all three areas simultaneously.

Working group members hypothesized that an East Ariri tamarin population might be more vulnerable to predation and disease; therefore, additional scenarios were developed in which mortality was increased by 10% for all age and sex classes in East Ariri (deterministic r = 0.084 instead of 0.103).

Results
Table22 gives the model results for these translocation scenarios. Probability of extinction for the species metapopulation remains 0 for all scenarios. Other measures of metapopulation viability – mean population size and amount of gene diversity retained – improve with the establishment of additional BFLT populations. Viability increases more with the addition of larger populations – with some benefit from

the recovery of East Ariri, more with Sebui, and the most with Taquari (Figures 22 and 23). Concurrent translocations into all three areas result in the most benefit to the species metapopulation, although the metapopulation still does not meet the GLT goal of 98% gene diversity.

Individual populations can be established with 6 - 10 initial translocations but experience some risk of extinction (1 - 13%) and maintain substantially lower levels of gene diversity (78% - 89%) than the metapopulation. At least 6 translocations (and up to 10 or more for smaller populations) may be needed to establish these populations, depending on size and other factors. East Ariri is most vulnerable and may require more translocation events, possibly due a combination of small population size and relatively high dispersal to Ariri in the model. If East Ariri is subject to higher levels of mortality, the probability of extinction can be substantially higher (24 - 29%).

The viability of individual populations under simultaneous translocation efforts is similar to that in comparable single area translocations, with the following exceptions. East Ariri shows higher viability (lower risk of extinction and higher retention of gene diversity) when all three areas are recovered rather than just East Ariri, probably because Taquari can then act as a second source of natural immigrants. Superagui begins to show signs of reduced viability (reduced size, lower gene diversity, higher probability of extinction, shorter time to extinction) after more than 3 consecutive years of tamarin removals to supply animals for translocation. A similar effect was not observed for the Ariri population.

Summary

The recovery of new BFLT populations via translocation may contribute positively to species metapopulation viability. Smaller areas of habitat, such as East Ariri, may require greater translocation efforts and may benefit from connectivity to multiple adjacent populations. Care should be given to adjust the removal of tamarins from source populations such that these populations are not negatively impacted through rapid loss of BFLTs over several years.

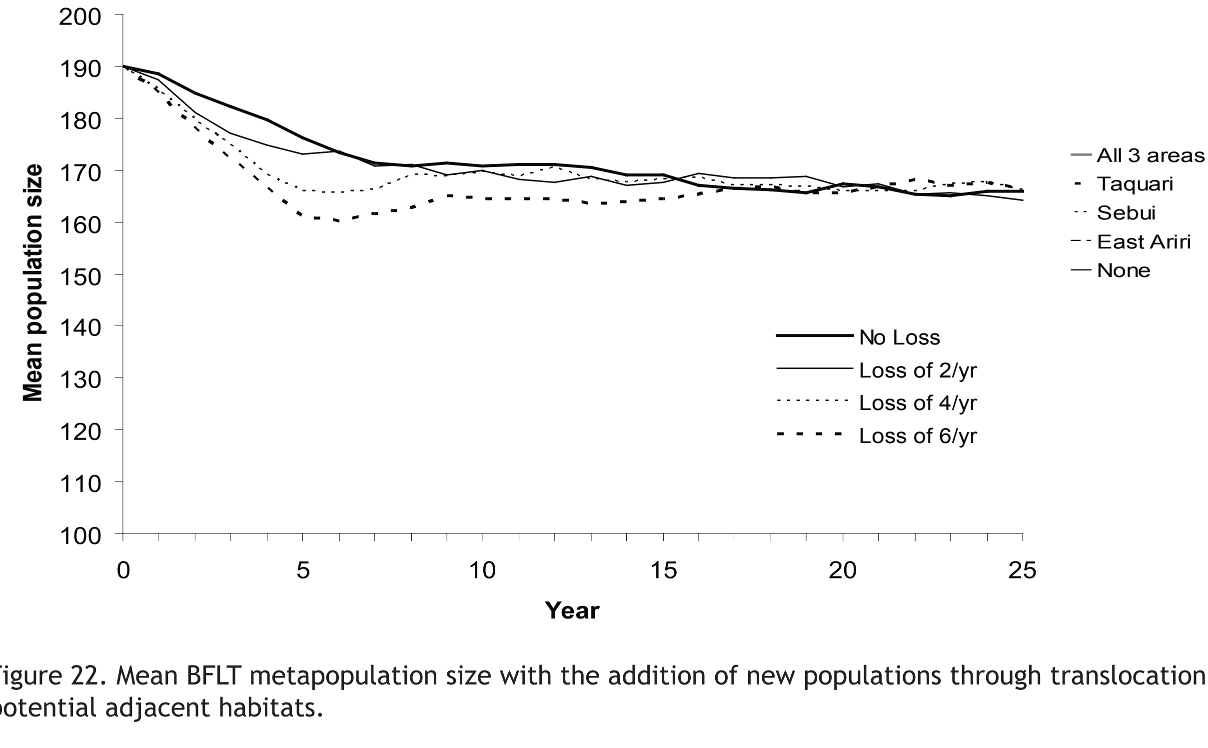


Figure 22. Mean BFLT metapopulation size with the addition of new populations through translocation into potential adjacent habitats.

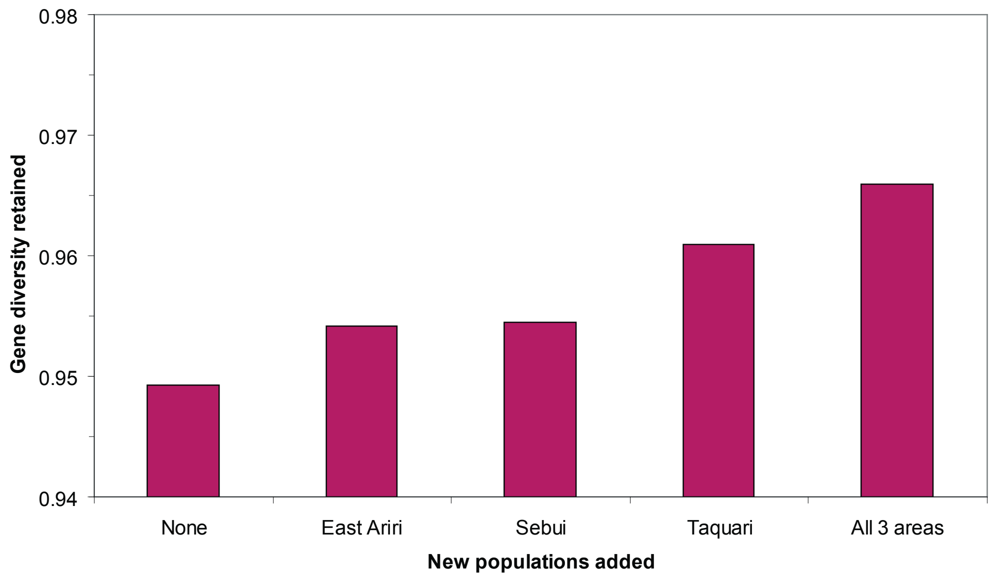


Figure 23. Gene diversity for BFLT metapopulation after 100 years with the addition of new populations through translocation into potential adjacent habitats.

Table 21. Simulation results for BFLT Scenarios 1 - 4 over 100 years (PE = probability of extinction; N = mean population size; GD = gene diversity; stoch. r = stochastic r; mean TE = mean time to extinction in years).

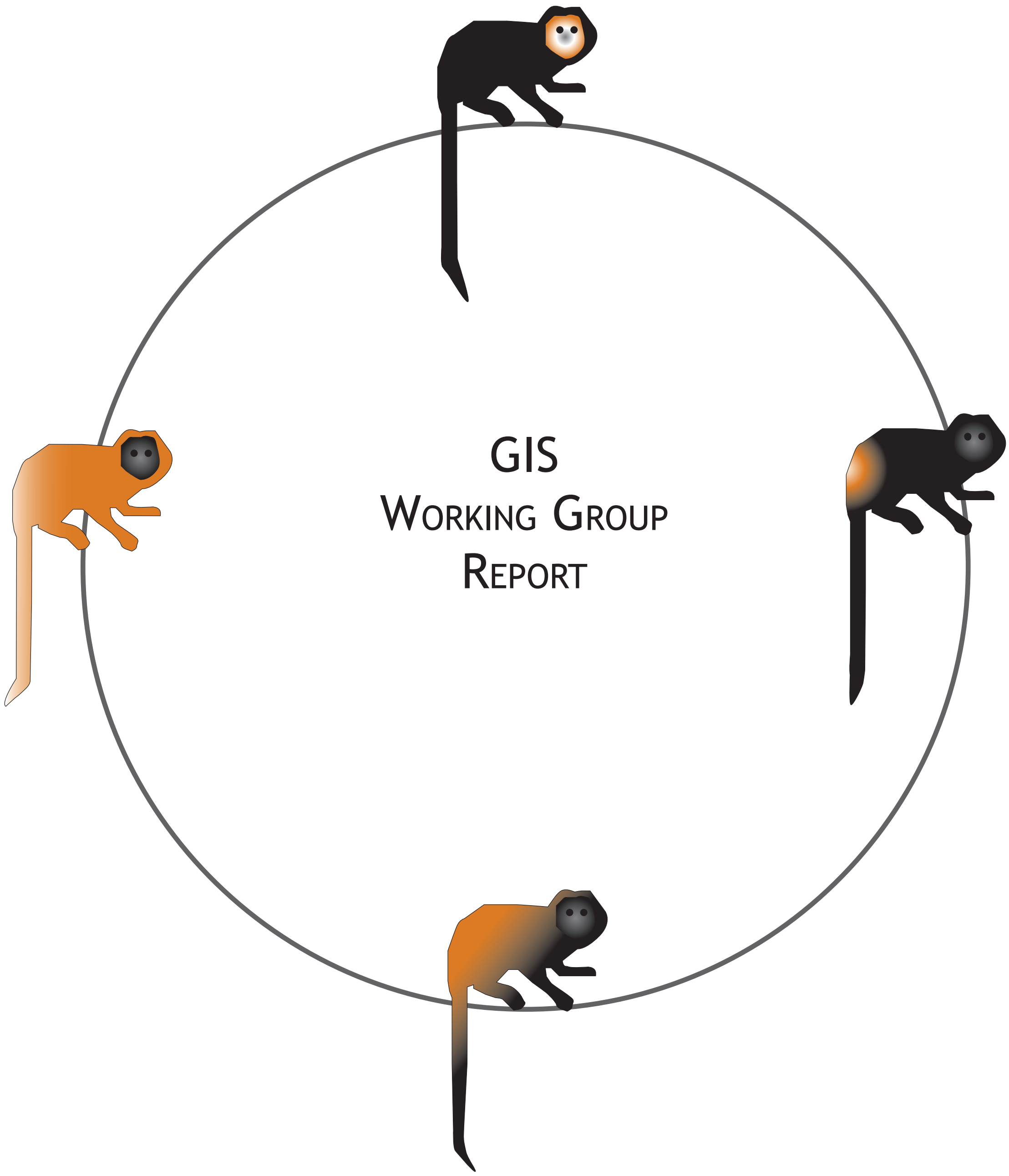
Population	Scenario	PE	N	GD	Stoch. r	Mean TE
Population Viability						
Metapopulation	Maximum	0	609	0.974	0.044	--
	Baseline	0	295	0.949	0.038	--
	Minimum	0	119	0.885	0.026	--
Superagui	Maximum	0.002	303	0.948	0.041	87
	Baseline	0.004	154	0.903	0.036	83
	Minimum	0.052	70	0.820	0.025	71
Ariri	Maximum	0	202	0.935	0.038	--
	Baseline	0.016	97	0.877	0.032	83
	Minimum	0.112	38	0.744	0.016	71
Rio dos Patos	Maximum	0.002	104	0.898	0.032	71
	Baseline	0.060	45	0.814	0.021	72
	Minimum	0.398	12	0.663	0.006	62
Effect of Reproductive Success						
Metapopulation	Baseline	0	295	0.949	0.038	--
	Low BrSucc	0.012	146	0.909	0.001	86
Superagui	Baseline	0.004	154	0.903	0.036	83
	Low BrSucc	0.102	87	0.871	-0.002	75
Ariri	Baseline	0.016	97	0.877	0.032	83
	Low BrSucc	0.212	47	0.825	-0.006	71
Rio dos Patos	Baseline	0.060	45	0.814	0.021	72
	Low BrSucc	0.468	13	0.744	-0.014	66
Effect of Dispersal Rates						
Metapopulation	Dispersal x 2	0	298	0.950	0.037	--
	Baseline	0	295	0.949	0.038	--
	Isolated	0	293	0.947	0.038	--
Ariri	Dispersal x 2	0.004	99	0.884	0.030	70
	Baseline	0.016	97	0.877	0.032	83
	Isolated	0.020	98	0.854	0.031	79
Rio dos Patos	Dispersal x 2	0.028	46	0.840	0.020	69
	Baseline	0.060	45	0.814	0.021	72
	Isolated	0.152	40	0.742	0.019	71
Reduction / Loss of Island Population						
Metapopulation	Baseline	0	295	0.949	0.038	--
	Reduction	0	234	0.937	0.035	--
	Mainland only	0.008	141	0.897	0.032	66
Superagui	Baseline	0.004	154	0.903	0.036	83
	Reduction	0.024	89	0.845	0.029	70
Harvest on Superagui						
Metapopulation	No Loss	0	295	0.949	0.037	--
	Baseline (2/yr x 5)	0	295	0.949	0.038	--
	Loss of 4/yr x 5	0	295	0.949	0.037	--
	Loss of 6/yr x 5	0	298	0.948	0.037	--
Superagui	No Loss	0	153	0.902	0.035	--
	Baseline (2/yr x 5)	0.004	154	0.903	0.036	83
	Loss of 4/yr x 5	0.002	153	0.903	0.035	55
	Loss of 6/yr x 5	0.006	154	0.900	0.034	70

Table 22. Simulation results for BFLT Scenario 6 over 100 years (PE = probability of extinction; N = mean population size; GD = gene diversity; stochastic r; mean TE = mean time to extinction in years).

Population	# consecutive translocations	PE	N	GD	Stoch. r	Mean TE
Translocations to Taquari						
Taquari	4	0.028	118	0.847	0.049	--
	6	0.016	127	0.866	0.053	--
	8	0.010	131	0.876	0.056	--
	10	0.016	131	0.887	0.057	--
Metapopulation	None	0	295	0.949	0.038	--
	4	0	414	0.956	0.039	--
	6	0	421	0.958	0.039	--
	8	0	423	0.959	0.038	--
	10	0	428	0.961	0.039	--
Translocations to Sebui						
Sebui	4	0.104	41	0.780	0.037	--
	6	0.084	43	0.797	0.039	--
	8	0.052	44	0.807	0.042	--
	10	0.052	44	0.805	0.042	--
Metapopulation	None	0	295	0.949	0.038	--
	4	0	340	0.955	0.037	--
	6	0	335	0.955	0.037	--
	8	0	344	0.956	0.038	--
	10	0	340	0.955	0.037	--
Translocations to East Ariri						
East Ariri	4	0.134	25	0.780	0.032	--
	6	0.124	25	0.784	0.033	--
	8	0.122	26	0.791	0.034	--
	10	0.090	26	0.780	0.037	--
Metapopulation	None	0	295	0.949	0.038	--
	4	0	323	0.953	0.036	--
	6	0	318	0.953	0.036	--
	8	0	321	0.952	0.036	--
	10	0	326	0.954	0.037	--
Translocations to East Ariri (high mortality)						
East Ariri	4	0.238	16	0.760	0.021	--
	6	0.290	16	0.764	0.022	--
	8	0.254	17	0.768	0.023	--
	10	0.262	16	0.770	0.024	--
Metapopulation	None	0	295	0.949	0.038	--
	4	0	316	0.952	0.037	--
	6	0	306	0.951	0.036	--
	8	0	308	0.952	0.035	--
	10	0	311	0.951	0.035	--
Translocations to All Three Areas						
Metapopulation	None	0	295	0.949	0.038	--
	4	0	483	0.961	0.037	--
	6	0	501	0.964	0.037	--
	8	0	499	0.965	0.037	--
	10	0	504	0.966	0.038	--

Summary of BFLT Model Results

The best estimates of population size, habitat carrying capacity and demographic rates for black-faced lion tamarins suggest that the species metapopulation is likely to persist for at least 100 years with high levels of gene diversity (but less than 98% gene diversity). Population size and reproductive and survival rates affect viability; more accurate estimates of these parameters will improve the ability to project future trends for BFLT populations. Connectivity of mainland habitats, through dispersal or translocation, may reduce inbreeding within populations, with increased benefits to small populations, but has little effect on overall metapopulation viability. The island population on Superagui is the largest individual population and is an important component of the metapopulation, but may not be critical to the persistence of the species if mainland populations are protected and do not experience increased or unforeseen threats. In contrast, Rio dos Patos provides the smallest available habitat area and is the most vulnerable of existing populations. Superagui and Ariri have the ability to sustain small, short-term losses (due to removals for translocation or other sources of tamarin removal), within limits. The expansion of the BFLT metapopulation through translocation and recovery of adjacent potential habitat patches has the potential to increase species metapopulation viability, particularly with the addition of larger populations such as Taquari.



GIS
Working Group Report

Report of the GIS (Geographic Information System) Group

By Márcio Augusto Reolon Schmidt

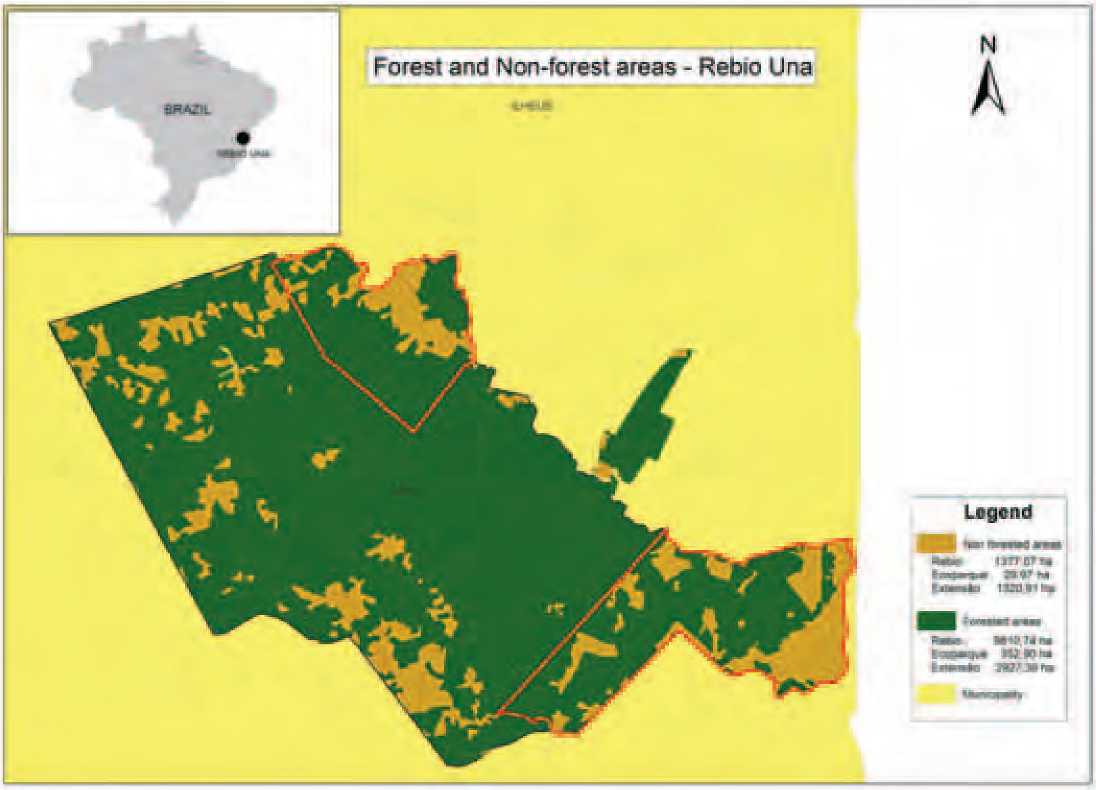
As the first modelling activity, a lecture was presented about GIS and its use in conservation action plans. Definitions and theoretical explanations on GIS were presented as well as the advantages of having such a system implemented in the organization. Several different uses of this tool were presented in order to motivate professionals and to create interest in how GIS can help the participants understand the phenomena that are observed in the field.

On the second day of the workshop, lists of lion tamarin conservation issues identified by the working groups of each species were addressed. A small group of participants interested in GIS was formed. The group consisted of Andréa Pires (Instituto Florestal do Estado de São Paulo - Forestry Institute of São Paulo State), Lúcia Agathe (IPÊ - Instituto de Pesquisas Ecológicas - Institute for Ecological Research), and Márcio A. R. Schmidt (Associação Mico Leão Dourado - Golden Lion Tamarin Association).

In the morning, the group evaluated the list of conservation issues in full detail, analyzing the needs in terms of GIS application. The result of this analysis was a list of opportunities for GIS to be used as a tool for decision making when discussing and addressing the different conservation issues, and solving the problems. The group came up with five recommendations that should be discussed in the four species specific working groups:

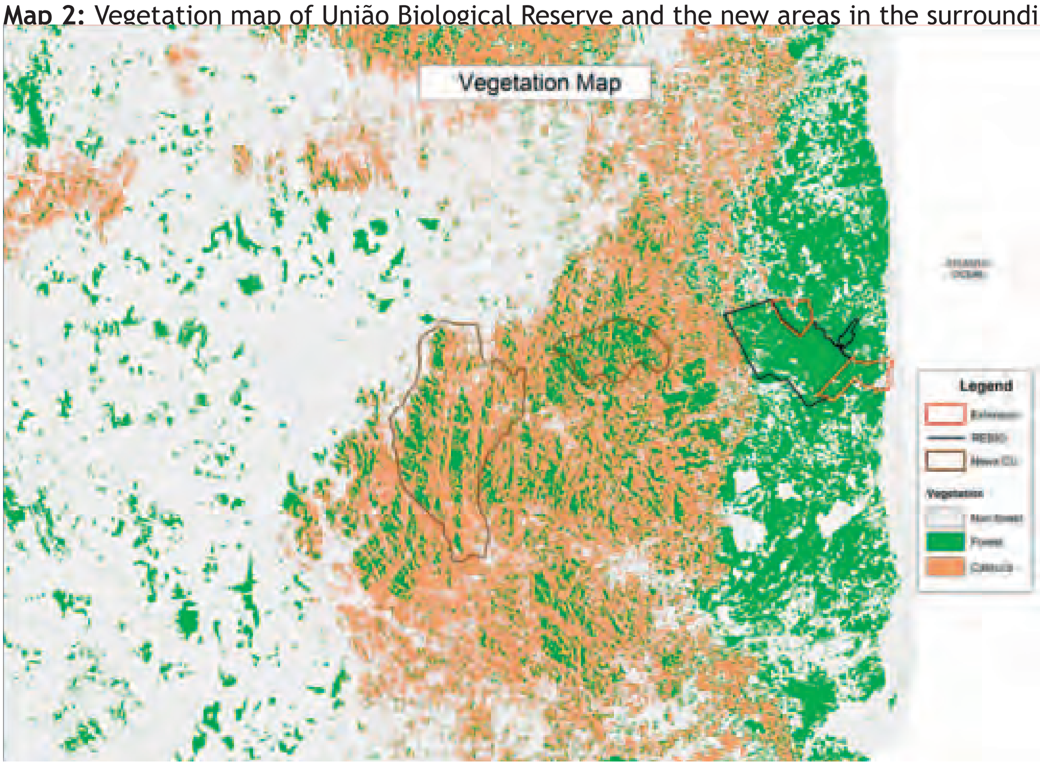
- To map and consolidate the landscape in the distribution area of the four lion tamarin species;
- To identify and prioritize specific areas of concern for management and conservation through Cost Analysis;
- To design and establish an integrated database project of the four lion tamarin species;
- To encourage governmental agencies to use GIS as a planning, monitoring and evaluation tool in conservation matters;
- To ensure the implementation and continuity of the long-term use of GIS in order to substantiate conservation research and action.

