

Recovery and Management Committees for Lion Tamarins: Partnerships in Conservation Planning and Implementation

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Abstract: *Four international recovery and management committees act as official technical advisors to the Brazilian federal environmental agency—the Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis—with respect to the conservation and management of both the in situ and ex situ populations of the endangered lion tamarins (*Leontopithecus*). The committees promote lion tamarins as “flagship” species, the ultimate intent being the preservation of the unique Atlantic rain forest (Mata Atlântica) ecosystem and its many endemic plants and animals. We summarize the history, organization, structure, and functioning of these oversight management committees and their current role in guiding, motivating, and focusing conservation efforts for the Mata Atlântica of Brazil and the four endangered *Leontopithecus* species therein. We discuss the role of science in conservation planning for the species, funding mechanisms, the decision-making process, conflicts and their resolution, and criteria used for evaluating success. The benefits of this particular species recovery process include the establishment of collaborative partnerships between the Brazilian government and a multitude of individuals and organizations and the use of multidisciplinary, semi-autonomous teams to implement conservation activities. The major limitation of the management committees is their lack of a formal budget and permanent staff.*

Comites de Recuperación y Manejo de León Tamarins: Colaboraciones en Planeación e Implementación de la Conservación

Resumen: *Cuatro comités de recuperación y manejo actúan como asesores técnicos del Instituto Brasileiro del Medio Ambiente y Recursos Naturales Renovables en lo concerniente a la conservación y manejo de poblaciones del león tamarins (*Leontopithecus*) tanto in situ como ex situ. Los comités promueven al león tamarins como una especie “bandera”, con la intención de preservar el peculiar ecosistema de bosque lluvioso del Atlántico (Mata Atlântica) así como sus plantas y animales endémicos. Resumimos la historia, organización, estructura y funcionamiento de estos comites de manejo, así como su papel actual en la conducción, motivación y enfoque de los esfuerzos de conservación del Mata Atlântica del Brasil y de las cuatro especies amenazadas de *Leontopithecus*. Discutimos el papel de la ciencia en la planeación de la conservación de las especies, los mecanismos de financiamiento, los procesos de toma de decisiones, los conflictos y sus soluciones y los criterios empleados para la evaluación de los avances. Los beneficios del proceso de recuperación de esta especie en particular incluyen el establecimiento de trabajo en colaboración entre el gobierno de Brasil y una gran cantidad de individuos y organizaciones, además del empleo de grupos multidisciplinarios semiautónomos para la implementación de actividades de conservación. Las mayores limitantes para los comités de manejo han sido la carencia de un presupuesto formal y de trabajadores permanente.*

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Introduction

Understanding the structure and functioning of recovery teams for endangered species and other conservation initiatives (Clark et al. 1994; Clark & Brunner 1996) is important for improving our methods and developing better criteria for evaluating the process and measuring success. Professionals within the social sciences have recently stressed several theoretical and practical constructs concerning the behavior of organizations which can have great significance for endangered species and habitat recovery efforts (Senge 1990; Lee 1993).

First, we briefly present the history and initial diversity of conservation activities for the four lion tamarin species (*Leontopithecus*) from Brazil. Second, we describe the composition and functioning of the *Leontopithecus* international recovery and management committees (IRMCs), the multidisciplinary partnerships between the Brazilian government, nongovernmental organizations (NGOs), and individuals. The IRMCs currently oversee, focus, and guide the activities of semi-autonomous interdependent teams in the genus and habitat recovery efforts (Clark & Westrum 1989; Clark & Cragun 1994). Finally, we appraise the advantages and limitations of the IRMCs in promoting and accomplishing their conservation objectives.

Brazil's Atlantic rain forest (Mata Atlântica) is one of the most endangered ecosystems on Earth, in which the majority of the original forest has been cleared for farming, mining, ranching, and expanding urban centers such as Rio de Janeiro and São Paulo. Perhaps 2% of the original forested area currently remains (Seal et al. 1990). Widespread habitat destruction continues unchecked in biologically important areas such as southern Bahia, where botanists from the New York Botanical Garden and their Brazilian colleagues found 450 different species of trees in a 1-ha plot of privately owned land near the Una Biological Reserve, the highest level of tree diversity described in the world today (Thomas & de Carvalho 1993; Mallinson 1994).