These recommendations were then incorporated in the work of the four species specific working groups.



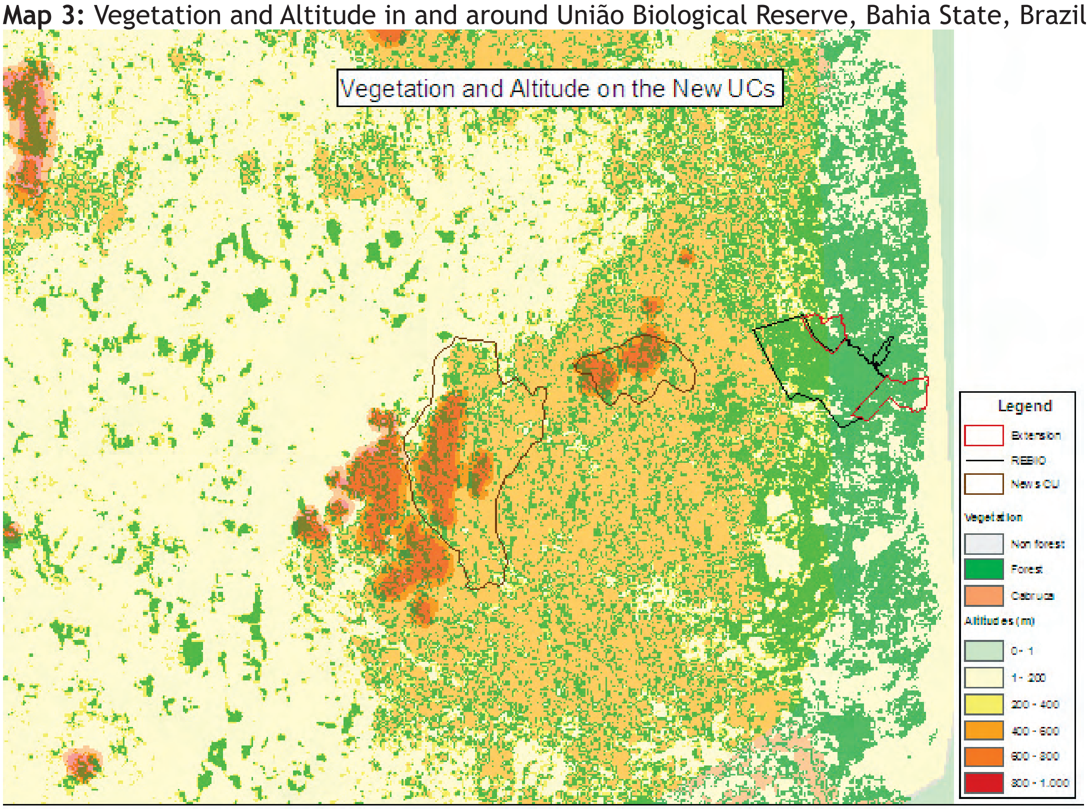
Map 1: Forested and non-forested areas inside the União Biological Reserve, Bahia State, Brazil.

Map 2: Vegetation map of União Biological Reserve and the new areas in the surroundings, Bahia State,



Brazil.

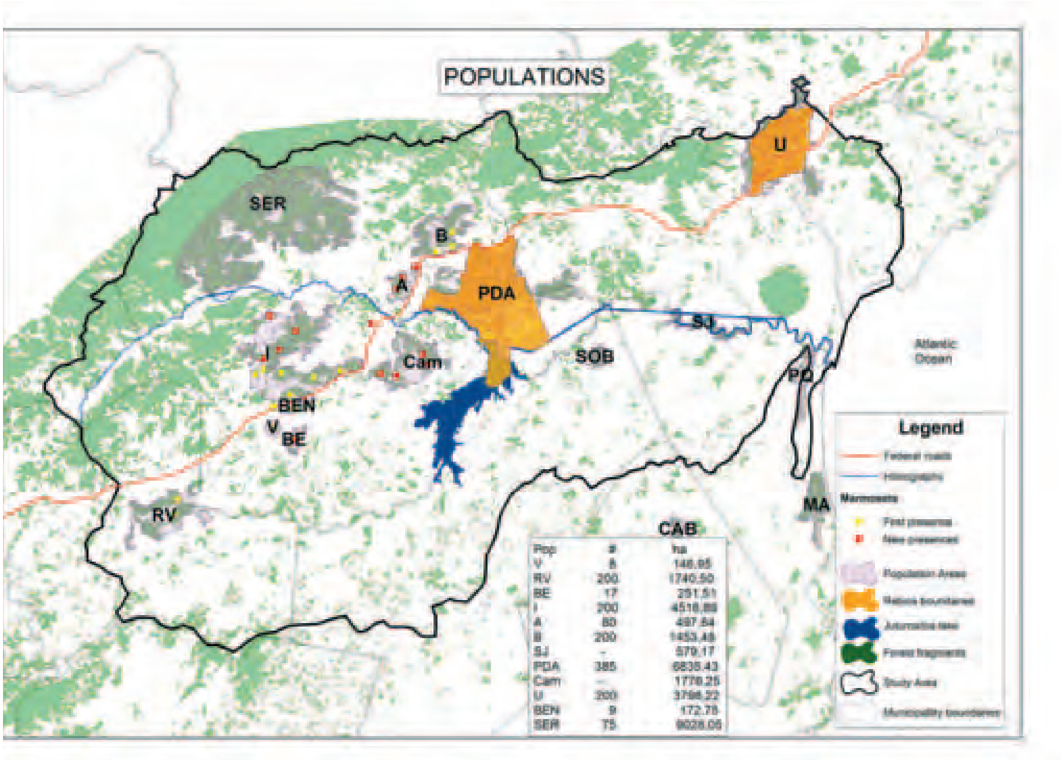
Map 3: Vegetation and Altitude in and around União Biological Reserve, Bahia State, Brazil



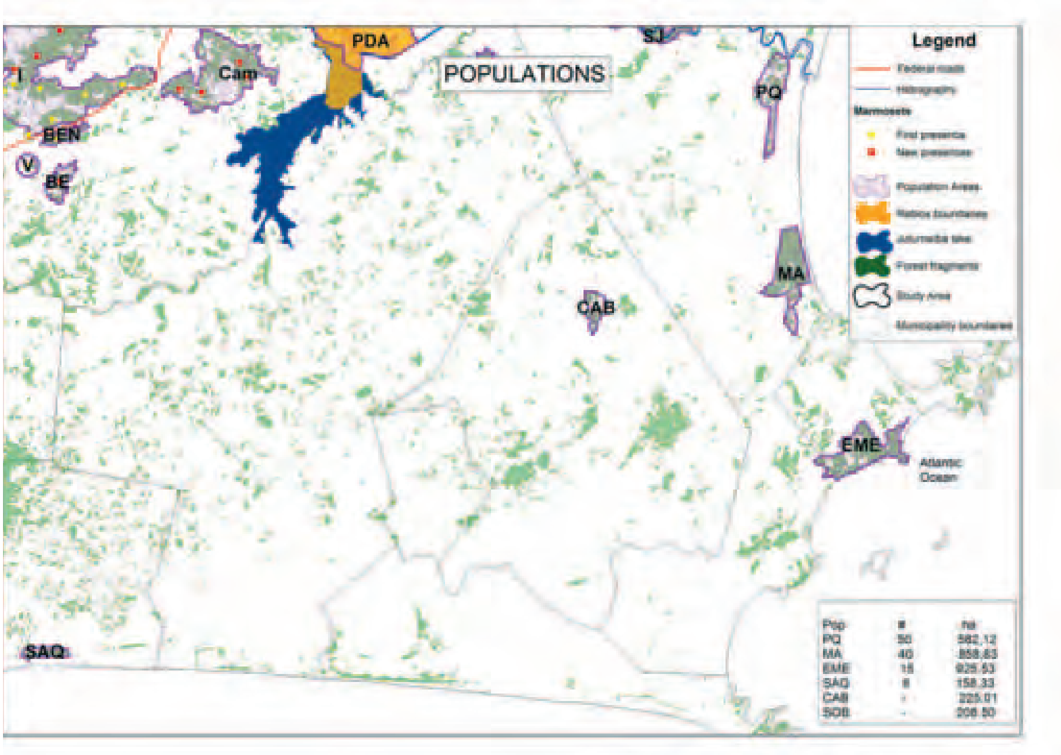
In the afternoon, the modelling work was focused on specific issues defined by the species specific working groups. The first group the GIS team worked with was the Golden Headed Lion Tamarin group. This group had very specific questions related to the amount of habitat in the protected areas and the altitude of these forest fragments in their region (see maps below):

The work of the GIS group continued to focus on answering specific questions of the species working groups, interacting with them as much as possible, as well as generating information and data to feed the Vortex modelling.

Species-Specific Conclusions:



Map 4a: Golden Lion Tamarin distribution and density, Rio de Janeiro State, Brazil.



Map 4b: Golden Lion Tamarin distribution and density, Rio de Janeiro State, Brazil.

Specifically for the Golden Lion Tamarin, the GIS group carried out an analysis of the demographic density and distribution of the populations. Results for the Golden Lion Tamarins are shown on Maps 4a and 4b.

In conclusion, the GIS group identified the urgent need to produce a list of recommendations for the Golden Headed Lion Tamarin and Black Lion Tamarin working groups, as well as to establish a strategic planning for a GIS for Black Faced Lion Tamarins. These recommendations were thoroughly discussed with representatives from each of these working groups, and these representatives were responsible for discussing our suggestions with the rest of their groups.

Recommendations for the Golden Headed Lion Tamarin:

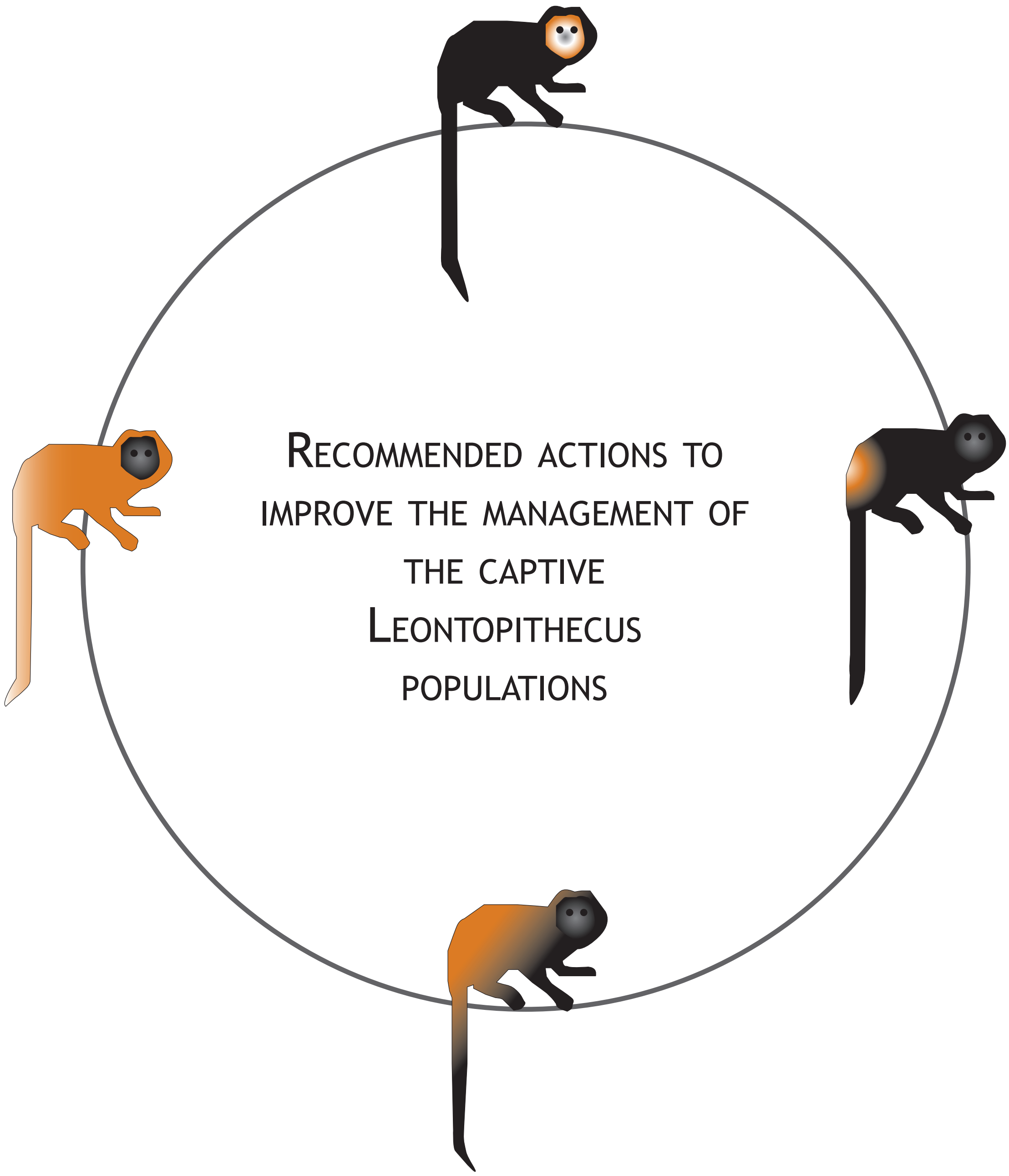
- It is recommended to maintain the information in separate functional topics such as forest fragments, infrastructure, images etc;
- The cartographic database of the species can be developed further and maintained up to date through the interpretation and classification of satellite images;
- Images can be downloaded for free from the Internet through the Website of the Instituto Nacional de Pesquisas Espaciais - INPE. These images offer resolution of twenty meters - satellite C-BERS - or thirty meters - satellite LandSat 7. Those resolutions are appropriate for scales from 1:35,000 to 1:50,000;
- Data on hydrology, altimetry lines and road system can be downloaded for free from the Internet through the Website of the of the Instituto Brasileiro de Geografia e Estatística - IBGE. These files are in a 1:50,000 scales and some in 1:25,000.
- The integration of all this information should be performed with criteria and very carefully in order to maintain the geometric quality of the information intact and ensure the accuracy of the working scale;
- When working with Córrego Alegre (an old Brazilian reference system) instead of SAD 69 (the current Brazilian reference system) it creates a huge difficulty to integrate data with other systems. In this case, it is necessary to convert data accordingly and to specify which system is used;

It is recommended to compile all GIS information of a given organization in an easily accessible database in a way that ensures that all information is up to date at all times.

Recommendations for the Black Faced Lion Tamarin:

- It is recommended to develop a cartographic database for BFLTs defining scales and systems used;
- It is recommended to collect available data on fragmentation and vegetation in the distribution area of BFLTs. These data can be extracted from satellite images and aerial photos covering the whole region;
- Images can be downloaded for free from the Internet through the Website of the Instituto Nacional de Pesquisas Espaciais - INPE. These images offer resolution of twenty meters - satellite C-BERS - or thirty meters - satellite LandSat 7. Those resolutions are appropriate for scales from 1:35,000 to 1:50,000;
- Data on hydrology, altimetry lines and road system can be downloaded for free from the Internet through the Website of the of the Instituto Brasileiro de Geografia e Estatística - IBGE. These files are in a 1:50,000 scales and some in 1:25,000.
- The integration of all this information should be performed with criteria and very carefully in order to maintain the geometric quality of the information intact and ensure the accuracy of the working scale;
- It is recommended to compile all GIS information of a given organization in an easily accessible database in a way that ensures that all information is up to date at all times.

Final Recommendations:
The Geographic Information System is an obviously powerful tool that should be implemented in all conservation organizations in order to obtain a visualization of the operations. It is a strong tool for monitoring and evaluating the implementation of conservation actions. The GIS tool also allows for a more profoundly based decision making process and for a more well argued prioritization of the defined action steps.



Recommended actions to improve the management of the captive *Leontopithecus* populations

Recommended actions to improve the management of the captive *Leontopithecus* populations:

Based on the recommendations from the working groups of the 2005 Population and Habitat Viability Assessment (PHVA) Workshop, IBAMA has requested a clarification of the recommendations for the management of the captive Leontopithecus populations. During the annual meeting of the International Committee for Conservation and Management (ICCM) of the Leontopithecus species a working group of people that participated in the PHVA in 2005 discussed the issue, and it was decided to add the report of the working group to the final report of the PHVA as an appendix – not discussed during the workshop, but approved by the ICCM in June 2006. The recommendations should thus be considered on line with the recommendations from the PHVA.

The captive populations of Leontopithecus are integral to the long-term conservation 3 of the species. Thus, we propose these actions to improve management and husbandry in Brazil.

Principles:

1. As long as mortality is high and reproduction is low, we should not recommend that any more ***Leontopithecus*** be brought into captivity from the wild (e.g. ***rosalia*** and ***chrysopygus)***.
2. IBAMA and especially the CPB need to continue systematically evaluating zoos and encouraging husbandry improvements, together with the Brazilian zoo association (SZB). Resources must be made available to implement these programs.

Activities:

1. *A single person is needed to handle the Studbooks for **rosalia** and **chrysomelas**. This person can also act as a facilitator for the exchange of information about husbandry and management and needs training in SPARKS / ZIMS. Catao offered a half-time person from Sao Paulo Zoo to assist. The new Studbook Keeper should systematically compile necropsy reports from all Brazilian zoos and send them out for analysis by a pathologist.*
2. We recommend an exchange of keepers between selected Brazilian zoos and overseas counterparts, e.g. Copenhagen, Antwerp, Brookfield, Bristol, National Zoo (Washington), Los Angeles, Denver, and Jersey could be paired with CPRJ , Sao Paulo, Belo Horizonte, Brasilia, Sorocaba, Americana, Goiania, Ilha Solteiro, Sao Carlos. Also, we encourage Brazilian keepers and curators to attend national and international training workshops (e.g. enrichment, Studbook management or callitrichid workshops). Funding must be made available to implement these programs.
3. We recommend having annual husbandry and occasional Studbook workshops in Brazil. Sao Paulo will host a husbandry workshop in 2007, when the SZB is held in Sao Paulo.
4. We recommend that Brazilian zoos conduct studies of reproduction, behavior, husbandry, nutrition and health to determine why individual animals are not reproducing and why mortality is high.
5. Identify funding and the most appropriate methods of contraception to be used in Brazil.
6. Brazilian callitrichid diets need to be reviewed and improved. We recommend that existing available diets be analyzed and tested.
7. We should concentrate on only a few institutions for management and breeding of *Leontopithecus*, selecting those that are willing to commit curator and keeper time to training and improved management and whose exhibits have an education impact.
8. Implementing Masterplans: a) IBAMA should ensure that recommendations for animal shipments are monitored and CITES permits issued promptly. b) Zoos without experience of international shipments need training in transport techniques and permitting processes. SZB should be involved and give support to zoos without such experience. c) Financial support for implementing Masterplans (eg helping smaller zoos pay for shipments) must be made available.

Approved by the ICCM on 25 May 2006

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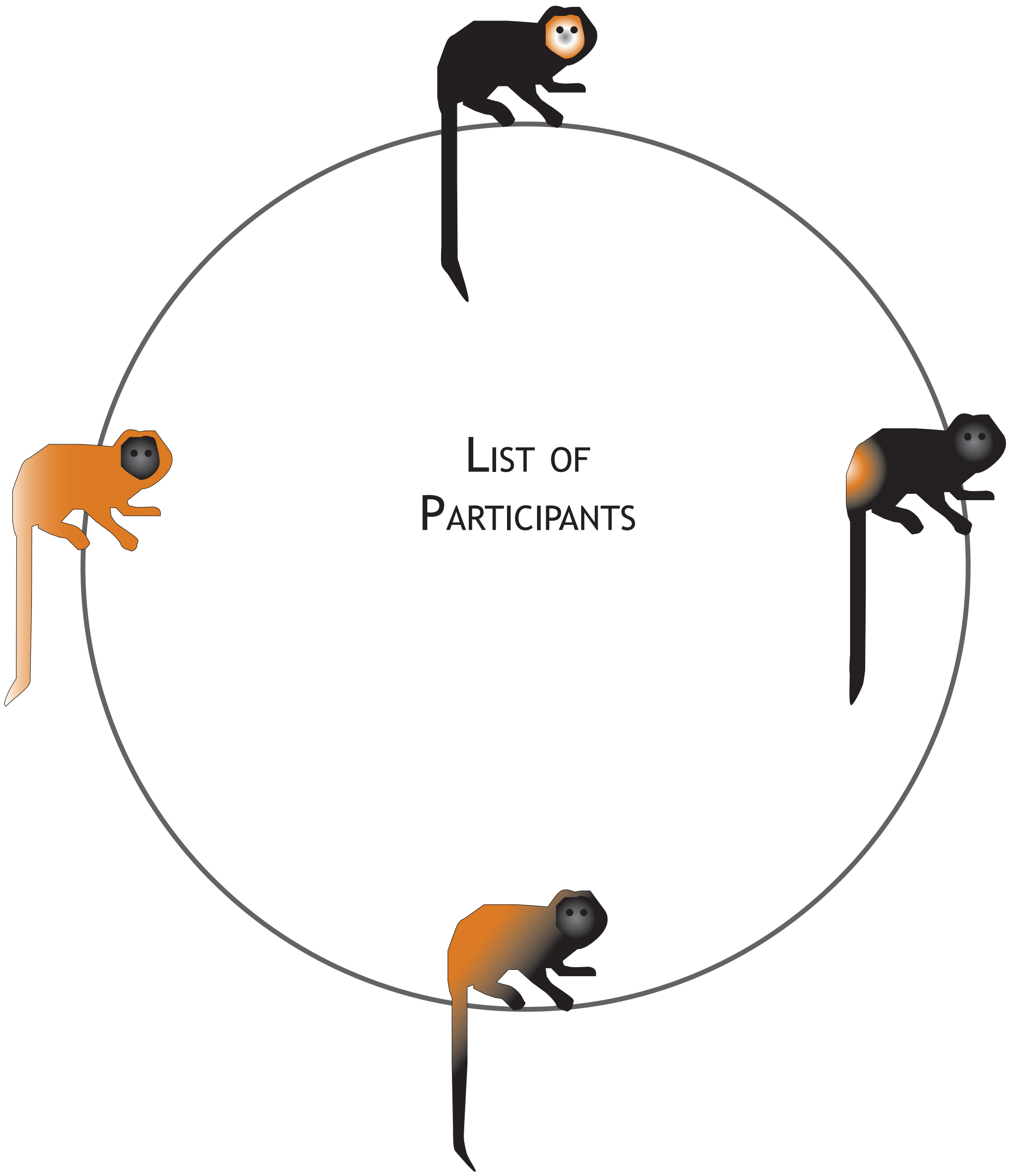

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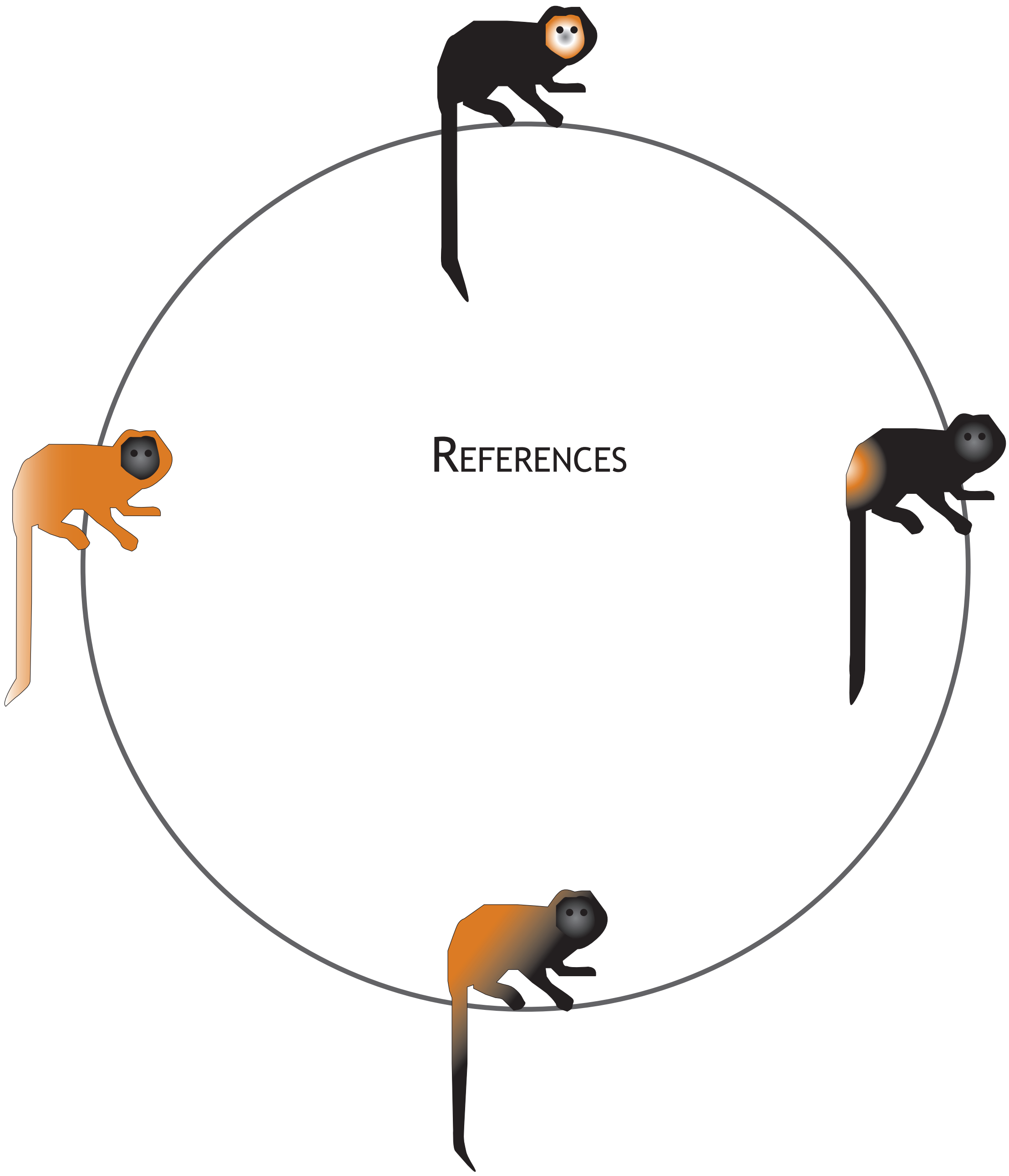

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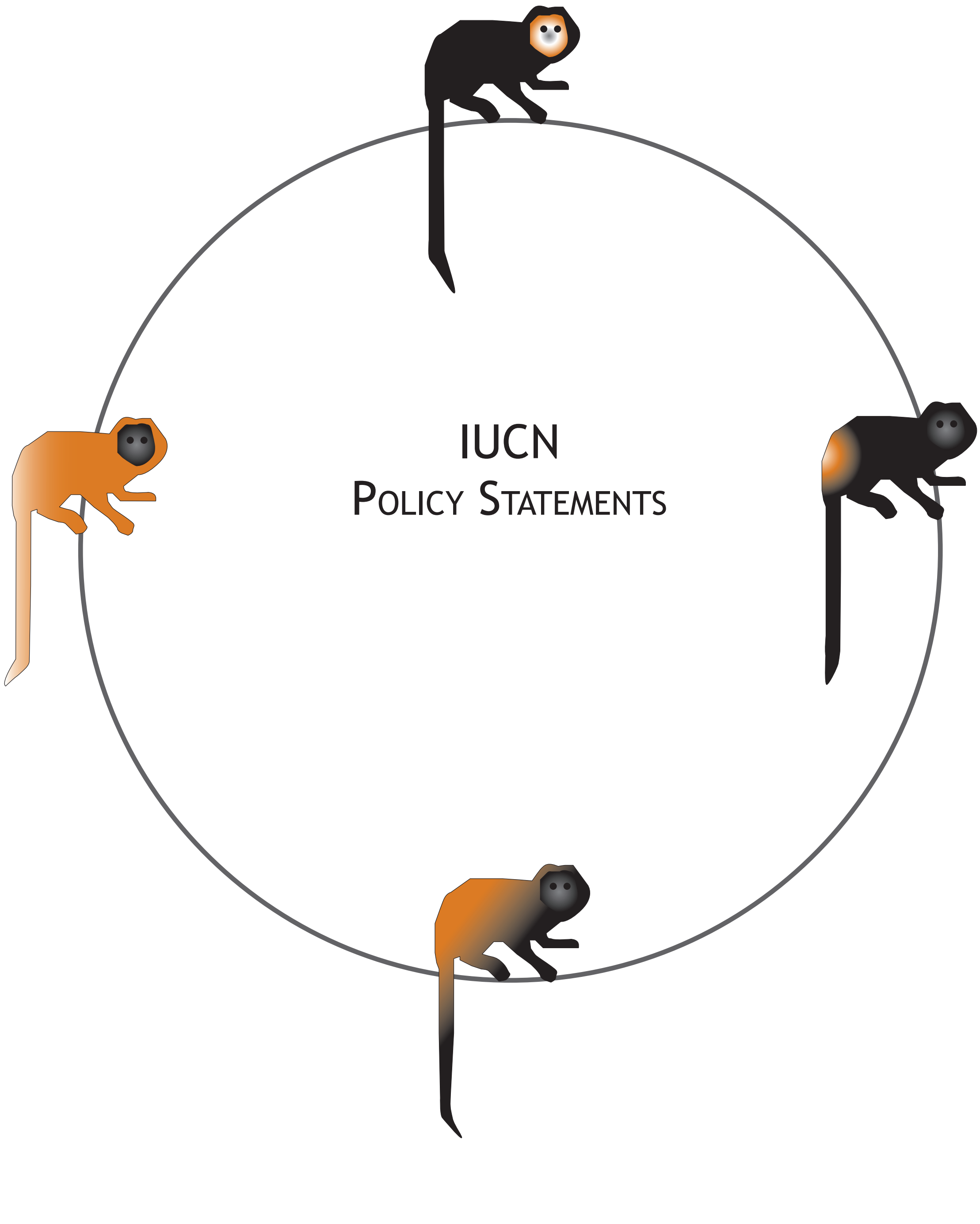

IUCN Technical Guidelines on the Management of Ex situ populations for Conservation

Approved at the 14th Meeting of the Programme Committee of Council, Gland Switzerland, 10 December 2002

PREAMBLE

IUCN affirms that a goal of conservation is the maintenance of existing genetic diversity and viable populations of all taxa in the wild in order to maintain biological interactions, ecological processes and function. Conservation managers and decision-makers should adopt a realistic and integrated approach to conservation implementation. The threats to biodiversity *in situ* continue to expand, and taxa have to survive in increasingly human-modified environments. Threats, which include habitat loss, climate change, unsustainable use, and invasive and pathogenic organisms, can be difficult to control. The reality of the current situation is that it will not be possible to ensure the survival of an increasing number of threatened taxa without effectively using a diverse range of complementary conservation approaches and techniques including, for some taxa, increasing the role and practical use of *ex situ* techniques.

If the decision to bring a taxon under *ex situ* management is left until extinction is imminent, it is frequently too late to effectively implement, thus risking permanent loss of the taxon. Moreover, *ex situ* conservation should be considered as a tool to ensure the survival of the wild population. *Ex situ* management should be considered only as an alternative to the imperative of *in situ* management in exceptional circumstances, and effective integration between *in situ* and *ex situ* approaches should be sought wherever possible.

The decision to implement an *ex situ* conservation programme as part of a formalised conservation management or recovery plan and the specific design of and prescription for such an *ex situ* programme will depend on the taxon's circumstances and conservation needs. A taxon-specific conservation plan may involve a range of *ex situ* objectives, including short-, medium- and long-term maintenance of *ex situ* stocks. This can utilise a variety of techniques including reproduction propagation, germplasm banking, applied research, reinforcement of existing populations and re-introduction into the wild or controlled environments. The objectives and overall purpose should be clearly stated and agreed among organisations participating in the programme, and other relevant stakeholders including landowners and users of the taxon involved. In order to maximise their full potential in conservation, *ex situ* facilities and their co-operative networks should adopt the guidelines defined by the Convention on Biological Diversity (CBD), the International Agenda for Botanic Gardens in Conservation, Center for Plant Conservation and the World Zoo Conservation Strategy, along with other guidelines, strategies, and relevant legislative requirements at national and regional levels. IUCN recognizes the considerable set of resources committed worldwide to *ex situ* conservation by the world's zoological and botanical gardens, gene banks and other *ex situ* facilities. The effective utilisation of these resources represents an essential component of conservation strategies at all levels.

VISION

To maintain present biodiversity levels through all available and effective means including, where appropriate, *ex situ* propagation, translocation and other *ex situ* methodologies.

GOAL

Those responsible for managing *ex situ* plant and animal populations and facilities will use all resources and means at their disposal to maximise the conservation and utilitarian values of these populations, including:
1) increasing public and political awareness and understanding of important conservation issues and the significance of extinction;
2) co-ordinated genetic and demographic population management of threatened taxa;
3) re-introduction and support to wild populations;
4) habitat restoration and management;
5) long-term gene and biomaterial banking;
6) institutional strengthening and professional capacity building;
7) appropriate benefit sharing;

8) research on biological and ecological questions relevant to *in situ* conservation; and
9) fundraising to support all of the above.

Ex situ agencies and institutions must follow national and international obligations with regard to access and benefit sharing (as outlined in the CBD) and other legally binding instruments such as CITES, to ensure full collaboration with all range States. Priority should be given to the *ex situ* management of threatened taxa (according to the latest IUCN Red List Categories) and threatened populations of economic or social/ cultural importance. *Ex situ* programmes are often best situated close to or within the ecogeographic range of the target taxa and where possible within the range State. Nevertheless a role for international and extra regional support for *ex situ* conservation is also recognised. The option of locating the *ex situ* programme outside the taxa's natural range should be considered if the taxa is threatened by natural catastrophes, political and social disruptions, or if further germplasm banking, propagation, research, isolation or reintroduction facilities are required and cannot be feasibly established. In all cases, *ex situ* populations should be managed in ways that minimize the loss of capacity for expression of natural behaviours and loss of ability to later again thrive in natural habitats.

TECHNICAL GUIDELINES

The basis for responsible *ex situ* population management in support of conservation is founded on benefits for both threatened taxa and associated habitats.

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- The primary objective of maintaining *ex situ* populations is to help support the conservation of a threatened taxon, its genetic diversity, and its habitat. *Ex situ* programmes should give added value to other complementary programmes for conservation.

  Although there will be taxa-specific exceptions due to unique life histories, the decision to initiate *ex situ* programmes should be based on one or more of the appropriate IUCN Red List Criteria, including:

  1. When the taxa/population is prone to effects of human activities or stochastic events or

  2. When the taxa/population is likely to become Critically Endangered, Extinct in the Wild, or Extinct in a very short time. Additional criteria may need to be considered in some cases where taxa or populations of cultural importance, and significant economic or scientific importance, are threatened. All Critically Endangered and Extinct in the Wild taxa should be subject to *ex situ* management to ensure recovery of wild populations.

- *Ex situ* conservation should be initiated only when an understanding of the target taxon's biology and *ex situ* management and storage needs are at a level where there is a reasonable probability that successful enhancement of species conservation can be achieved; or where the development of such protocols could be achieved within the time frame of the taxon's required conservation management, ideally before the taxa becomes threatened in the wild. *Ex situ* institutions are strongly urged to develop *ex situ* protocols prior to any forthcoming *ex situ* management. Consideration must be given to institutional viability before embarking on a long term *ex situ* project.

- For those threatened taxa for which husbandry and/or cultivation protocols do not exist, surrogates of closely related taxa can serve important functions, for example in research and the development of protocols, conservation biology research, staff training, public education and fundraising.

- While some *ex situ* populations may have been established prior to the ratification of the CBD, all *ex situ* and *in situ* populations should be managed in an integrated, multidisciplinary manner, and where possible, in accordance with the principles and provisions of the CBD.

- Extreme and desperate situations, where taxa/populations are in imminent risk of extinction, must be dealt with on an emergency basis. This action must be implemented with the full consent and support of the range State.

- All *ex situ* populations must be managed so as to reduce risk of loss through natural catastrophe, disease or political upheaval. Safeguards include effective quarantine procedures, disease and pathogen monitoring, and duplication of stored germplasm samples in different locations and provision of emergency power supplies to support collection needs (e.g. climate control for long term germplasm repositories).

- All *ex situ* populations should be managed so as to reduce the risk of invasive escape from propagation, display and research facilities. Taxa should be assessed as to their invasive potential and appropriate controls taken to avoid escape and subsequent naturalisation.

- The management of *ex situ* populations must minimise any deleterious effects of *ex situ* management, such as loss of genetic diversity, artificial selection, pathogen transfer and hybridisation, in the interest of maintaining the genetic integrity and viability of such material. Particular attention should be paid to initial sampling techniques, which should be designed to capture as much wild genetic variability as practicable. *Ex situ* practitioners should adhere to, and further develop, any taxon- or region-specific record keeping and genetic management guidelines produced by *ex situ* management agencies.

- Those responsible for managing *ex situ* populations and facilities should seek both to increase public awareness, concern and support for biodiversity, and to support the implementation of conservation management, through education, fundraising and professional capacity building programmes, and by supporting direct action *in situ*.

- Where appropriate, data and the results of research derived from *ex situ* collections and *ex situ* methodologies should be made freely available to ongoing in-country management programmes concerned with supporting conservation of *in situ* populations, their habitats, and the ecosystems and landscapes in which they occur .

NB. *Ex situ* conservation is defined here, as in the CBD, as “the conservation of components of biological diversity outside their natural habitats”. *Ex situ* collections include whole plant or animal collections, zoological parks and botanic gardens, wildlife research facilities, and germplasm collections of wild and domesticated taxa (zygotes, gametes and somatic tissue).

IUCN Guidelines for the Placement of Confiscated Animals

EXECUTIVE SUMMARY

Live wild animals are confiscated by local, regional, and national authorities for a variety of reasons. Once they have taken possession of these animals, these authorities must dispose of them responsibly, in a timely and efficient manner. Prevailing legislation, cultural practices, and economic conditions will influence decisions on appropriate disposition of confiscated animals. Within a conservation context, there are several possible options from which to choose:

1) to maintain the animals in captivity for the remainder of their natural lives;
2) to return the animals to the wild;
3) to euthanize the animals, i.e., humanely destroy them

The IUCN Guidelines for the Placement of Confiscated Animals discuss the benefits and risks involved in each of these options. These Guidelines should be read in conjunction with the IUCN Guidelines for Re-introductions (IUCN 1998). They should also be read with reference to the CITES Guidelines for the Disposal of Confiscated Live Species of Species Included in the Appendices (Resolution Conf. 10.7) and the IUCN Guidelines for the Prevention of Biodiversity Loss Caused by Alien Invasive Species.

Returning confiscated animals to the wild is often considered the most popular option for a confiscating agency and can garner strong public support. However, such action poses real risks and problems and generally confers few benefits. These risks and problems include, but are not limited to, the following.

1. The mortality of animals released from captivity is usually high. Confiscated mammals and birds captured as juveniles have not learned the skills they need to survive in the wild. Other animals may be weakened or otherwise affected by their time in captivity and, thus, less able to survive. Finally, there is little chance of survival if the animals are released at a site that is not appropriate for the ecology or behavior of the species.
2. Animals released into the wild outside of their natural range – if they survive at all – have the potential to become pests or invasive. The effects of invasive alien species are a major cause of biodiversity loss, as such species compete with native species and in other ways compromise the ecological integrity of the habitats in which they have become established.
3. Having been in trade or a holding facility often in association with other wild animals and, in some instances, domesticated ones, confiscated wild animals are likely to have been exposed to diseases and parasites. If returned to the wild, these animals may infect other wild animals, thus causing serious, and potentially irreversible, problems.
4. In many instances, confiscated wild animals have been moved great distances from the site of capture and changed hands several times, such that their actual provenance is unknown. It may, therefore, be impossible or very difficult to establish an appropriate site for return to the wild that takes into account the ecological needs of the species, the animals' genetic make-up, and other attributes that are important to minimize risks (e.g., competition, hybridization) to wild populations at a release site.
5. in cases where the provenance is known, the ecological niche vacated by that animal may already be filled by other individuals and replacing the animal could result in further undesired disturbance of the ecosystem
6. Responsible programs to return animals to the wild (c.f. IUCN 1998) are long-term endeavors that require substantial human and financial resources; hence, they can divert scarce resources away from other more effective conservation activities.

If returning confiscated animals to the wild is to be consistent with conservation principles and practice, it should a) *only* be into a site outside of the species' natural range if such an action is in accordance with the IUCN Guidelines for Re-introductions for a conservation introduction; and b) only be practiced in cases where the animals are of high conservation value and/or the release is part of a management programme. Any release to the wild must include the necessary screening and monitoring to address potential negative impacts, as set forth in the IUCN Guidelines for Re-introductions (IUCN 1998).

Retaining confiscated wild animals in captivity is a clear – and, in most cases, preferable - alternative to returning them to the wild. Clearly, returning animals to their owners will be required in cases of theft. There are a number of options for keeping animals in captivity; however, each of these also has costs and risks.

- As confiscated animals are likely to have been exposed to diseases and parasites, if held in captivity, they may infect other captive animals, causing serious, and potentially irreversible, problems.
- Finding an appropriate home for confiscated animals can be time-consuming, and caring for the animals during that time can be expensive.
- Wild animals have specific nutritional requirements and require specific care. Short-term and long-term humane care of confiscated wild animals requires space, finances and expertise not readily available in many countries.
- Transfer of ownership from a confiscating government authority to a private entity – individual or non-commercial or commercial care facility – can raise complicated legal and ethical issues, which are difficult – and time-consuming - to address. Sale or transfer of ownership may – or may be seen to - stimulate demand for these animals and exacerbate any threat that trade may pose to the species. It may also give the appearance that the government condones illegal or irregular trade or, in the case of actual sale, is benefiting from such trade.

In addition to avoiding risks to wild populations engendered by return to the wild, keeping confiscated animals in captivity provides other benefits, for example:

- Confiscated animals can be used to educate people about wildlife and conservation, as well as the consequences of trade in live wildlife.
- Confiscated animals placed in captivity can provide breeding stock for zoos, aquariums, and other facilities, thus potentially reducing the demand for wild-caught animals although the opposite effect may also occur.
- In specific instances where the provenance of the confiscated specimens is known, these animals can provide the nucleus, and breeding stock, for possible reintroduction programs.
- Confiscated animals can be the subject of a range of non-invasive research, training and teaching programs with important potential benefits for conservation.

Euthanasia must be considered a valid alternative to placing animals in captivity or returning them to the wild. Although it may appear counter-intuitive to employ euthanasia, it is by definition a humane act and can be wholly consistent with both conservation and animal welfare considerations. Further, although many confiscating authorities may be wary of criticism elicited by a decision to euthanize confiscated animals, there are a number of reasons to justify its use, including the following:

- In many, if not most, circumstances, euthanasia offers the most humane alternative for dealing with confiscated wild animals.

- Euthanasia eliminates the genetic, ecological, and other risks that release to the wild may pose to wild populations and ecosystems.
- Euthanasia eliminates the serious risk of spreading disease to wild or captive populations of animals.
- Euthanasia will often be the least costly option.

Establishment of an overall policy framework, with specific procedures for confiscating authorities, will facilitate consideration of the above three options for disposition, including the logistical, legal, and ethical questions that these authorities must address.

IUCN Guidelines for the Placement of Confiscated Animals

Statement of Principle

When live wild animals[1] are confiscated by government authorities, these authorities have a responsibility to dispose of them appropriately. Within a conservation context, and the confines of national and international law, the ultimate decision on placement of confiscated animals must achieve three goals: 1) to maximise the conservation value of the animals without in any way endangering the health, behavioural repertoire, genetic characteristics, or conservation status of wild or captive populations of the species[2] or any other wild living organism; 2) to discourage further illegal or irregular[3] trade in the species; and 3) to provide a humane solution, whether this involves maintaining the animals in captivity, returning them to the wild, or employing euthanasia to destroy them.

Statement of Need

Increased regulation of trade in wildlife and enforcement of these laws and regulations have resulted in an increase in the number of live wild animals that are confiscated by government agencies as a result of non-compliance with these regulations. In some instances, the confiscation is a result of patently illegal trade; in others, it is in response to other irregularities. While in some cases the number of confiscated animals is small, in many others the number is in the hundreds or greater. The large numbers involved, and the need to care for and dispose of them responsibly, have placed serious pressures on confiscating authorities, many of whom lack the technical, financial or human resources or the necessary frameworks to address these situations adequately.

In many countries, the practice has generally been to donate confiscated[4] animals to zoos or aquaria. However, this option is proving less viable. Zoos and aquaria generally cannot accommodate large numbers of animals that become available through confiscations. In addition to the resources required to house them and administer veterinary and other care, these institutions are usually less interested in the common species that comprise the vast proportion of wildlife confiscations. The international zoo community has recognized that placing animals of low conservation priority in limited cage space may benefit those individuals but may also detract from conservation efforts as a whole. Therefore, they are setting priorities for cage space (IUDZG/CBSG 1993), thus reducing their availability to receive confiscated animals.

There has been an increasing tendency to address the problem of disposition of confiscated animals by releasing them back into the wild. In some cases, release of confiscated animals into existing wild populations has been made after careful evaluation and with due regard for existing general guidelines (IUCN 1987, IUCN 1998). In other cases, such releases have not been well planned and have been inconsistent with general conservation objectives and

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[1]In these Guidelines, unless stated otherwise, confiscated animals should be understood to refer to live wild animals, not those that have been captive-bred.
[2]Although this document refers to species, in the case of species with well-defined subspecies , the issues addressed will apply to lower taxonomic units.
[3]Irregular trade in a species refers to, for example, insufficient or incomplete paperwork from the exporting country or poor packing that has comprised the welfare of the live animals in the shipment.
[4]Although not discussed here, it should be understood that, depending on the statutory authority of the agencies involved, animals may first be seized and then confiscated only on completion of legal proceedings resulting in forfeiture by the individual having previously claimed ownership of the animals.

humane considerations. Animals released in inappropriate habitat are usually doomed to starvation or death from other causes that the animals are not equipped or adapted against. In addition to humane concerns, release into wild populations may also have strong negative conservation value by threatening existing wild populations for the following reasons.

1) Animals released into the wild outside their natural range can become pests or invasive, thus threatening agriculture and other sectors, native species, and the ecological integrity of the area in which they become established. The effects of invasive alien species are a major cause of global biodiversity loss.
2) The former home range of a confiscated animal may be quickly occupied by other individuals and releasing the confiscated animal could lead to further disruption of the animal's social ecology.
3) Diseases and parasites acquired by confiscated animals while held in captivity can easily spread into existing wild populations if these animals are released.
4) Individuals released into existing populations, or in areas near to existing populations, that are not of the same race or sub-species as those in the wild population, results in mixing of distinct genetic lineages.
5) Animals held in captivity, particularly immature animals, can acquire an inappropriate behavioural repertoire from individuals of other species, and/or lose certain behaviours or not develop the full behavioural repertoire necessary for survival in the wild. It is also possible that release of animals could result in inter-specific hybridisation, a problem also to be avoided.

In light of these trends, there is an increasing demand -- and urgent need -- for information and advice on considerations relating to responsible placement of confiscated animals. There is also a pressing need for technical expertise and assistance in assessing the veterinary, husbandry and other questions that must be addressed in this process. Recognizing this problem, the Parties to the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) have adopted guidelines for Disposal of Confiscated Live Specimens of Species Included in the Appendices (Resolution Conf. 10.7), applicable to both plants and animals. These IUCN guidelines build on and supplement those drawn up by CITES to apply more broadly to confiscated animals and confiscation situations.

Disposition of confiscated animals is not a simple or straightforward process. Only on rare occasions will the optimum course be obvious or result in an action of conservation value. Options for disposition of confiscated animals have thus far been influenced by the public's perception that returning animals to the wild is the optimal solution in terms of both animal welfare and conservation. However, a growing body of scientific study of re-introduction of captive animals, the nature and dynamics of wildlife diseases, and the nature and extent of the problems associated with invasive species suggests that such actions may be among the least appropriate options for many reasons, including those enumerated above. This recognition requires that the options available to confiscating authorities for disposition be carefully reviewed.

Management Options

In deciding on the disposition of confiscated animals, there is a need to ensure both the humane treatment of the animals and the conservation and welfare of existing wild populations. Options for disposition fall into three principal categories: 1) maintenance of the individual(s) in captivity; 2) returning the individual(s) in question to the wild; and 3) euthanasia.

Within a conservation perspective, by far the most important consideration in reviewing the options for disposition of confiscated animals is the conservation status of the species concerned. Where the animals represent an endangered or threatened species or are otherwise of high conservation value[5], particular effort should be directed towards evaluating whether and how these animals might contribute to a conservation programme for the species. The expense and difficulty of returning animals to the wild as part of a conservation (c.f. IUCN 1998) or management programme or pursuing certain captive options will generally only be justified for species of high conservation value. How to allocate resources to the large numbers of confiscated animals representing common species is one of the fundamental policy questions that confiscating authorities must address.

The decision as to which option to employ in the disposition of confiscated animals will depend on various legal, social, economic and biological factors. The "Decision Tree" provided in the present guidelines is intended to facilitate consideration of these options. The tree has been designed so that it may be used for both threatened and common species. However, it recognizes that that conservation value of the species will be the primary consideration affecting the options available for placement. International networks of experts, such as the IUCN Species Survival Commission Specialist Groups (see Annex 3 for contact details), should be able to assist confiscating authorities in their deliberations as to the appropriate disposition of confiscated animals.

In some instances, in the case of international trade, there may be a demand for confiscated animals to be returned to their country of origin, and the government authorities of that country may request their return. CITES has established guidelines on this question through Resolution Conf. 10.7. It should be noted that it is often difficult to establish the true origin (including country of origin) of many animals in trade. Moreover, final disposition of confiscated animals upon their return to the country of origin will require consideration of the same options presented here. There is a need for cooperative efforts to review these options in order to ensure that repatriation is not undertaken simply to shift the burden of addressing the problem to the country of origin.

Option 1 -- Captivity

Confiscated animals are already in captivity; there are numerous options for maintaining them there. Depending on the circumstances and the prevailing legal or policy prescriptions, animals. can be donated, loaned, or sold, to public or private facilities, commercial or non-commercial, and to private individuals. Placement can be in the country of origin (or export), country of confiscation, or a country with adequate and/or specialized facilities for the species or animals in question. If animals are maintained in captivity, in preference to being returned to the wild or euthanized, they must be afforded humane conditions and ensured proper care for their natural lives.

Zoos and aquaria are the captive facilities most commonly considered for placement of animals, but these institutions are generally less willing and available to receive such animals than is assumed. As most confiscated animals are common species, the full range of captive options should be considered. These include zoos and aquaria as well as the following:

- **Rescue centers**, established specifically to treat injured or confiscated animals;
- **Life-time care facilities** devoted to the care of confiscated animals;

[5] It is recognized that “conservation value” may not always be easy to assess and may be a function of species’ status at national or regional level as much as international level (e.g., listed as threatened by IUCN).

- **Specialist societies** or clubs devoted to the study and care of single species or species groups (e.g., reptiles, amphibians, birds) have provided an avenue for the disposition of confiscated animals through placement with these societies or individual members.

- **Humane societies** established to care and seek owners for abandoned animals may be in a position to assist with placement of confiscated animals with private individuals who can provide life-time care.

- **Commercial captive breeders** may be willing to receive and care for animals as well as to incorporate them into captive breeding activities. Such facilities, although commercial in nature, are likely to have the technical expertise and other resources to care for the animals. In addition, production of animals from captive breeding operations may reduce the demand for wild-caught animals.

- **Research institutions** maintain collections of exotic animals for many kinds of research (e.g. behavioural, ecological, physiological, psychological, medical and veterinary). Some research programmes have direct relevance to conservation. Attitudes towards vivisection or, in some instances, the non-invasive use of animals in research programmes as captive study populations vary widely from country to country and even within countries. These attitudes are likely to affect consideration of such programmes as an option for confiscated animals. However, it should be noted that transfer to facilities involved in research conducted under humane conditions may offer an alternative - and one that may eventually contribute information relevant to the species' conservation.

Choosing amongst these options will depend on the conservation value of the animals involved, the condition of the animals, the circumstances of trade in the species, and other factors. As a general rule, where confiscated animals are of high conservation value, an effort should be made to place them in a captive facility that ensures their availability for conservation efforts over the long term, such as with a zoo, ex-situ research programme, or an established captive breeding program or facility.

Captivity – Sale, Loan or Donation

Animals can be placed with an institution or individual in a number of ways. It is critical to consider two issues: the ownership of the animals and/or their progeny, and the payment of any fees as part of transfer of ownership. Confiscating authorities and individuals or organizations involved in the placement of confiscated specimens must clarify ownership, both of the specimens being transferred and any progeny. They must also consider the possible implications of payment of fees in terms of public perception and for achieving the purpose of confiscation, which is to penalize and, in so doing, deter illegal and irregular trade. The following points should considered.

Transfer of ownership/custody**.** Unless specific legal provisions apply, the confiscating authority should consider including in an agreement to transfer ownership or custody the conditions under which the transfer is made, such as any restrictions on use (e.g., exhibition, education, captive breeding, commercial or non-commercial) or obligations concerning use (breeding efforts), that the animals may be put to. Such an agreement may set forth conditions relating to:

- subsequent transfer of ownership or custody;
- changes in the use of the animals by the new owner or custodian; and
- consequences of violation of the terms of transfer by the new owner or custodian.

Payment of fees. There may be cases where captive facilities are willing to receive and commit to care for confiscated animals providing payment is made by the confiscating authority against those costs. More frequently, the confiscating authority may seek to recoup the costs of caring for the animals prior to placement by levying a fee as part of transfer of ownership. Such payment of fees is problematic for many reasons, including the following:

- it may weaken the impact of the confiscation as a deterrent;
- it may risk creating a public perception that the confiscating authority is perpetuating or benefiting from illegal or irregular trade; or
- depending on the level of the fees proposed, it may work against finding a suitable option for maintaining the animals in captivity.

It is important that confiscating authorities be prepared to make public the conditions under which ownership of confiscated animals has been transferred and, where applicable, the basis for any payments involved.

Captivity – Benefits

In addition to avoiding the risks associated with attempting to return them to the wild, there are numerous benefits of placing confiscated animals in a facility that will provide life-time care under humane conditions. These include:

a) educational value in terms of possible exhibition or other use;
b) the satisfaction to be derived from the increased chances for survival of the animals;
c) the potential for the animals to be used in a captive breeding programme to replace wild-caught animals as a source for trade;
d) the potential for captive breeding for possible re-introduction or other conservation programmes; and
e) the potential for use in conservation and other valuable research programs.

Captivity - Concerns

The concerns raised by placing animals in captivity include:

A) DISEASE. Confiscated animals may serve as vectors for disease, which can affect con-specifics and other species held in captivity. As many diseases cannot be screened for, even the strictest quarantine and most extensive screening for disease cannot ensure that an animal is disease-free. Where quarantine cannot adequately ensure that an individual is disease-free, isolation for an indefinite period, or euthanasia, must be carried out.

B) CAPTIVE ANIMALS MAINTAINED OUTSIDE THEIR RANGE CAN ESCAPE from captivity and become pests or invasive. Unintentionally introduced exotic species have become invasive in many countries, causing tremendous damage to agriculture, fisheries, and transport, but also to native animal populations. The decline of the European mink (*Mustela lutreola*), listed as Endangered by IUCN, is in part a result of competition from American mink (*Mustela vison*) escaped from fur farms, while the negative effects of competition from introduced North American red-eared slider turtles (*Trachemys scripta elegans)*, originally imported as pets, have been raised in relation to European and Asian freshwater turtles.

C) COST OF PLACEMENT. Providing housing and veterinary and other care to confiscated animals can be expensive; as a result, it may be difficult to identify institutions or individuals willing to assume these costs.

D) POTENTIAL TO ENCOURAGE UNDESIRED TRADE. As is discussed above, transfer of ownership of confiscated animals to individuals or institutions, whether it involves loan, donation, or sale, is problematic. Some have argued that any transfer of ownership - whether commercial or non-commercial - of confiscated animals risks promoting a market for these species and creating a perception of the confiscating authority's being involved in illegal or irregular trade. These risks must be weighed in relation to the benefits, in particular that maintenance in captivity offers over return to the wild or euthanasia. Some factors that might be considered in assessing the degree to which transfer of ownership – and sale - might promoted undesired trade are:

1) whether the animals in question are already available for sale legally in the confiscating country in commercial quantities; and
2) whether wildlife traders under indictment for, or convicted of, crimes related to illegal or irregular trade in wildlife can be prevented from purchasing the animals in question.
3) the monetary/ commercial value of the animals in question

As regards the latter question, it should be noted that experience in selling confiscated animals suggests that it is virtually impossible to ensure that commercial dealers suspected or implicated in illegal or irregular trade are excluded, directly or indirectly, in purchasing confiscated animals.

In certain circumstances, transfer to commercial captive breeders may have a clearer potential for the conservation of the species, or welfare of the individuals, than non-commercial disposition or euthanasia. In the case of common species, commercial breeders may be a particularly attractive option; in the case of species of high conservation value, this option should be carefully assessed. There may be a risk of stimulating demand from wild populations through increased availability of the species, and it may be difficult to secure access to these animals for future conservation activities.

Option 2 -- Return to the Wild

Because of the serious risks posed to wild animal populations from released confiscated animals, return to the wild is considered here to be a desirable option in only a very small number of instances and under very specific circumstances. The IUCN Guidelines for Re-introductions (IUCN 1998) make a clear distinction between the different options for returning animals to the wild to meet conservation objectives and discuss the purposes, rationale and procedures relating to these options.

The present Guidelines do not consider a viable option the return of animals to the wild except in accordance with the IUCN Guidelines for Re-introductions. Poorly planned or executed release or (re-)introduction programmes are no better than dumping animals in the wild and should be vigorously opposed on both conservation and humane grounds.

A) **Re-introduction**: an attempt to establish a population in an area that was once part of the range of the species but from which it has become extirpated.

Some of the best known re-introductions have been of species that had become extinct in the wild. Examples include: Père David's deer (*Elaphurus davidanus*) and the Arabian oryx (*Oryx leucoryx*). Other re-introduction programmes have involved species that persist in some parts of their historical range but have been eliminated from others; the aim of these programmes is to re-establish a population in an area, or region, from which the species has disappeared. An example of this type of re-introduction is the recent re-introduction of the swift fox (*Vulpes velox*) in Canada.

B) **Reinforcement of an Existing Population** (also referred to as Supplementation): the addition of individuals to an existing population of the same species.

Reinforcement can be a powerful conservation tool when natural populations are diminished by a process which, at least in theory, can be reversed. One of the few examples of a successful reinforcement project involves the golden lion tamarin (*Leontopithecus rosalia*) in Brazil. Habitat loss, coupled with capture of live animals for pets, resulted in a rapid decline of the golden lion tamarin. When reserves were expanded, and capture for trade curbed, captive-bred golden lion tamarins were then used to supplement depleted wild populations.

Reinforcement has been most widely pursued in the context of rehabilitation programmes, i.e., when individual injured animals have been provided with veterinary care and released. Such activities are common in many countries, and specific programmes exist for species as diverse as hedgehogs and birds of prey. However common an activity, reinforcement carries with it the very grave risk that individuals held in captivity, even temporarily, are potential vectors for the introduction of disease or infectious organisms into wild populations.

Because of disease and other risks to wild populations, as well as the costs of screening and post-release monitoring, reinforcement should only be employed in instances where there is a direct and measurable conservation benefit (demographically and/or genetically, and/or to enhance conservation in the public’s eye), or, at least, where the presumed benefits clearly outweigh these risks.

C) **Conservation Introductions** (also referred to as Beneficial or Benign Introductions): an attempt to establish a species, for the purpose of conservation, outside its recorded distribution but within an appropriate habitat and eco-geographical area. This is a feasible conservation tool only when there is no remaining area left within a species’ historic range.

Extensive use of conservation introductions has been made in New Zealand, where endangered birds have been transferred to off-shore islands that were adjacent to, but not part of, the animals' original range. Conservation introductions can also be a component of a larger programme of re-introduction, an example being the breeding of red wolves (*Canis rufus*) on islands outside their natural range and subsequent transfer to mainland range areas.

Return to the Wild - Benefits

There are benefits of returning confiscated animals to the wild, providing the pre-requisite veterinary, genetic, and other screening is undertaken and post-release monitoring programmes are established (as per IUCN 1998).

a) In situations where the existing population is severely threatened, re-introduction might improve the long-term conservation potential of the species as a whole, or of a local population of the species (e.g., golden lion tamarins).

b) Return to the wild makes a strong political/educational statement concerning the fate of animals and may serve to promote local conservation values. However, as part of any education or public awareness programmes, the costs and difficulties associated with the return to the wild must be emphasized.

c) Species returned to the wild have the possibility of continuing to fulfill their biological and ecological roles.

Return to the Wild - Concerns

As indicated above, because of the risk of biological invasion, these guidelines do not consider it a viable option to return animals to the wild outside of their natural range in any but the most exceptional circumstances. Before return to the wild (as per IUCN 1998) of confiscated animals is considered, several issues of concern must be considered in general terms: welfare, conservation value, cost, and disease.

A) WELFARE. While some consider return to the wild to be humane, ill-conceived projects may return animals to the wild which then die from starvation or do not adapt to an unfamiliar or inappropriate environment. Humane considerations require that each effort to return confiscated animals to the wild be thoroughly researched and carefully planned. Re-introduction projects also require long-term commitment in terms of monitoring the fate of released individuals.

In order for return to the wild to be seriously considered on welfare grounds, some have advocated that the survival prospects for released animals must at least approximate those of wild animals of the same sex and age. While such demographic data on wild populations are rarely available, the spirit of this suggestion should be respected -- there must be humane treatment of confiscated animals when attempting to return them to the wild, and there should be a reasonable assessment of the survival prospects of the animals to justify the risks involved.

B) CONSERVATION VALUE AND COST. In cases where returning confiscated animals to the wild appears to be the most humane option, such action can only be undertaken if it does not threaten existing populations of con-specifics or populations of other interacting species, or the ecological integrity of the area in which they live. The conservation of the species as a whole, and of other animals already living free, must take precedent over the welfare of individual animals that are already in captivity.

Before animals are used in programmes in which existing populations are reinforced, or new populations are established, it must be determined that returning these individuals to the wild will make a significant contribution to the conservation of the species, or populations of other interacting species, or it must serve a purpose directly related to the conservation and management of the species or ecosystem involved. Based solely on demographic considerations, large populations are less likely to go extinct, and, therefore, reinforcing existing very small wild populations may reduce the probability of extinction. In very small populations, a lack of males or females may result in reduced population growth or population decline and, therefore, reinforcing a very small population lacking animals of a particular sex may also improve prospects for survival of that population. However, genetic and behavioural considerations, as well as the possibility of disease introduction, also play a fundamental role in determining the long-term survival of a population. The potential conservation benefit of the re-introduction should clearly outweigh the risks.

The cost of returning animals to the wild in a responsible manner can be prohibitive, suggesting that this option should only be pursued when species are of high conservation value. Exceptions to this rule may be instances where the confiscated animals are not of high conservation value, but the circumstances and technical and other resources are available to ensure re-introduction is undertaken in accordance with conservation guidelines (e.g., IUCN 1998)

C) DISEASE. Animals held in captivity and/or transported, even for a very short time, may be exposed to a variety of pathogens. Release of these animals to the wild may result in introduction of disease to con-specifics or unrelated species with potentially catastrophic effects. Even if there is a very small risk that confiscated animals have been infected by exotic pathogens, the potential effects of introduced diseases on wild populations are often so great that this should preclude returning confiscated animals to the wild.

Release into the wild of any animal that has been held in captivity is risky. Animals held in captivity are more likely to acquire diseases and parasites. While some of these diseases can be tested for, tests do not exist for many animal diseases. Furthermore, animals held in captivity are frequently exposed to diseases not usually encountered in their natural habitat. Veterinarians and quarantine officers, thinking that the species in question is only susceptible to certain diseases, might not test for the diseases picked up in captivity. It should be assumed that all diseases are potentially contagious.

In assessing the possibilities for disease, it may be particularly helpful to consider the known or presumed circumstances of trade, including:

a) the time and distance from point of capture; the number of stages of trade and types of transport;
b) whether the animals have been held or transported in proximity to wild or domesticated animals of the same or other species and what specific diseases have been known to be carried by such animals.

D) SOURCE OF INDIVIDUALS. If the precise provenance of the confiscated animals is not known (they may be from several different sites of origin), or if there is any question of the source of animals, supplementation may lead to inadvertent pollution of distinct genetic races or subspecies. If particular local races or sub-species show specific adaptation to their local environments, mixing in individuals from other races or sub-species may be damaging to the local population. Where the origin and habitat and ecological requirements of the species are unknown, introducing an individual or individuals into the wrong habitat type may also doom them to death.

Given that any release incurs some risk, the following “precautionary principle” should be adopted: ***if there is no conservation value in releasing confiscated animals to the wild or no management programme exists within which such release can be undertaken according to conservation guidelines, the possibility of accidentally introducing a disease, or behavioural and genetic aberrations that are not already present into the environment, however unlikely, should rule out returning confiscated specimens to the wild as a placement option.***

Option 3 -- Euthanasia

Euthanasia -- the killing of animals carried out according to humane guidelines -- is a valid alternative to maintaining animals in captivity or returning them to the wild. Although it may appear counter-intuitive to employ euthanasia, it is, by definition, humane, and, thus can be wholly consistent with conservation and animal considerations. In many cases, it may be the most feasible option for conservation and humane, as well as economic, reasons. It is recognized that euthanasia is unlikely to be a popular option amongst confiscating authorities for disposition of confiscated animals. However, it cannot be overstressed that it may be the most responsible option. In many cases, authorities confiscating live animals will encounter the following situations:

a) In the course of trade or while held in captivity, the animals have contracted a chronic disease that is incurable and poses a risk to other animals, whether held in captivity or in the wild.

b) The actual provenance of the animals is unknown, and there is evidence to suggest that there may be genetic or other differences between them and presumed con-specifics in the wild, which could compromise the integrity of wild and captive populations, including those involved in breeding or conservation research activities.

c) There are insufficient resources to return the animals to the wild in accordance with biological (e.g., IUCN 1998) and animal welfare (e.g., International Academy of Animal Welfare Sciences 1992) guidelines.

d) There are no feasible options for maintaining the animals in captivity.

In these instances, euthanasia may be the only responsible option and, thus, should be employed.

Euthanasia-- Benefits

a) With respect to the conservation of the species in question and of captive and wild populations of animals, euthanasia carries far fewer risks (e.g. disease, genetic pollution, biological invasion) than maintenance in captivity or return to the wild.

b) Euthanasia may be the best (and only) possible solution to an acute problem with confiscated animals. Many possibilities for maintenance in captivity may not guarantee the animals' welfare over the long term, and the survival prospects of animals returned to the wild are generally not high, as, depending on the circumstances, such animals often die of starvation, disease or predation.

c) Euthanasia acts to discourage the activities that gave rise to confiscation, as the animals in question are completely lost to the trade, with no chance of recovery by the traders involved. This removes any potential monetary gain from illegal trade. In addition, euthanasia may serve as a broader deterrent, in educating the public and other sectors about the serious and complex problems that can arise from trade in live wild animals.

d) The choice of euthanasia over maintenance in captivity or return to the wild offers an opportunity for confiscating authorities and other agencies to educate the public about more esoteric conservation problems, including those relating to invasive species and the potential negative consequences of releasing animals to the wild without adequate safeguards. Increased public awareness may generate additional ideas on placement of confiscated animals.

e) Euthanasia can be inexpensive as compared to other options. As such, it does not divert human and financial resources that could be allocated to other conservation or related activities, such as re-introduction or lifetime care of other animals, or the conservation of threatened species in the wild.

When animals are euthanized, or die in captivity, an effort should be made to make the best use of the dead specimens for scientific purposes, such as placing them in a reference collection in a university or research institute, which are very important for the study of biodiversity, or making them available for pathology or other research.

Euthansia- Risks

A) Just as there is potential positive educational value in employing euthanasia, there is a problem that it may give rise to negative perceptions of the confiscating authority for having taken that decision over other options. In such instances, there is a need to foresee such criticism and offer the rationale for the decision to euthanize.

B) There is a risk of losing unique behavioural, genetic and ecological material within an individual or group of individuals that represents variation within a species and may be of value for the conservation of the species.

Establishing the Necessary Frameworks

In order for prospective confiscating agencies to address the logistical, legal and other difficulties resulting from the seizure of wild animals, their eventual confiscation, and responsible disposition based on the above three options, there should be established an overall policy framework and specific procedures that *inter alia*:

- Identify the authority or authorities with responsibility for confiscation and placement of wild animals;
- Identify or provide the basis for establishing the facilities that will receive and, as necessary, quarantine, seized animals and hold them until final disposition is decided;
- Identify government or non-government agencies and experts that can assist in the identification, care, and screening of the seized or confiscated animals and assist in the process of deciding on appropriate disposition;
- Identify institutions, agencies, and private individuals and societies who can provide assistance to confiscating authorities in disposing of confiscated animals (including humane euthanasia) or can receive such animals;
- Elaborate on and provide for the implementation of the above guidelines in terms of specific legal and regulatory provisions and administrative procedures concerning transfer of ownership (including sale) of confiscated animals, short-term (e.g., upon seizure) and long-term (e.g., post-confiscation) care, levying of fees and other payments for care of confiscated animals, and other considerations that may be required to ensure that confiscated wild animals are disposed of responsibly in terms of both their welfare and the conservation.
- Produce and implement written policies on disposal of confiscated wildlife, taking steps to ensure that all enforcement personnel are provided the necessary resources to implement the policy.

Decision Tree Analysis

For decision trees dealing with “Return to the Wild” and “Captive Options,” the confiscating party must first ask the question:

Question 1: Will “Return to the Wild” make a significant contribution to the conservation of the species? Is there a management programme that has sufficient resources to enable return according to IUCN Re-introduction Guidelines?

The most important consideration in deciding on placement of confiscated specimens is the conservation value of the specimen in question. Conservation interests are best served by ensuring the survival of as many individuals as possible; hence, the re-introduction of confiscated animals must improve the prospects for survival of the wild population. Re-introducing animals that have been held in captivity will always involve some level of risk to populations of the same or other species in the ecosystem, because there can never be absolute certainty that a confiscated animal is disease- and parasite-free. If the specimen is not of conservation value, the costs of re-introducing the animals to the wild may divert resources away from conservation programmes for other species or more effective conservation activities. In most instances, the benefits of return to the wild will be outweighed by the costs and risks of such an action. If returning animals to the wild is not of conservation value, captive options pose fewer risks and may offer more humane alternatives.

Q1 Answer: **Yes:** Investigate "Return to the Wild" Options.
NO: Investigate "Captive Options".

DECISION TREE ANALYSIS - CAPTIVITY

The decision to maintain confiscated animals in captivity involves a simpler set of considerations than that involving attempts to return confiscated animals to the wild.

Question 2: Have animals been subjected to comprehensive veterinary screening and quarantine?

Animals that may be transferred to captive facilities must have a clean bill of health because of the risk of introducing disease to captive populations. This should be established through quarantine and screening.

Q2 Answer: Yes: Proceed to Question 3.
No: Quarantine and screen, and proceed to Question 3

Question 3: Have animals been found to be disease-free by comprehensive veterinary screening and quarantine, or can they be treated for any infection discovered?

If, during quarantine, the animals are found to harbour diseases that cannot reasonably be cured, they must be euthanized to prevent infection of other animals. If the animals are suspected to have come into contact with diseases for which screening is impossible, extended quarantine, transfer to a research facility, or euthanasia must be considered.

Q3 Answer: Yes: Proceed to Question 4
No: If chronic and incurable infection exists, first offer animals to research institutions. If impossible to place in such institutions, euthanize.

Question 4: Are there grounds for concern that certain options for transfer will stimulate further illegal or irregular trade or reduce the effectiveness of confiscation as a deterrent to such trade?

As much as possible, the confiscating authority should be satisfied that:

1) those involved in the illegal or irregular transaction that gave rise to confiscation cannot obtain the animals proposed for transfer;
2) the transfer does not compromise the objective of confiscation; and
3) the transfer will not increase illegal, irregular or otherwise undesired trade in the species.

What options can guarantee this will depend on the conservation status of the species in question, the nature of the trade in that species, and the circumstances of the specific incident that gave rise to confiscation. The payment of fees – to or by the confiscating authority – will complicate this assessment. Confiscating authorities must consider the various options for transfer in light of these concerns and weigh them against potential benefits that certain options might offer.

Answer: Yes: Proceed to Question 5a.
No: Proceed to Question 5b.

Question 5a: Is space available with a captive facility where the benefits of placement will outweigh concerns about the risks associated with transfer?

Question 5b: Is space available in a captive facility that offers particular benefits for the animals in question or the species?

There are a range of options for placement of confiscated animals in captivity, including public and private facilities, either commercial or non-commercial, specialist societies and individuals. Where several options for placement exist, it may be helpful to consider which offers the opportunity to maximize the conservation value of the animals, such as involvement in a conservation education or research programme or a captive-breeding programme. The conservation potential must be carefully weighed against the risk of stimulating trade that could exert further pressure on the wild population of the species.

Although placement with a commercial captive-breeding operation has the potential to reduce demand for wild-caught animals, this option should be carefully assessed: it may be difficult to monitor these facilities, and such programmes may, unintentionally or intentionally, stimulate trade in wild animals. In many countries, there are active specialist societies or clubs of individuals with considerable expertise in the husbandry and breeding of individual species or groups of species. Such societies can assist in finding homes for confiscated animals with individuals who have expertise in the husbandry of those species

When a choice must be made between several options, the paramount consideration should be which option can:

1) offer the opportunity for the animals to participate in a programme that may benefit the conservation of the species;
2) provide the most consistent care; and
3) ensure the welfare of the animals.

In instances, where no facilities are available in the country in which animals are confiscated, transfer to a captive facility outside the country of confiscation may be possible. Whether to pursue this will depend on the conservation value of the species or the extent of interest in it. An important consideration in assessing this option is the cost involved and the extent to which these resources may be more effectively allocated to other conservation efforts.

The confiscating authorities should conclude an agreement to transfer confiscated animals to captive facilities. This agreement should set forth the terms and conditions of the transfer, including:

a) restrictions on any use (e.g., exhibition, education, captive breeding), commercial or non-commercial, that the animals may be put to;
b) a commitment to ensure life-time care or, in the event that this becomes impossible, transfer to another facility that can ensure life-time care, or to euthanize the animals; and
c) conditions regarding subsequent transfer of ownership, including sale, of the

animals or their offspring.

Q5 Answer: Yes: Execute agreement and sell.
No: Proceed to Question 6.

Question 6: Are institutions interested in animals for research under humane conditions?

Many research institutions maintain collections of exotic animals for research conducted under humane conditions. If these animals are kept in conditions that ensure their welfare, transfer to such institutions may provide an acceptable alternative to other options, such as transfer to another captive facility or euthanasia. As in the preceding instances, such transfer should be subject to terms and conditions agreed with the confiscating authority; in addition to those already suggested, it may be advisable to include terms that stipulate the types of research the confiscating authority considers permissible. If no placement is possible, the animals should be euthanized.

Q6 Answer: Yes: Execute Agreement and Transfer.
No: Euthanize.

DECISION TREE ANALYSIS -- RETURN TO THE WILD

Question 2: Have animals been subjected to a comprehensive veterinary screening and quarantine?

Because of the risk of introducing disease to wild populations, confiscated animals that may be released must have a clean bill of health. The animals must be placed in quarantine to determine if they are disease-free before being considered for released.

Q2 Answer: Yes: Proceed to Question 3.
No: Quarantine and screen, and proceed to Question 3.

Question 3: Have animals been found to be disease-free by comprehensive veterinary screening and quarantine, or can they be treated for any infection discovered?

If, during quarantine, the confiscated animals are found to harbour diseases that cannot reasonably be cured, unless any institutions are interested in the animals for research under humane conditions, they must be euthanized to prevent infection of other animals. If the animals are suspected to have come into contact with diseases for which screening is impossible, extended quarantine, donation to a research facility, or ethanasia must be considered.

Q3 Answer: Yes: Proceed to Question 4
No: If chronic and incurable infection exists, first offer animals to research institutions. If impossible to place in such institutions, euthanize.

Question 4: Can the country of origin and site of capture be confirmed?

The geographical location from which confiscated animals have been removed from the wild must be determined if these individuals are to be used to re-inforce existing wild populations. As a general rule, animals should only be returned to the population from which they were taken, or from populations that are known to have natural exchange of individuals with this population.

If provenance of the animals is not known, release for reinforcement may lead to inadvertent hybridisation of distinct genetic races or sub-species. Related species of animals that may live in sympatry in the wild and never hybridise have been known to hybridise when held in captivity in multi-species groups. This type of generalisation of species recognition under abnormal conditions can result in behavioural problems, which can compromise the success of any future release and also pose a threat to wild populations by artificially destroying reproductive isolation that is behaviourally mediated.

Q4 Answer: Yes: Proceed to Question 5.
No: Pursue 'Captive Options'.

Question 5: Do the animals exhibit behavioural abnormalities that might make them unsuitable for return to the wild?

Behavioural abnormalities as a result of captivity can render animals unsuitable for release into the wild. A wide variety of behavioural traits and specific behavioural skills are necessary for survival, in the short-term for the individual, and in the long-term for the population. Skills for hunting, avoiding predators, food selectivity, etc. are necessary to ensure survival.

Q5 Answer: Yes: Pursue 'Captive Options'.
No: Proceed to Question 6.

Question 6: Can the animals be returned expeditiously to their site of origin (specific location), and will benefits to conservation of the species outweigh any risks of such action?

Return of the animals to the wild through reinforcement of the wild population should follow the IUCN Re-introduction Guidelines and will only be an option under certain conditions, including:

a) appropriate habitat for such an operation still exists in the specific location that the individual was removed from; and
b) sufficient funds are available, or can be made available.

Q6 Answer: Yes: Re-inforce at origin (specific location) following IUCN Guidelines.
No: Proceed to Question 7.

Question 7: For the species in question, does a generally recognized programme exist the aim of which is conservation of the species and eventual return to the wild of confiscated individuals and/or their progeny? *Contact IUCN/SSC, IIUDZG, Studbook Keeper, or Breeding Programme Coordinator (See Annex 3).*

In the case of species for which active captive breeding and/or re-introduction programmes exist, and for which further breeding stock/founders are required, confiscated animals should be transferred to such programmes after consultation with the appropriate scientific authorities. If the species in question is part of a captive breeding programme, but the taxon (sub-species or race) is not part of this programme, other methods of disposition must be considered. Particular attention should be paid to genetic screening to avoid jeopardizing captive breeding programmes through inadvertent hybridisation.

Q7 Answer: Yes: Execute agreement and transfer to existing programme.
No: Proceed to Question 8.

Question 8: Is there a need, and is it feasible to establish a new re-introduction programme *following IUCN Guidelines*?

In cases where individuals cannot be transferred to existing re-introduction programmes, re-introduction following IUCN Guidelines, may be possible, providing:

a) appropriate habitat exists for such an operation;
b) sufficient funds are available, or can be made available, to support a programme over the many years that (re)introduction will require; and
c) sufficient numbers of animals are available so that re-introduction efforts are potentially viable.

In the majority of cases, at least one, if not all, of these requirements will fail to be met. In this instance, either conservation introductions outside the historical range of the species or other options for disposition of the animals must be considered.

If a particular species is confiscated with some frequency, consideration should be made as to whether to establish a re-introduction, reinforcement, or introduction programme for that species. Animals should not be held by the confiscating authority indefinitely while such programmes are planned, but should be transferred to a holding facility after consultation with the organization which is establishing the new programme.

Q8 Answer: Yes: Execute agreement and transfer to holding facility or new programme.
No: Pursue 'Captive Options'.

Relevant Documents

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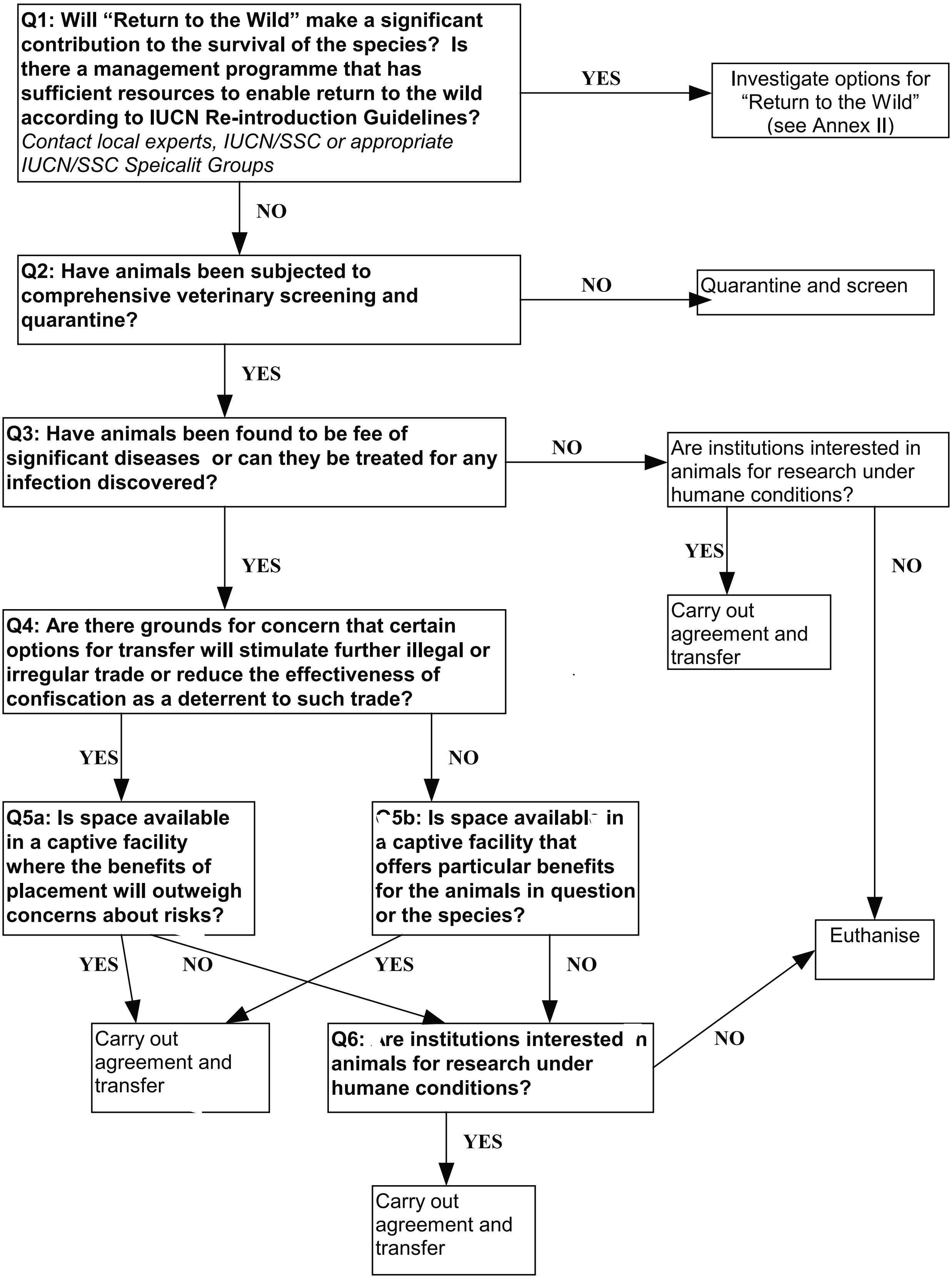
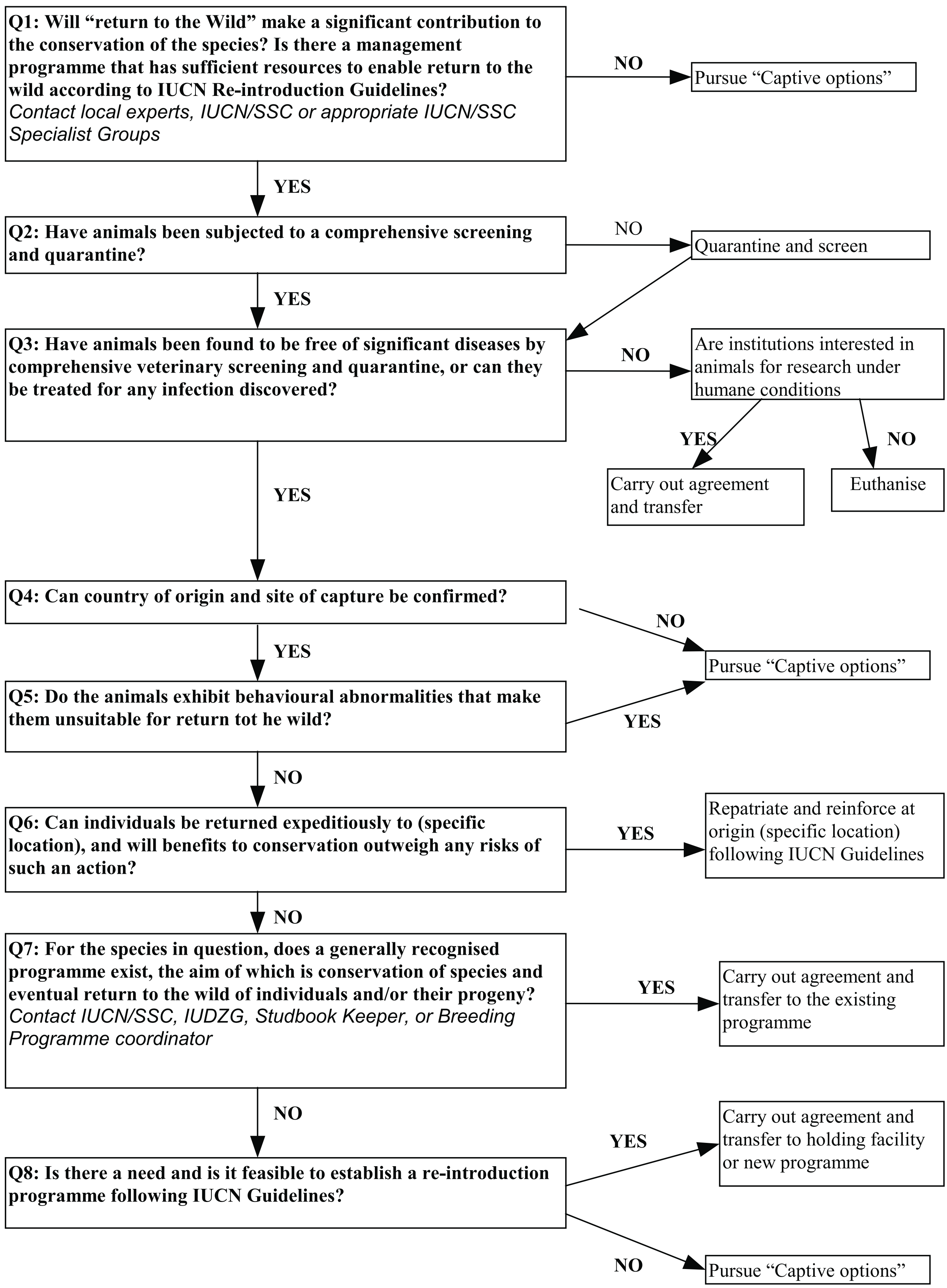
Annexes

Annex 1- Decision Tree for Captive Options



Annex 2 - Decision Tree for Return to the Wild



Annex 3 - Key Contacts

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Website: www.cites.org

15 January 2002

IUCN Position Statement on Translocation of Living Organisms
INTRODUCTIONS, REINTRODUCTIONS AND RE-STOCKING

Prepared by the Species Survival Commission in collaboration with the Commission on Ecology, and the Commission on Environmental Policy, Law and Administration

Approved by the 22nd Meeting of the IUCN Council, Gland, Switzerland, 4 September 1987

- INTRODUCTIONS
- THE RE-INTRODUCTION OF SPECIES
- RESTOCKING
- NATIONAL, INTERNATIONAL AND SCIENTIFIC IMPLICATIONS OF TRANSLOCATIONS

FOREWORD

This statement sets out IUCN's position on translocation of living organisms, covering introductions, re-introductions and re-stocking. The implications of these three sorts of translocation are very different so the paper is divided into four parts dealing with Introductions, Re-introductions, Re-stocking and Administrative Implications, respectively.

DEFINITIONS:

Translocation is the movement of living organisms from one area with free release in another. The three main classes of translocation distinguished in this document are defined as follows:

- **Introduction** of an organism is the intentional or accidental dispersal by human agency of a living organism outside its historically known native range.
- **Re-introduction** of an organism is the intentional movement of an organism into a part of its native range from which it has disappeared or become extirpated in historic times as a result of human activities or natural catastrophe.
- **Re-stocking** is the movement of numbers of plants or animals of a species with the intention of building up the number of individuals of that species in an original habitat.

Translocations are powerful tools for the management of the natural and man made environment which, properly used, can bring great benefits to natural biological systems and to man, but like other powerful tools they have the potential to cause enormous damage if misused. This IUCN statement describes the advantageous uses of translocations and the work and precautions needed to avoid the disastrous consequences of poorly planned translocations.

PART I

INTRODUCTIONS

BACKGROUND

Non-native (exotic) species have been introduced into areas where they did not formerly exist for a variety of reasons, such as economic development, improvement of hunting and fishing, ornamentation, or maintenance of the cultures of migrated human communities. The damage done by harmful introductions to natural systems far outweighs the benefit derived from them. The introduction and establishment of alien species in areas where they did not formerly occur, as an accidental or intended result of human activities, has often been directly harmful to the native plants and animals of many parts of the world and to the welfare of mankind.

The establishment of introduced alien species has broken down the genetic isolation of communities of co-evolving species of plants and animals. Such isolation has been essential for the evolution and maintenance of the diversity of plants and animals composing the biological wealth of our planet.

Disturbance of this isolation by alien species has interfered with the dynamics of natural systems causing the premature extinction of species. Especially successful and aggressive invasive species of plants and animals increasingly dominate large areas having replaced diverse autochthonous communities. Islands, in the broad sense, including isolated biological systems such as lakes or isolated mountains, are especially vulnerable to introductions because their often simple ecosystems offer refuge for species that are not aggressive competitors. As a result of their isolation they are of special value because of high endemism (relatively large numbers of unique local forms) evolved under the particular conditions of these islands over a long period of time. These endemic species are often rare and highly specialised in their ecological requirements and may be remnants of extensive communities from bygone ages, as exemplified by the Pleistocene refugia of Africa and Amazonia.

The diversity of plants and animals in the natural world is becoming increasingly important to man as their demands on the natural world increase in both quantity and variety, notwithstanding their dependence on crops and domestic animals nurtured within an increasingly uniform artificial and consequently vulnerable agricultural environment.

Introductions, can be beneficial to man. Nevertheless the following sections define areas in which the introduction of alien organisms is not conducive to good management, and describe the sorts of decisions that should be made before introduction of an alien species is made.

To reduce the damaging impact of introductions on the balance of natural systems, governments should provide the legal authority and administrative support that will promote implementation of the following approach.

Intentional Introduction

General

1. Introduction of an alien species should only be considered if clear and well defined benefits to man or natural communities can be foreseen.

2. Introduction of an alien species should only be considered if no native species is considered suitable for the purpose for which the introduction is being made.

Introductions to Natural Habitats

3. No alien species should be deliberately introduced into any natural habitat, island, lake, sea, ocean or centre of endemism, whether within or beyond the limits of national jurisdiction. A natural habitat is defined as a habitat not perceptibly altered by man. Where it would be effective, such areas should be surrounded by a buffer zone sufficiently large to prevent unaided spread of alien species from nearby areas. No alien introduction should be made within the buffer zone if it is likely to spread into neighbouring natural areas.

Introduction into Semi-natural Habitat

4. No alien species should be introduced into a semi-natural habitat unless there are exceptional reasons for doing so , and only when the operation has been comprehensively investigated and carefully planned in advance. A semi-natural habitat is one which has been detectably changed by man's actions or one which is managed by man, but still resembles a natural habitat in the diversity of its species and the complexity of their interrelationships. This excludes arable farm land, planted ley pasture and timber plantations.

Introductions into Man-made Habitat

5. An assessment should be made of the effects on surrounding natural and semi-natural habitats of the introduction of any species, sub-species, or variety of plant to artificial, arable, ley pasture or other predominantly monocultural forest systems. Appropriate action should be taken to minimise negative effects.

Planning a Beneficial introduction

6. Essential features of investigation and planning consist of:

- an assessment phase culminating in a decision on the desirability of the introduction;
- an experimental, controlled trial;
- the extensive introduction phase with monitoring and follow-up.

THE ASSESSMENT PHASE

Investigation and planning should take the following factors into account:

a) No species should be considered for introduction to a new habitat until the factors which limit its distribution and abundance in its native range have been thoroughly studied and understood by competent ecologists and its probable dispersal pattern appraised.

Special attention should be paid to the following questions:

- What is the probability of the exotic species increasing in numbers so that it causes damage to the environment, especially to the biotic community into which it will be introduced?
- What is the probability that the exotic species will spread and invade habitats besides those into which the introduction is planned? Special attention should be paid to the exotic species' mode of dispersal.
- How will the introduction of the exotic proceed during all phases of the biological and climatic cycles of the area where the introduction is planned? It has been found that fire, drought and flood can greatly alter the rate of propagation and spread of plants.
- What is the capacity of the species to eradicate or reduce native species by interbreeding with them?
- Will an exotic plant interbreed with a native species to produce new species of aggressive polyploid invader? Polyploid plants often have the capacity to produce varied offspring some of which quickly adapt to and dominate, native floras and cultivars alike.
- Is the alien species the host to diseases or parasites communicable to other flora and fauna, man, their crops or domestic animals, in the area of introduction?
- What is the probability that the species to be introduced will threaten the continued existence or stability of populations of native species, whether as a predator, competitor for food, cover, breeding sites or in any other way? If the introduced species is a carnivore, parasite or specialised herbivore, it should not be introduced if its food includes rare native species that could be adversely affected.

b) There are special problems to be considered associated with the introduction of aquatic species. These species have a special potential for invasive spread.

- Many fish change trophic level or diet preference following introduction, making prediction of the results of the re-introduction difficult. Introduction of a fish or other species at one point on a river system or into the sea may lead to the spread of the species throughout the system or area with unpredictable consequences for native animals and plants. Flooding may transport introduced species from one river system to another.
- introduced fish and large aquatic invertebrates have shown a great capacity to disrupt natural systems as their larval, sub-adult and adult forms often use different parts of the same natural system.

c) No introduction should be made for which a control does not exist or is not possible. A risk-and-threat analysis should be undertaken including investigation of the availability of methods for the control of the introduction should it expand in a way not predicted or have unpredicted undesirable effects, and the methods of control should be socially acceptable, efficient, should not damage vegetation and fauna, man, his domestic animals or cultivars.

d)When the questions above have been answered and the problems carefully considered, it should be decided if the species can reasonably be expected to survive in its new habitat, and if so, if it can reasonably be expected to enhance the flora and fauna of the area, or the economic or aesthetic value of the area, and whether these benefits outweigh the possible disadvantages revealed by the investigations.

THE EXPERIMENTAL CONTROLLED TRIAL

Following a decision to introduce a species, a controlled experimental introduction should be made observing the following advice:

- Test plants and animals should be from the same stock as those intended to be extensively introduced.
- They should be free of diseases and parasites communicable to native species, man, his crops and domestic livestock.
- The introduced species' performance on parameters in 'the Assessment Phase' above should be compared with the pre-trial assessment, and the suitability of the species for introduction should be reviewed in light of the comparison.

THE EXTENSIVE INTRODUCTION

If the introduced species behaves as predicted under the experimental conditions, then extensive introductions may commence but should be closely monitored. Arrangements should be made to apply counter measures to restrict, control, or eradicate the species if necessary.

The results of all phases of the introduction operation should be made public and available to scientists and others interested in the problems of introductions.

The persons or organisation introducing the species, not the public, should bear the cost of control of introduced organisms and appropriate legislation should reflect this.

ACCIDENTAL INTRODUCTIONS

1. Accidental introductions of species are difficult to predict and monitor, nevertheless they ”should be discouraged where possible. The following actions are particularly important:
    - o On island reserves, including isolated habitats such as lakes, mountain tops and isolated forests, and in wilderness areas, special care should be taken to avoid accidental introductions of seeds of alien plants on shoes and clothing and the introduction of animals especially associated with man, such as cats, dogs, rats and mice.
    - o Measures, including legal measures, should be taken to discourage the escape of farmed, including captive-bred, alien wild animals and newly-domesticated species which could breed with their wild ancestors if they escaped.
    - o In the interest of both agriculture and wildlife, measures should be taken to control contamination of imported agricultural seed with seeds of weeds and invasive plants.
    - o Where large civil engineering projects are envisaged, such as canals, which would link different biogeographical zones, the implications of the linkage for mixing the fauna and flora of the two regions should be carefully considered. An example of this is the mixing of species from the Pacific and Caribbean via the Panama Canal, and the mixing of Red Sea and Mediterranean aquatic organisms via the Suez Canal. Work needs to be done to consider what measures can be taken to restrict mixing of species from different zones through such large developments.
2. Where an accidentally introduced alien successfully and conspicuously propagates itself, the balance of its positive and negative economic and ecological effects should be investigated. If the overall effect is negative, measures should be taken to restrict its spread.

WHERE ALIEN SPECIES ARE ALREADY PRESENT

1. In general, introductions of no apparent benefit to man, but which are having a negative effect on the native flora and fauna into which they have been introduced, should be removed or eradicated. The present ubiquity of introduced species will put effective action against the majority of invasives beyond the means of many States but special efforts should be made to eradicate introductions on:

    - o islands with a high percentage of endemics in the flora and fauna;
    - o areas which are centres of endemism;
    - o areas with a high degree of species diversity;
    - o areas with a high degree of other ecological diversity;
    - o areas in which a threatened endemic is jeopardised by the presence of the alien.

2. Special attention should be paid to feral animals. These can be some of the most aggressive and damaging alien species to the natural environment, but may have value as an economic or genetic resource in their own right, or be of scientific interest. Where a feral population is believed to have a value in its own right, but is associated with changes in the balance of native vegetation and fauna, the conservation of the native flora and fauna should always take precedence. Removal to captivity or domestication is a valid alternative for the conservation of valuable feral animals consistent with the phase of their evolution as domestic animals.

1. Special attention should be paid to the eradication of mammalian feral predators from areas where there are populations of breeding birds or other important populations of wild fauna. Predatory mammals are especially difficult, and sometimes impossible to eradicate, for example, feral cats, dogs, mink, and ferrets.

2. In general, because of the complexity and size of the problem, but especially where feral mammals or several plant invaders are involved, expert advice should be sought on eradication.

BIOLOGICAL CONTROL

1. Biological control of introductions has shown itself to be an effective way of controlling and eradicating introduced species of plants and more rarely, of animals. As biological control involves introduction of alien species, the same care and procedures should be used as with other intentional introductions.

MICRO-ORGANISMS

1. There has recently been an increase of interest in the use of micro-organisms for a wide variety of purposes including those genetically altered by man.

1. Where such uses involve the movement of micro-organisms to areas where they did not formerly exist, the same care and procedures should be used as set out above for other species.

PART II

THE RE-INTRODUCTION OF SPECIES*

• Re-introduction is the release of a species of animal or plant into an area in which it was indigenous before extermination by human activities or natural catastrophe. Re-introduction is a particularly useful tool for restoring a species to an original habitat where it has become extinct due to human persecution, over-collecting, over-harvesting or habitat deterioration, but where these factors can now be controlled.

• Re-introductions should only take place where the original causes of extinction have been removed.

• Re-introductions should only take place where the habitat requirements of the species are satisfied. There should be no re-introduction if a species became extinct because of habitat change which remains unremedied, or where significant habitat deterioration has occurred since the extinction.

The species should only be re-introduced if measures have been taken to reconstitute the habitat to a state suitable for the species.

- The basic programme for re-introduction should consist of:
  - a feasibility study;
  - a preparation phase;
  - release or introduction phase; and a
  - follow-up phase.

THE FEASIBILITY STUDY

An ecological study should assess the previous relationship of the species to the habitat into which the re-introduction is to take place, and the extent that the habitat has changed since the local extinction of the species. If individuals to be re-introduced have been captive-bred or cultivated, changes in the species should also be taken into account and allowances made for new features liable to affect the ability of the animal or plant to re-adapt to its traditional habitat.

The attitudes of local people must be taken into account especially if the reintroduction of a species that was persecuted, over-hunted or over collected , is proposed. If the attitude of local people is unfavorable an education and interpretive programme emphasizing the benefits to them of the re-introduction, or other inducement, should be used to improve their attitude before re-introduction takes place.

The animals or plants involved in the re-introduction must be of the closest available race or type to the original stock and preferably be the same race as that previously occurring in the area.

Before commencing a re-introduction project, sufficient funds must be available to ensure that the project can be completed, including the follow-up phase.

THE PREPARATION AND RELEASE OR INTRODUCTORY PHASES

The successful re-introduction of an animal or plant requires that the biological needs of the species be fulfilled in the area where the release is planned. This requires a detailed knowledge of both the needs of the animal or plant and the ecological dynamics of the area of re-introduction. For this reason the best available scientific advice should be taken at all stages of a species re-introduction.

This need for clear analysis of a number of factors can be clearly seen with reference to introductions of ungulates such as ibex, antelope and deer where re-introduction involves understanding and applying the significance of factors such as the ideal age for re-introducing individuals, ideal sex ratio, season, specifying capture techniques and mode of transport to re-introduction site, freedom of both the species and the area of introduction from disease and parasites, acclimatisation, helping animals to learn to forage in the wild, adjustment of the gut flora to deal with new forage, ‘imprinting’ on the home range, prevention of wandering of individuals from the site of re-introduction, and on-site breeding in enclosures before release to expand the released population and acclimatise the animals to the site. The re-introduction of other taxa of plants and animals can be expected to be similarly complex.

FOLLOW-UP PHASE

Monitoring of released animals must be an integral part of any re-introduction programme. Where possible there should be long-term research to determine the rate of adaptation and dispersal, the need for further releases and identification of the reasons for success or failure of the programme.

The species impact on the habitat should be monitored and any action needed to improve conditions identified and taken.

Efforts should be made to make available information on both successful and unsuccessful re-introduction programmed through publications, seminars and other communications.

PART III

RESTOCKING

1. Restocking is the release of a plant or animal species into an area in which it is already present. Restocking may be a useful tool where:

    - o it is feared that a small reduced population is becoming dangerously inbred; or
    - o where a population has dropped below critical levels and recovery by natural growth will be dangerously slow; or
    - o where artificial exchange and artificially-high rates of immigration are required to maintain outbreeding between small isolated populations on biogeographical islands.

2. In such cases care should be taken to ensure that the apparent nonviability of the population, results from the genetic institution of the population and not from poor species management which has allowed deterioration in the habitat or over-utilisation of the population. With good management of a population the need for re-stocking should be avoidable but where re-stocking is contemplated the following points should be observed:

1. a) Restocking with the aim of conserving a dangerously reduced population should only be attempted when the causes of the reduction have been largely removed and natural increase can be excluded.

    b) Before deciding if restocking is necessary, the capacity of the area it is proposed to restock should be investigated to assess if the level of the population desired is sustainable. If it is, then further work should be undertaken to discover the reasons for the existing low population levels. Action should then be taken to help the resident population expand to the desired level. Only if this fails should restocking be used.

2. Where there are compelling reasons for restocking the following points should be observed.

    a) Attention should be paid to the genetic constitution of stocks used for restocking.

    - o In general, genetic manipulation of wild stocks should be kept to a minimum as it may adversely affect the ability of a species or population to survive. Such manipulations modify the effects of natural selection and ultimately the nature of the species and its ability to survive.
    - o Genetically impoverished or cloned stocks should not be used to re-stock populations as their ability to survive would be limited by their genetic homogeneity.

    b) The animals or plants being used for re-stocking must be of the same race as those in the population into which they are released.

    c) Where a species has an extensive natural range and restocking has the aim of conserving a dangerously reduced population at the climatic or ecological edge of its range, care should be taken that only individuals from a similar climatic or ecological zone are used since interbreeding with individuals from an area with a milder climate may interfere with resistant and hardy genotypes on the population’s edge.

    d) Introduction of stock from zoos may be appropriate, but the breeding history and origin of the animals should be known and follow as closely as possible Assessment Phase guidelines a, b, c and d (see pages 5-7). In addition the dangers of introducing new diseases into wild populations must be avoided: this is particularly important with primates that may carry human zoonoses.

    e) Restocking as part of a sustainable use of a resource (e.g. release of a proportion of crocodiles hatched from eggs taken from farms) should follow guidelines a and b (above).

    f) Where restocking is contemplated as a humanitarian effort to release or rehabilitate captive animals it is safer to make such releases as re-introductions where there is no danger of infecting wild populations of the same species with new diseases and where there are no problems of animals having to be socially accepted by wild individuals of the species.

PART IV

NATIONAL, INTERNATIONAL AND SCIENTIFIC IMPLICATIONS OF TRANSLOCATIONS

NATIONAL ADMINISTRATION

1. Pre-existing governmental administrative structures and frameworks already in use to protect agriculture, primary industries, wilderness and national parks should be used by governments to control both intentional and unintentional importation of organisms, especially through use of plant and animal quarantine regulations.

2. Governments should set up or utilise pre-existing scientific management authorities or experts in the fields of biology, ecology and natural resource management to advise them on policy matters concerning translocations and on individual cases where an introduction, re-introduction or restocking or farming of wild species is proposed.

3. Governments should formulate national policies on:

    - translocation of wild species;
    - capture and transport of wild animals;
    - artificial propagation of threatened species;
    - selection and propagation of wild species for domestication; and
    - prevention and control of invasive alien species.

4. At the national level legislation is required to curtail introductions:

1. **Deliberate introductions** should be subject to a permit system. The system should apply not only to species introduced from abroad but also to native species introduced to a new area in the same country. It should also apply to restocking.

Accidental introductions

- for all potentially harmful organisms there should be a prohibition to import them and to trade in them except under a permit and under very stringent conditions. This should apply in particular to the pet trade;
- where a potentially harmful organism is captive bred for commercial purposes (e.g. mink) there should be established by legislation strict standards for the design and operation of the captive breeding facilities. In particular, procedures should be established for the disposal of the stock of animals in the event of a discontinuation of the captive breeding operation;
- there should be strict controls on the use of live fish bait to avoid inadvertent introductions of species into water where they do not naturally occur.

Penalties

2. Deliberate introductions without a permit as well as negligence resulting in the escape or introduction of species harmful to the environment should be considered criminal offences and punished accordingly. The author of a deliberate introduction without a permit or the person responsible for an introduction by negligence should be legally liable for the damage incurred and should in particular bear the costs of eradication measures and of habitat restoration where required.

INTERNATIONAL ADMINISTRATION

Movement of Introduced Species Across International Boundaries

1. Special care should be taken to prevent introduced species from crossing the borders of a

neighboring state. When such an occurence is probable, the neighboring state should be promptly warned and consultations should be held in order to take adequate measures.

The Stockholm Declaration

2. According to Principle 21 of the Stockholm Declaration on the Human Environment, states have the responsibility ’to ensure that activities within their jurisdiction or control do not cause damage to the environment of other states’.

International Codes of Practice, Treaties and Agreements

3. States should be aware of the following international agreements and documents relevant to translocation of species:

    - ICES, Revised Code of Practice to Reduce the Risks from introduction of Marine Species, 1982.
    - FAO, Report of the Expert Consultation on the Genetic Resources of Fish, Recommendations to Governments No L 1980.
    - EIFAC (European Inland Fisheries Advisory Commission), Report of the Working Party on Stock Enhancement, Hamburg, FRG 1983.
    - The Bonn Convention MSC: Guidelines for Agreements under the Convention.
    - The Berne Convention: the Convention on the Conservation of European wildlife and Natural Habitats.
    - The ASEAN Agreement on the Conservation of Nature and Natural Resources.
    - Law of the Sea Convention, article 196.
    - Protocol on Protected Areas and Wild Fauna and Flora in Eastern African Region.

    In addition to the international agreements and documents cited, States also should be aware of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). International shipments of endangered or threatened species listed in the Appendices to the Convention are subject to CITES regulation and permit requirements. Enquiries should be addressed to: CITES Secretariat**, Case Postale 456, CH-1219 Chatelaine, Genève, Switzerland; telephone: 41/22/979 9149, fax: 41/22/797 3417.

Regional Development Plans

4. International, regional or country development and conservation organisations, when considering international, regional or country conservation strategies or plans, should include in-depth studies of the impact and influence of introduced alien species and recommend appropriate action to ameliorate or bring to an end their negative effects.

Scientific Work Needed

5. A synthesis of current knowledge on introductions, re-introductions and re-stocking is needed.
6. Research is needed on effective, target specific, humane and socially acceptable methods of eradication and control of invasive alien species.
7. The implementation of effective action on introductions, re-introductions and re-stocking frequently requires judgements on the genetic similarity of different stocks of a species of plant or animal. More research is needed on ways of defining and classifying genetic types.
8. Research is needed on the way in which plants and animals are dispersed through the agency of man (dispersal vector analysis).

    A review is needed of the scope, content and effectiveness of existing legislation relating to introductions.

IUCN Responsibilities

International organisations, such as UNEP, UNESCO and FAO, as well as states planning to introduce, re-introduce or restock taxa in their territories, should provide sufficient funds, so that IUCN as an international independent body, can do the work set out below and accept the accompanying responsibilities.

9. IUCN will encourage collection of information on all aspects of introductions, re-introductions and restocking, but especially on the case histories of re-introductions; on habitats especially vulnerable to invasion; and notable aggressive invasive species of plants and animals.

   Such information would include information in the following categories:

   - a bibliography of the invasive species;
   - the taxonomy of the species;
   - the synecology of the species; and
   - methods of control of the species.

10. The work of the Threatened Plants Unit of IUCN defining areas of high plant endemism, diversity and ecological diversity should be encouraged so that guidance on implementing recommendations in this document may be available.

11. A list of expert advisors on control and eradication of alien species should be available through IUCN.

Note:
* The section on re-introduction of species has been enhanced by the Guidelines For Re-Introductions

IUCN Policy Statement on Research Involving Species at Risk of Extinction

Approved by the 27th Meeting of IUCN Council, Gland Switzerland, 14 June 1989

PROLOGUE

IUCN holds that all research on or affecting a threatened species carries a moral responsibility for the preservation or enhancement of the survival of that species. Conservation of the research resource is clearly in the interest of the researchers.

IUCN recognises that the taking and trading of specimens of threatened species are covered by international agreements and are normally included in national legislation which provides authorised exemptions for the purpose of scientific research.

Basic and applied research is critically needed on many aspects of the biology of animal and plant species at risk of extinction (e.g. those listed by IUCN as Vulnerable, Rare,Endangered, or Indeterminate) to provide knowledge vital to their conservation.

Other scientific interests may involve the use of threatened species in a wide variety of studies. Taking into account the importance of many kinds of research, as well as potential threats such species could be subject to in such activities, IUCN, after careful consideration, adopts the following statements as policy.

POLICY

IUCN encourages basic and applied research on threatened species that contributes to the likelihood of survival of those species.

When a choice is available among captive-bred or propagated, wild-caught or taken, or free-living stock for research not detrimental to the survival of a threatened species, IUCN recommends the option contributing most positively to sustaining wild populations of the species.

IUCN recommends that research programmes on threatened species that do not directly contribute to conservation of the species should acknowledge an obligation to the species by devoting monetary or other substantial resources to their conservation, preferably to sustaining populations in the natural environment.

Whether animals involved are captive-bred, wild-caught, or free living, or whether plants involved are propagated, taken from the wild, or in their natural habitat, IUCN opposes research that directly or indirectly impairs the survival of threatened species and urges that such research not be undertaken.

PROTOCOLS

In this context IUCN urges researchers to accept a personal obligation to satisfy themselves that the processes by which research specimens are acquired (including transportation) conform scrupulously to procedures and regulations adopted under international legal agreements. Further, researchers should adopt applicable professional standards for humane treatment of animal specimens, including their capture and use in research.

IUCN urges that any research on threatened species be conducted in conformity with all applicable laws, regulations and veterinary professional standards governing animal acquisition, health and welfare, and with all applicable agricultural and genetic resource laws and regulations governing acquisition, transport, and management of plants.

IUCN/SSC Guidelines for Reintroductions

Prepared by the SSC Re-introduction Specialist Group *****

Approved by the 41st Meeting of the IUCN Council, Gland Switzerland, May 1995

INTRODUCTION

These policy guidelines have been drafted by the Re-introduction Specialist Group of the IUCN's Species Survival Commission (1), in response to the increasing occurrence of re-introduction projects worldwide, and consequently, to the growing need for specific policy guidelines to help ensure that the re-introductions achieve their intended conservation benefit, and do not cause adverse side-effects of greater impact. Although IUCN developed a Position Statement on the Translocation of Living Organisms in 1987, more detailed guidelines were felt to be essential in providing more comprehensive coverage of the various factors involved in re-introduction exercises.

These guidelines are intended to act as a guide for procedures useful to re-introduction programmes and do not represent an inflexible code of conduct. Many of the points are more relevant to re-introductions using captive-bred individuals than to translocations of wild species. Others are especially relevant to globally endangered species with limited numbers of founders. Each re-introduction proposal should be rigorously reviewed on its individual merits. It should be noted that re-introduction is always a very lengthy, complex and expensive process.

Re-introductions or translocations of species for short-term, sporting or commercial purposes - where there is no intention to establish a viable population - are a different issue and beyond the scope of these guidelines. These include fishing and hunting activities.

This document has been written to encompass the full range of plant and animal taxa and is therefore general. It will be regularly revised. Handbooks for re-introducing individual groups of animals and plants will be developed in future.

CONTEXT

The increasing number of re-introductions and translocations led to the establishment of the IUCN/SSC Species Survival Commission's Re-introduction Specialist Group. A priority of the Group has been to update IUCN's 1987 Position Statement on the Translocation of Living Organisms, in consultation with IUCN's other commissions.

It is important that the Guidelines are implemented in the context of IUCN's broader policies pertaining to biodiversity conservation and sustainable management of natural resources. The philosophy for environmental conservation and management of IUCN and other conservation bodies is stated in key documents such as "Caring for the Earth" and "Global Biodiversity Strategy" which cover the broad themes of the need for approaches with community involvement and participation in sustainable natural resource conservation, an overall enhanced quality of human life and the need to conserve and, where necessary, restore ecosystems. With regards to the latter, the re-introduction of a species is one specific instance of restoration where, in general, only this species is missing. Full restoration of an array of plant and animal species has rarely been tried to date.

Restoration of single species of plants and animals is becoming more frequent around the world. Some succeed, many fail. As this form of ecological management is increasingly common, it is a priority for the Species Survival Commission's Re-introduction Specialist Group to develop guidelines so that re-introductions are both justifiable and likely to succeed, and that the conservation world can learn from each initiative, whether successful or not. It is hoped that these Guidelines, based on extensive review of case - histories and wide consultation across a range of disciplines will introduce more rigour into the concepts, design, feasibility and implementation of re-introductions despite the wide diversity of species and conditions involved.

Thus the priority has been to develop guidelines that are of direct, practical assistance to those planning, approving or carrying out re-introductions. The primary audience of these guidelines is, therefore, the practitioners (usually managers or scientists), rather than decision makers in governments. Guidelines directed towards the latter group would inevitably have to go into greater depth on legal and policy issues.

1. DEFINITION OF TERMS

“Re-introduction”: an attempt to establish a species(2) in an area which was once part of its historical range, but from which it has been extirpated or become extinct (3) (“Re-establishment” is a synonym, but implies that the re-introduction has been successful).

“Translocation”: deliberate and mediated movement of wild individuals or populations from one part of their range to another.

“Re-inforcement/Supplementation”: addition of individuals to an existing population of conspecifics.

“Conservation/Benign Introductions”: an attempt to establish a species, for the purpose of conservation, outside its recorded distribution but within an appropriate habitat and eco-geographical area. This is a feasible conservation tool only when there is no remaining area left within a species’ historic range.

2. AIMS AND OBJECTIVES OF RE-INTRODUCTION

a. Aims:

The principle aim of any re-introduction should be to establish a viable, free-ranging population in the wild, of a species, subspecies or race, which has become globally or locally extinct, or extirpated, in the wild. It should be re-introduced within the species’ former natural habitat and range and should require minimal long-term management.

b. Objectives:

The objectives of a re-introduction may include: to enhance the long-term survival of a species; to re-establish a keystone species (in the ecological or cultural sense) in an ecosystem; to maintain and/or restore natural biodiversity; to provide long-term economic benefits to the local and/or nataional economy; to promote conservation awareness; or a combination of these.

3. MULTIDISCIPLINARY APPROACH

A re-introduction requires a multidisciplinary approach involving a team of persons drawn from a variety of backgrounds. As well as government personnel, they may include persons from governmental natural resource management agencies; non-governmental organisations; funding bodies; universities; veterinary institutions; zoos (and private animal breeders) and/or botanic gardens, with a full range of suitable expertise. Team leaders should be responsible for coordination between the various bodies and provision should be made for publicity and public education about the project.

4. PRE-PROJECT ACTIVITIES

4a. BIOLOGICAL

(i) Feasibility study and background research

- An assessment should be made of the taxonomic status of individuals to be re-introduced. They should preferably be of the same subspecies or race as those which were extirpated, unless adequate numbers are not available. An investigation of historical information about the loss and fate of individuals from the re-introduction area, as well as molecular genetic studies, should be undertaken in case of doubt as to individuals' taxonomic status. A study of genetic variation within and between populations of this and related taxa can also be helpful. Special care is needed when the population has long been extinct.

- Detailed studies should be made of the status and biology of wild populations(if they exist) to determine the species' critical needs. For animals, this would include descriptions of habitat preferences, intraspecific variation and adaptations to local ecological conditions, social behaviour, group composition, home range size, shelter and food requirements, foraging and feeding behaviour, predators and diseases. For migratory species, studies should include the potential migratory areas. For plants, it would include biotic and abiotic habitat requirements, dispersal mechanisms, reproductive biology, symbiotic relationships (e.g. with mycorrhizae, pollinators), insect pests and diseases. Overall, a firm knowledge of the natural history of the species in question is crucial to the entire re-introduction scheme.

- The species, if any, that has filled the void created by the loss of the species concerned, should be determined; an understanding of the effect the re-introduced species will have on the ecosystem is important for ascertaining the success of the re-introduced population.

- The build-up of the released population should be modelled under various sets of conditions, in order to specify the optimal number and composition of individuals to be released per year and the numbers of years necessary to promote establishment of a viable population.

- A Population and Habitat Viability Analysis will aid in identifying significant environmental and population variables and assessing their potential interactions, which would guide long-term population management.

(ii) Previous Re-introductions

- Thorough research into previous re-introductions of the same or similar species and wide-ranging contacts with persons having relevant expertise should be conducted prior to and while developing re-introduction protocol.

(iii) Choice of release site and type

- Site should be within the historic range of the species. For an initial re-inforcement there should be few remnant wild individuals. For a re-introduction, there should be no remnant population to prevent disease spread, social disruption and introduction of alien genes. In some circumstances, a re-introduction or re-inforcement may have to be made into an area which is fenced or otherwise delimited, but it should be within the species' former natural habitat and range.

- A conservation/ benign introduction should be undertaken only as a last resort when no opportunities for re-introduction into the original site or range exist and only when a significant contribution to the conservation of the species will result.

- The re-introduction area should have assured, long-term protection (whether formal or otherwise).

(iv) Evaluation of re-introduction site

- Availability of suitable habitat: re-introductions should only take place where the habitat and landscape requirements of the species are satisfied, and likely to be sustained for the for-seeable future. The possibility of natural habitat change since extirpation must be considered. Likewise, a change in the legal/ political or cultural environment since species extirpation needs to be ascertained and evaluated as a possible constraint. The area should have sufficient carrying capacity to sustain growth of the re-introduced population and support a viable (self-sustaining) population in the long run.

- Identification and elimination, or reduction to a sufficient level, of previous causes of decline: could include disease; over-hunting; over-collection; pollution; poisoning; competition with or predation by introduced species; habitat loss; adverse effects of earlier research or management programmes; competition with domestic livestock, which may be seasonal. Where the release site has undergone substantial degradation caused by human activity, a habitat restoration programme should be initiated before the re-introduction is carried out.

(v) Availability of suitable release stock

- It is desirable that source animals come from wild populations. If there is a choice of wild populations to supply founder stock for translocation, the source population should ideally be closely related genetically to the original native stock and show similar ecological characteristics (morphology, physiology, behaviour, habitat preference) to the original sub-population.

- Removal of individuals for re-introduction must not endanger the captive stock population or the wild source population. Stock must be guaranteed available on a regular and predictable basis, meeting specifications of the project protocol.

- Individuals should only be removed from a wild population after the effects of translocation on the donor population have been assessed, and after it is guaranteed that these effects will not be negative.
- If captive or artificially propagated stock is to be used, it must be from a population which has been soundly managed both demographically and genetically, according to the principles of contemporary conservation biology.
- Re-introductions should not be carried out merely because captive stocks exist, nor solely as a means of disposing of surplus stock.
- Prospective release stock, including stock that is a gift between governments, must be subjected to a thorough veterinary screening process before shipment from original source. Any animals found to be infected or which test positive for non-endemic or contagious pathogens with a potential impact on population levels, must be removed from the consignment, and the uninfected, negative remainder must be placed in strict quarantine for a suitable period before retest. If clear after retesting, the animals may be placed for shipment.
- Since infection with serious disease can be acquired during shipment, especially if this is intercontinental, great care must be taken to minimize this risk.
- Stock must meet all health regulations prescribed by the veterinary authorities of the recipient country and adequate provisions must be made for quarantine if necessary.

(vi) Release of captive stock

- Most species of mammal and birds rely heavily on individual experience and learning as juveniles for their survival; they should be given the opportunity to acquire the necessary information to enable survival in the wild, through training in their captive environment; a captive bred individual's probability of survival should approximate that of a wild counterpart.
- Care should be taken to ensure that potentially dangerous captive bred animals (such as large carnivores or primates) are not so confident in the presence of humans that they might be a danger to local inhabitants and/or their livestock.

4b. SOCIO-ECONOMIC AND LEGAL REQUIREMENTS

- Re-introductions are generally long-term projects that require the commitment of long-term financial and political support.
- Socio-economic studies should be made to assess impacts, costs and benefits of the re-introduction programme to local human populations.
- A thorough assessment of attitudes of local people to the proposed project is necessary to ensure long term protection of the re-introduced population, especially if the cause of species' decline was due to human factors (e.g. over-hunting, over-collection, loss or alteration of habitat). The programme should be fully understood, accepted and supported by local communities.
- Where the security of the re-introduced population is at risk from human activities, measures should be taken to minimise these in the re-introduction area. If these measures are inadequate, the re-introduction should be abandoned or alternative release areas sought.
- The policy of the country to re-introductions and to the species concerned should be assessed. This might include checking existing provincial, national and international legislation and regulations, and provision of new measures and required permits as necessary.
- Re-introduction must take place with the full permission and involvement of all relevant government agencies of the recipient or host country. This is particularly important in re-introductions in border areas, or involving more than one state or when a re-introduced population can expand into other states, provinces or territories.
- If the species poses potential risk to life or property, these risks should be minimised and adequate

provision made for compensation where necessary; where all other solutions fail, removal or destruction of the released individual should be considered. In the case of migratory/mobile species, provisions should be made for crossing of international/state boundaries.

5. PLANNING, PREPARATION AND RELEASE STAGES

- Approval of relevant government agencies and land owners, and coordination with national and international conservation organizations.
- Construction of a multidisciplinary team with access to expert technical advice for all phases of the programme.
- Identification of short- and long-term success indicators and prediction of programme duration, in context of agreed aims and objectives.
- Securing adequate funding for all programme phases.
- Design of pre- and post- release monitoring programme so that each re-introduction is a carefully designed experiment, with the capability to test methodology with scientifically collected data. Monitoring the health of individuals, as well as the survival, is important; intervention may be necessary if the situation proves unforseeably favourable.
- Appropriate health and genetic screening of release stock, including stock that is a gift between governments. Health screening of closely related species in the re-introduction area.
- If release stock is wild-caught, care must be taken to ensure that: a) the stock is free from infectious or contagious pathogens and parasites before shipment and b) the stock will not be exposed to vectors of disease agents which may be present at the release site (and absent at the source site) and to which it may have no acquired immunity.
- If vaccination prior to release, against local endemic or epidemic diseases of wild stock or domestic livestock at the release site, is deemed appropriate, this must be carried out during the "Preparation Stage" so as to allow sufficient time for the development of the required immunity.
- Appropriate veterinary or horticultural measures as required to ensure health of released stock throughout the programme. This is to include adequate quarantine arrangements, especially where founder stock travels far or crosses international boundaries to the release site.
- Development of transport plans for delivery of stock to the country and site of re-introduction, with special emphasis on ways to minimize stress on the individuals during transport.
- Determination of release strategy (acclimatization of release stock to release area; behavioural training - including hunting and feeding; group composition, number, release patterns and techniques; timing).
- Establishment of policies on interventions (see below).
- Development of conservation education for long-term support; professional training of individuals involved in the long-term programme; public relations through the mass media and in local community; involvement where possible of local people in the programme.
- The welfare of animals for release is of paramount concern through all these stages.

6. POST-RELEASE ACTIVITIES

- Post release monitoring is required of all (or sample of) individuals. This most vital aspect may be by direct (e.g. tagging, telemetry) or indirect (e.g. spoor, informants) methods as suitable.
- Demographic, ecological and behavioural studies of released stock must be undertaken.
- Study of processes of long-term adaptation by individuals and the population.
- Collection and investigation of mortalities.

- Interventions (e.g. supplemental feeding; veterinary aid; horticultural aid) when necessary.
- Decisions for revision, rescheduling, or discontinuation of programme where necessary.
- Habitat protection or restoration to continue where necessary.
- Continuing public relations activities, including education and mass media coverage.
- Evaluation of cost-effectiveness and success of re- introduction techniques.
- Regular publications in scientific and popular literature.

Footnotes:

1 Guidelines for determining procedures for disposal of species confiscated in trade are being developed separately by IUCN.

2 The taxonomic unit referred to throughout the document is species; it may be a lower taxonomic unit (e.g. subspecies or race) as long as it can be unambiguously defined.

3 A taxon is extinct when there is no reasonable doubt that the last individual has died

The IUCN/SSC Re-introduction Specialist Group (RSG) is a disciplinary group (as opposed to most SSC Specialist Groups which deal with single taxonomic groups), covering a wide range of plant and animal species. The RSG has an extensive international network, a re-introduction projects database and re-introduction library. The RSG publishes a bi-annual newsletter RE-INTRODUCTION NEWS.

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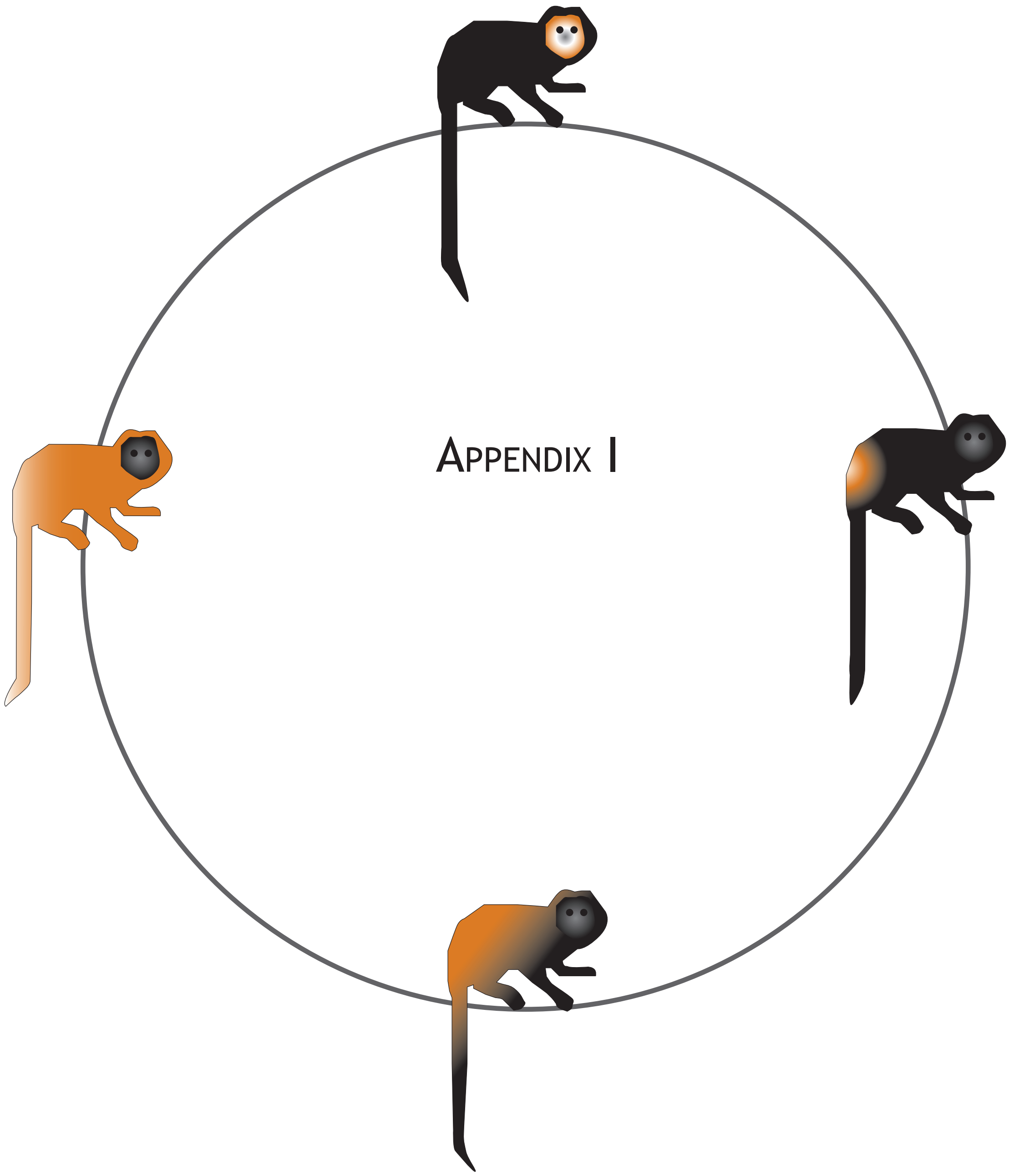
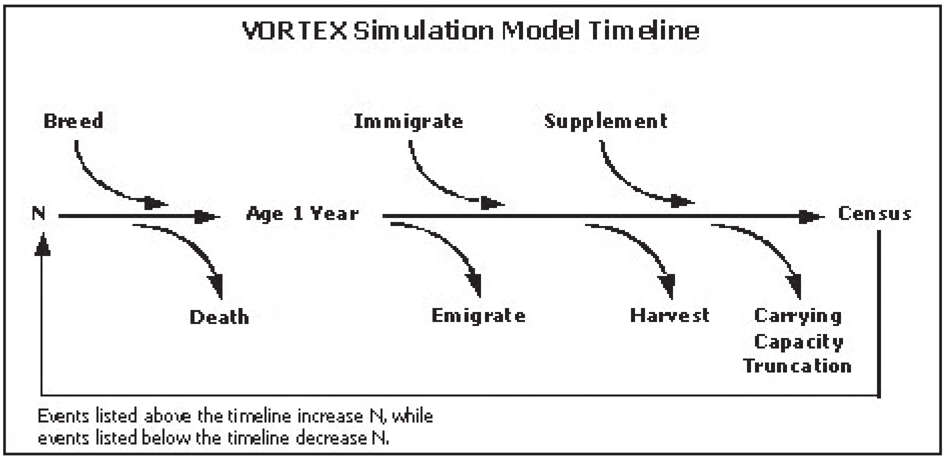
Appendix I



Introduction to Vortex 9

The Vortex computer program is a simulation of the effects of deterministic forces as well as demographic, environmental and genetic stochastic events on wildlife populations. It is an attempt to model many of the extinction vortices that can threaten persistence of small populations (hence, its name). Vortex models population dynamics as discrete, sequential events that occur according to probabilities that are random variables following user-specified distributions. Vortex simulates a population by stepping through a series of events that describe an annual cycle of a typical sexually reproducing, diploid organism: mate selection, reproduction, mortality, increment of age by one year, migration among populations, removals, supplementation, and then truncation (if necessary) to the carrying capacity. Although Vortex simulates life events on an annual cycle, a user could model "years" that are other than 12 months duration. The simulation of the population is iterated many times to generate the distribution of fates that the population might experience.

Vortex is an individual-based model. That is, it creates a representation of each animal in its memory and follows the fate of the animal through each year of its lifetime. Vortex keeps track of the sex, age, and



parentage of each animal. Demographic events (birth, sex determination, mating, dispersal, and death) are modeled by determining for each animal in each year of the simulation whether any of the events occur. (See figure below.)

Vortex requires a lot of population-specific data. For example, the user must specify the amount of annual variation in each demographic rate caused by fluctuations in the environment. In addition, the frequency of each type of catastrophe (drought, flood, epidemic disease) and the effects of the

catastrophes on survival and reproduction must be specified. Rates of migration (dispersal) between each pair of local populations must be specified. Because Vortex requires specification of many biological parameters, it is not necessarily a good model for the examination of population dynamics that would result from some generalized life history. It is most usefully applied to the analysis of a specific population in a specific environment.

In the program explanation that follows, demographic rates are described as constants specified by the user. Although this is the way the program is most commonly and easily used, Vortex does provide the capability to specify most demographic rates as functions of time, density, and other parameters.

Demographic stochasticity

Vortex models demographic stochasticity by determining the occurrence of probabilistic events such as reproduction, litter size, sex determination, and death with a pseudo-random number generator. For each life event, if the random value sampled from a specified distribution falls above the user-specified probability, the event is deemed to have occurred, thereby simulating a binomial process. Demographic stochasticity is therefore a consequence of the uncertainty regarding whether each demographic event occurs for any given animal.

The source code used to generate random numbers uniformly distributed between 0 and 1 was obtained from Maier (1991), based on the algorithm of Kirkpatrick and Stoll (1981). Random deviates from binomial distributions, with mean p and standard deviation s, are obtained by first determining the

$$N = \frac{p(1-p)}{s^2}$$

integral number of binomial trials, N, that would produce the value of s closest to the specified value, according to: N binomial trials are then simulated by sampling from the uniform 0-1 distribution to obtain the desired result, the frequency or proportion of successes. If the value of N determined for a desired binomial distribution is larger than 25, a normal approximation is used in place of the binomial distribution. This normal approximation must be truncated at 0 and at 1 to allow use in defining probabilities, although, with such large values of N, s is small relative to p and the truncation would be invoked only rarely. To avoid introducing bias with this truncation, the normal approximation to the binomial (when used) is truncated symmetrically around the mean. The algorithm for generating random numbers from a unit normal distribution follows Latour (1986).

Environmental variation

Vortex can model annual fluctuations in birth and death rates and in carrying capacity as might result from environmental variation. To model environmental variation, each demographic parameter is assigned a distribution with a mean and standard deviation that is specified by the user. Annual fluctuations in probabilities of reproduction and mortality are modeled as binomial distributions. Environmental variation in carrying capacity is modeled as a normal distribution. Environmental variation in demographic rates can be correlated among populations.

Catastrophes

Catastrophes are modeled in Vortex as random events that occur with specified probabilities. A catastrophe will occur if a randomly generated number between zero and one is less than the probability of occurrence. Following a catastrophic event, the chances of survival and successful breeding for that simulated year are multiplied by severity factors. For example, forest fires might occur once in 50 years, on average, killing 25% of animals, and reducing breeding by survivors 50% for the year. Such a catastrophe would be modeled as a random event with 0.02 probability of occurrence each year, and severity factors of 0.75 for survival and 0.50 for reproduction. Catastrophes can be local (impacting populations independently), or regional (affecting sets of populations simultaneously).

Genetic processes

Vortex models loss of genetic variation in populations, by simulating the transmission of alleles from parents to offspring at a hypothetical neutral (non-selected) genetic locus. Each animal at the start of the simulation is assigned two unique alleles at the locus. Each offspring created during the simulation is randomly assigned one of the alleles from each parent. Vortex monitors how many of the original alleles remain within the population, and the average heterozygosity and gene diversity (or “expected heterozygosity”) relative to the starting levels. Vortex also monitors the inbreeding coefficients of each animal, and can reduce the juvenile survival of inbred animals to model the effects of inbreeding depression.

Inbreeding depression is modeled as a loss of viability of inbred animals during their first year. The severity of inbreeding depression is commonly measured by the number of “lethal equivalents” in a population (Morton et al. 1956). The number of lethal equivalents per diploid genome estimates the average number of lethal alleles per individual in the population if all deleterious effects of inbreeding were due entirely to recessive lethal alleles. A population in which inbreeding depression is one lethal equivalent per diploid genome may have one recessive lethal allele per individual, it may have two recessive alleles per individual, each of which confer a 50% decrease in survival, or it may have some other combination of recessive deleterious alleles which equate in effect with one lethal allele per individual.

Vortex partitions the total effect of inbreeding (the total lethal equivalents) into an effect due to recessive lethal alleles and an effect due to loci at
which there is heterozygote advantage (superior fitness of heterozygotes relative to all homozygote genotypes). To model the effects of lethal alleles, each founder starts with a unique recessive lethal allele (and a dominant non-lethal allele) at up to five modeled loci. By virtue of the deaths of individuals that are homozygous for lethal alleles, such alleles can be removed slowly by natural selection during the generations of a simulation. This diminishes the probability that inbred individuals in subsequent generations will be homozygous for a lethal allele.

Heterozygote advantage is modeled by specifying that juvenile survival is related to inbreeding according to the logarithmic model:

$$\ln(S) = A - BF$$

in which S is survival, F is the inbreeding coefficient, A is the logarithm of survival in the absence of inbreeding, and B is the portion of the lethal equivalents per haploid genome that is due to heterozygote advantage rather than to recessive lethal alleles. Unlike the situation with fully recessive deleterious alleles, natural selection does not remove deleterious alleles at loci in which the heterozygote has higher fitness than both homozygotes, because all alleles are deleterious when homozygous and beneficial when present in heterozygous combination with other alleles. Thus, under heterozygote advantage, the impact of inbreeding on survival does not diminish during repeated generations of inbreeding. Unfortunately, for relatively few species are data available to allow estimation of the effects of inbreeding, and the magnitude of these effects apparently varies considerably among species (Falconer 1981; Ralls et al. 1988; Lacy et al. 1993) and even among populations of the same species (Lacy et al. 1995). Even without detailed pedigree data from which to estimate the number of lethal equivalents in a population and the underlying nature of the genetic load (recessive alleles or heterozygote advantage), PVAs must make assumptions about the effects of inbreeding on the population being studied. If genetic effects are ignored, the PVA will overestimate the viability of small populations. In some cases, it might be considered appropriate to assume that an inadequately studied species would respond to inbreeding in accord with the median (3.14 lethal equivalents per diploid) reported in the survey by Ralls et al. (1988). In other cases, there might be reason to make more optimistic assumptions (perhaps the lower quartile, 0.90 lethal equivalents), or more pessimistic assumptions (perhaps the upper quartile, 5.62 lethal equivalents). In the few species in which inbreeding depression has been studied carefully, about half of the effects of inbreeding are due recessive lethal alleles and about half of the effects are due to heterozygote advantage or other genetic mechanisms that are not diminished by natural selection during generations of inbreeding, although the proportion of the total inbreeding effect can vary substantially among populations (Lacy and Ballou 1998).

A full explanation of the genetic mechanisms of inbreeding depression is beyond the scope of this manual, and interested readers are encouraged to refer to the references cited above.

Vortex can model monogamous or polygamous mating systems. In a monogamous system, a relative scarcity of breeding males may limit reproduction by females. In polygamous or monogamous models, the user can specify the proportion of the adult males in the breeding pool. Males are randomly reassigned to the breeding pool each year of the simulation, and all males in the breeding pool have an equal chance of siring offspring.

Deterministic processes

Vortex can incorporate several deterministic processes, in addition to mean age-specific birth and death rates. Density dependence in mortality is modeled by specifying a carrying capacity of the habitat. When the population size exceeds the carrying capacity, additional morality is imposed across all age classes to bring the population back down to the carrying capacity. Each animal in the population has an equal probability of being removed by this truncation. The carrying capacity can be specified to change over time, to model losses or gains in the amount or quality of habitat.

Density dependence in reproduction is modeled by specifying the proportion of adult females breeding each year as a function of the population size. The default functional relationship between breeding and density allows entry of Allee effects (reduction in breeding at low density) and/or reduced breeding at high densities.

Populations can be supplemented or harvested for any number of years in each simulation. Harvest may be culling or removal of animals for translocation to another (unmodeled) population. The numbers of additions and removals are specified according to the age and sex of animals.

Migration among populations

Vortex can model up to 50 populations, with possibly distinct population parameters. Each pairwise migration rate is specified as the probability of an individual moving from one population to another. Migration among populations can be restricted to one sex and/or a limited age cohort. Emigration from a population can be restricted to occur only when the number of animals in the population exceeds a specified proportion of the carrying capacity. Dispersal mortality can be specified as a probability of death for any migrating animal, which is in addition to age-sex specific mortality. Because of between-population migration and managed supplementation, populations can be recolonized. Vortex tracks the dynamics of local extinctions and recolonizations through the simulation.

Output

Vortex outputs: (1) probability of extinction at specified intervals (e.g., every 10 years during a 100 year simulation), (2) median time to extinction, if the population went extinct in at least 50% of the simulations, (3) mean time to extinction of those simulated populations that became extinct, and (4) mean size of, and genetic variation within, extant populations.

Standard deviations across simulations and standard errors of the mean are reported for population size and the measures of genetic variation. Under the assumption that extinction of independently replicated populations is a binomial process, the standard error of the probability of extinction is reported by Vortex as:

$$SE(p) = \sqrt{\frac{p(1-p)}{n}}$$

in which the frequency of extinction was p over n simulated populations. Demographic and genetic statistics are calculated and reported for each subpopulation and for the metapopulation.

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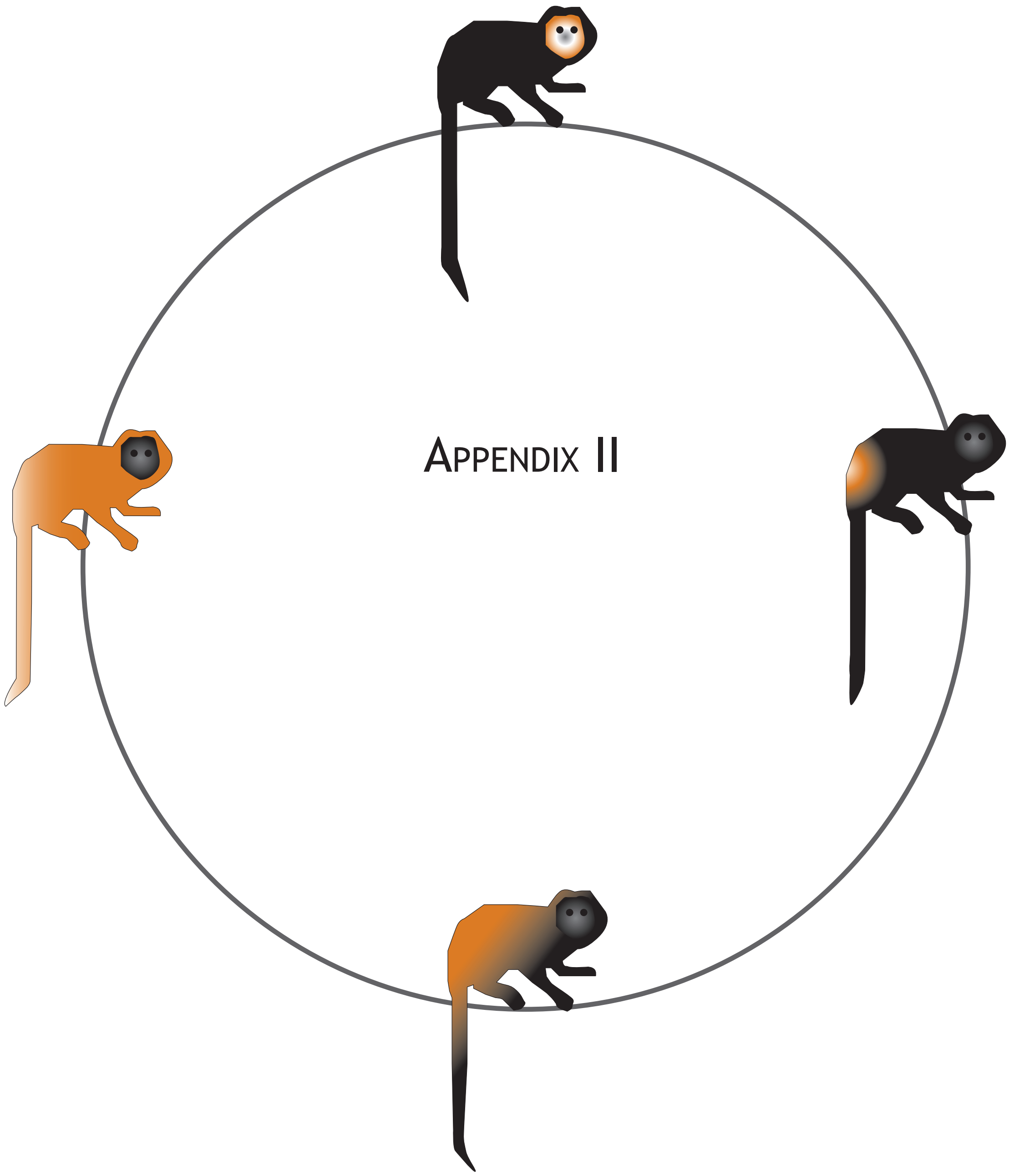
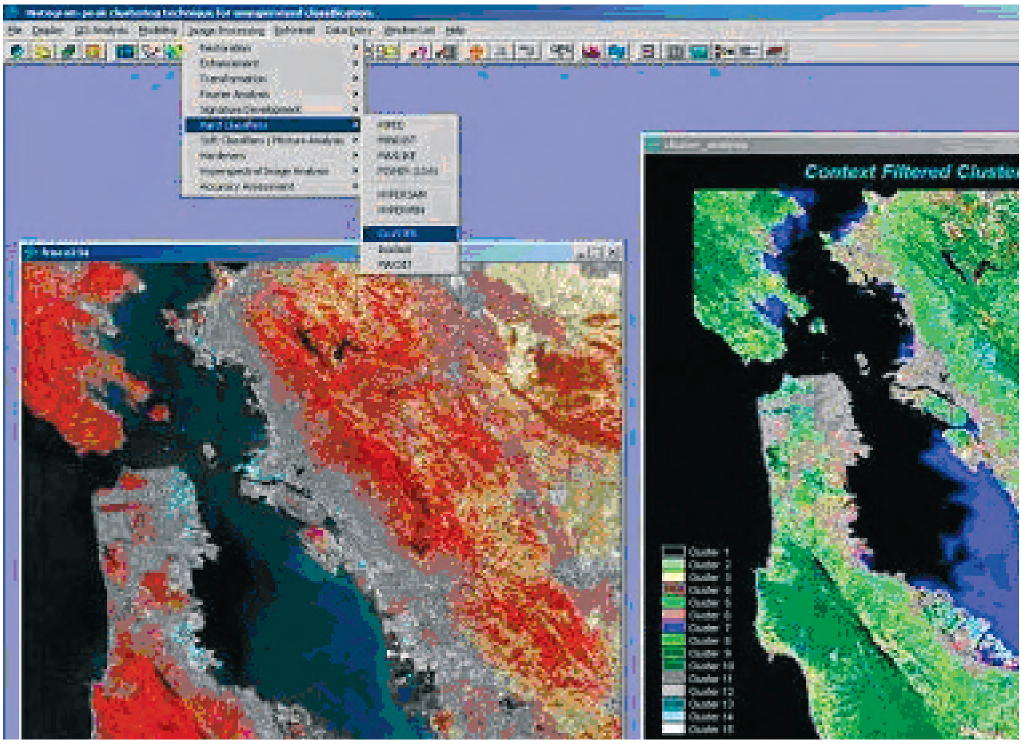
Appendix II



Introduction to GIS (Geographic Information System)

A geographic information system (GIS) is a system for managing spatial data and associated attributes. In the strictest sense, it is a computer system capable of integrating, storing, editing, analyzing, and displaying geographically-referenced information. In a more generic sense, GIS is a “smart map” tool that allow users to create interactive queries (user created searches), analyze the spatial information, and edit data.



Geographic information systems technology can be used for scientific investigations, resource management, asset management, development planning, cartography and route planning. For example, a GIS might allow emergency planners to easily calculate emergency response times in the event of a natural disaster, or a GIS might be used to find wetlands that need protection from pollution.

History of development

35,000 years ago, on the walls of caves near Lascaux, France, Cro-Magnon hunters drew pictures of the animals they hunted. Associated with the animal drawings are track lines and tallies thought to depict migration routes. These early records followed the two-element structure of modern geographic information systems: a graphic file linked to an attribute database.

In the 1700s modern surveying techniques for topographic mapping were implemented, along with early versions of thematic mapping, e.g. for scientific or census data.

The early 20th century saw the development of “photo lithography” where maps were separated into layers. Computer hardware development spurred by nuclear weapon research would lead to general purpose computer “mapping” applications by the early 1960s.

The year 1967 saw the development of the world’s first true operational GIS in Ottawa, Ontario by the federal Department of Energy, Mines and Resources. Developed by Roger Tomlinson, it was called “Canadian GIS” (CGIS) and was used to store, analyse and manipulate data collected for the Canada Land Inventory (CLI)—an initiative to determine the land capability for rural Canada by mapping various information on soils, agriculture, recreation, wildlife, waterfowl, forestry, and land use at a scale of 1:250,000. A rating classification factor was also added to permit analysis.

CGIS was the world’s first “system” and was an improvement over “mapping” applications as it provided capabilities for overlay, measurement, digitizing/scanning, supported a national coordinate system that spanned the continent, coded lines as “arcs” having a true embedded topology, and it stored the attribute and locational information in separate files. Its developer, geographer Roger Tomlinson, has become known as the “father of GIS.”

CGIS lasted into the 1990s and built the largest digital land resource data base in Canada. It was developed as a mainframe based system in support of federal and provincial resource planning and management. Its strength was continent-wide analysis of complex data sets. The CGIS was never available in a commercial form. Its initial development and success stimulated various commercial mapping applications being sold by vendors such as Intergraph. The development of micro-computer hardware spurred vendors such as ESRI, MapInfo and CARIS to successfully incorporate many of the CGIS features, combining the 1st generation approach to separation of spatial and attribute information with a 2nd generation approach to organizing attribute data into database structures. The 1980s and 1990s industry growth were spurred on by the growing use of GIS on UNIX workstations and the personal computer. By the end of the 20th century, the rapid growth in various systems had been consolidated and standardized on relatively few platforms and users were beginning to export the concept of viewing GIS data over the Internet, requiring data format and transfer standards.

Techniques used in GIS

Relating information from different sources

If you could relate information about the rainfall of your state to aerial photographs of your county, you might be able to tell which wetlands dry up at certain times of the year. A GIS, which can use information from many different sources in many different forms, can help with such analyses. The primary requirement for the source data consists of knowing the locations for the variables. Location may be annotated by x,y, and z coordinates of longitude, latitude, and elevation, or by other geocode systems like ZIP Codes or by highway mile markers. Any variable that can be located spatially can be fed into a GIS. Several computer databases that can be directly entered into a GIS are being produced by government agencies and non-government organizations. Different kinds of data in map form can be entered into a GIS.

A GIS can also convert existing digital information, which may not yet be in map form, into forms it can recognize and use. For example, digital satellite images generated through remote sensing can be analyzed to produce a map-like layer of digital information about vegetative covers.

Likewise, census or hydrologic tabular data can be converted to map-like form, serving as layers of thematic information in a GIS.

Data representation

GIS data represents real world objects (roads, land use, elevation) with digital data. Real world objects can be divided into two abstractions: discrete objects (a house) and continuous fields (rain fall amount or elevation). There are two broad methods used to store data in a GIS for both abstractions: Raster and Vector.

Raster data type consists of rows and columns of cells where in each cell is stored a single value. Most often, raster data are images (raster images), but besides just color, the value recorded for each cell may be a discrete value, such as land use, a continuous value, such as rainfall, or a null value if no data is available. While a raster cell stores a single value, it can be extended by using raster bands to represent RGB (red, green, blue) colors, colormaps (a mapping between a thematic code and RGB value), or an extended attribute table with one row for each unique cell value. The resolution of the raster dataset is its cell width in ground units. For example, one cell of a raster image represents one meter on the ground. Usually cells represent square areas of the ground, but other shapes can also be used.

Vector data type uses geometries such as points, lines (series of point coordinates), or polygons, also called areas (shapes bounded by lines), to represent objects. Examples include property boundaries for a housing subdivision represented as polygons and well locations represented as points. Vector features can be made to respect spatial integrity through the application of topology rules such as ‘polygons must not overlap’. Vector data can also be used to represent continuously varying phenomena. Contour lines and triangulated irregular networks (TIN) are used to represent elevation or other continuously changing values. TIN’s record values at point locations, which are connected by lines to form an irregular mesh of triangles. The face of the triangles represent the terrain surface.

There are advantages and disadvantages to using a raster or vector data model to represent reality. Raster datasets record a value for all points in the area covered which may require more storage space than representing data in a vector format that can store data only where needed. Raster data also allows easy implementation of overlay operations, which are more difficult with vector data. Vector data can be displayed as vector graphics used on traditional maps, whereas raster data will appear as an image that may have a blocky appearance for object boundaries.

Additional non-spatial data can also be stored besides the spatial data represented by the coordinates of a vector geometry or the position of a raster cell. In vector data, the additional data are attributes of the object. For example, a forest inventory polygon may also have an identifier value and information about tree species. In raster data the cell value can store attribute information, but it can also be used as an identifier that can relate to records in another table.

Data capture

Data capture—entering information into the system—consumes much of the time of GIS practitioners. There are a variety of methods used to enter data into a GIS where it is stored in a digital format.

Existing data printed on paper or mylar maps can be digitized or scanned to produce digital data. A digitizer produces vector data as an operator traces points, lines, and polygon boundaries from a map. Scanning a map results in raster data that could be further processed to produce vector data.

Survey data can be directly entered into a GIS from digital data collection systems on survey instruments. Positions from a global positioning system (GPS), another survey tool, can also be directly entered into a GIS.

Remotely sensed data also plays an important role in data collection and consist of sensors attached to a platform. Sensors include cameras, digital scanners and LIDAR, while platforms usually consist of aircrafts and satellites.

The majority of digital data currently comes from photo interpretation of aerial photographs. Soft copy workstations are used to digitize features directly from stereo pairs of digital photographs. These systems allow data to be captured in 2 and 3 dimensions, with elevations measured directly from a stereo pair using principles of photogrammetry. Currently, analog aerial photos are scanned before being entered into a soft copy system, but as high quality digital cameras become cheaper this step will be skipped.

Satellite remote sensing provides another important source of spatial data. Here satellites use different sensor packages to passively measure the reflectance from parts of the electromagnetic spectrum or radio waves that were sent out from an active sensor such as radar. Remote sensing collects raster data that can be further processed to identify objects and classes of interest, such as land cover.

When data is captured, the user should consider if the data should be captured with either a relative accuracy or absolute accuracy, since this could not only influence how information will be interpreted but also the cost of data capture.

In addition to collecting and entering spatial data, attribute data is also entered into a GIS. For vector data this includes additional information about the objects represented in the system.

After entering data into a GIS, it usually requires editing, to remove errors, or further processing. For vector data it must be made “topologically correct” before it can be used for some advanced analysis. For example, in a road network, lines must connect with nodes at an intersection. Errors such as undershoots and overshoots must also be removed. For scanned maps, blemishes on the source map may need to be removed from the resulting raster. For example, a fleck of dirt might connect two lines that should not be connected.

Data manipulation

Data restructuring can be performed by a GIS to convert data into different formats. For example, a GIS may be used to convert a satellite image map to a vector structure by generating lines around all cells with the same classification, while determining the cell spatial relationships, such as adjacency or inclusion.

Since digital data are collected and stored in various ways, the two data sources may not be entirely compatible. So a GIS must be able to convert geographic data from one structure to another.

Projections, coordinate systems and registration

A property ownership map and a soils map might show data at different scales. Map information in a GIS must be manipulated so that it registers, or fits, with information gathered from other maps. Before the digital data can be analyzed, they may have to undergo other manipulations—projection and coordinate conversions, for example—that integrate them into a GIS.

The earth can be represented by various models, each of which may provide a different set of coordinates (e.g., latitude, longitude, elevation) for any given point on the earth’s surface. The simplest model is to assume the earth is a perfect sphere. As more measurements of the earth have accumulated, the models of the earth have become more sophisticated and more accurate. In fact, there are models that apply to different areas of the earth to provide increased accuracy (e.g., North American Datum, 1983 - NAD83 - works well in North America, but not in Europe).

Projection is a fundamental component of map making. A projection is a mathematical means of transferring information from a model of the Earth, which represents a three-dimensional curved surface, to a two-dimensional medium—paper or a computer screen. Different projections are used for different types of maps because each projection particularly suits certain uses. For example, a projection that accurately represents the shapes of the continents will distort their relative sizes.

Since much of the information in a GIS comes from existing maps, a GIS uses the processing power of the computer to transform digital information, gathered from sources with different projections and/or different coordinate systems, to a common projection and coordinate system.

A contribution of the Conservation Breeding Specialist Group.