The four lion tamarin species—golden lion tamarin (*Leontopithecus rosalia*), golden-headed lion tamarin (*L. chrysomelas*), black or golden-rumped lion tamarin (*L. chrysopygus*), and black-faced lion tamarin or caissara (*L. caissara*)—are endemic to this southeastern region of Brazil but are now restricted to fragmented patches of low-altitude forest in the states of Bahia, Rio de Janeiro, São Paulo, and Paraná, an area that is densely inhabited by people. Because of the fragmentation of the populations of the four species and their habitat, metapopulation management programs integrating known in situ subpopulations and scientifically managed captive populations have become the method of choice for ensuring that viable, self-sustaining populations of lion tamarins and their habitat will ultimately survive (except for *L. caissara*, for which there is no captive population). Also, by

focusing on the four forms of *Leontopithecus* as “flag-ship” species (Dietz et al. 1994a), and thereby attracting public attention, we believe that the potential for the preservation and conservation of both the endangered animals and the associated unique ecosystems of the Mata Atlântica of Brazil can be (and has already been) significantly improved.

The organizational structure for this effort derived from multiple teams that initiated separate research and conservation efforts beginning in the 1970s. The Brazilian Institute of Environment and Renewable Natural Resources (Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis—IBAMA) began coordinating the activities of the teams by establishing, between 1985 and 1991, four IRMCs to provide IBAMA with official guidance in the recovery efforts and management of the four species. A population viability analysis (PVA) workshop (Seal et al. 1990) set the conservation priorities for all four forms, including instituting a common process for the functioning of the IRMCs. Although there are priorities held in common for all species of *Leontopithecus*, there are also significant differences in their individual requirements for recovery because of species-specific problems, issues, and histories (Rylands 1993–1994).

Early Conservation Efforts

A summary of the major events in the conservation of *Leontopithecus* and the formation of the IRMCs is presented in Table 1. Golden lion tamarins have been known to the outside world since the sixteenth century, being popular pets for European royalty (Mallinson 1996). During the nineteenth and twentieth centuries many were exported for the pet trade and for zoos and research laboratories. Mallinson (1996) summarizes the history of golden lion tamarins in captivity outside of Brazil.

Public concern about the lion tamarins began in the early 1960s when Ademar Coimbra-Filho, the doyen of Brazil's primatologists, called attention to the severe plight of *L. rosalia*: numbers had decreased dramatically because of exportation and deforestation in Rio de Janeiro state (Coimbra-Filho 1969). At approximately the same time, Coimbra rediscovered the presumed-extinct *L. chrysopygus* in São Paulo state (Coimbra-Filho 1970). Coimbra-Filho actively lobbied for, and his input was essential to, the establishment of biological reserves to protect the lion tamarin species and also for the establishment of a breeding center for endangered species of Brazilian primates. Coimbra-Filho founded the Rio de Janeiro Primate Center (Centro de Primatologia do Rio de Janeiro—CPRJ-FEEMA) and was the first to breed black and golden-headed lion tamarins (Coimbra-Filho et al. 1989).

International concern over the declining numbers of lion tamarins in zoos and of Coimbra and his colleagues in Brazil resulted in the Wild Animal Preservation Trust

Table 1. A chronology of events leading to the establishment of the *Leontopithecus* committees.

<i>Event</i>	<i>Date</i>	<i>Reference</i>
<i>L. rosalia</i> first reference	1519	Feio 1953
<i>L. rosalia</i> first fully described	1766	Linnaeus 1766
<i>L. rosalia</i> in Paris menagerie	1818	Geoffroy 1827
<i>L. chrysomelas</i> at London Zoo	1869	Coimbra-Filho & Mittermeier 1977
Brazilian Fauna Protection Law No. 5, 197 regulating exports of endangered species	1967	Coimbra-Filho 1969
U.S. Rare and Endangered Species Act (U.S. Public Law 90-135) prevented acquisition of <i>Leontopithecus</i>	1969	Bridgwater 1972
<i>L. chrysopygus</i> rediscovered	1970	Coimbra-Filho 1970
Saving the lion marmoset conference at National Zoological Park, Washington, D.C.	1972	Bridgwater 1972
First International Studbook for <i>L. rosalia</i> published	1973	
Poço das Antas Biological Reserve established	1975	
Una Biological Reserve created	1980	
First field study of <i>L. chrysomelas</i>	1980	Rylands 1982
Cooperative Research and Management Agreement for zoo <i>L. rosalia</i> developed	1981	Kleiman et al. 1982
Fieldwork on <i>L. rosalia</i> in Poço das Antas Biological Reserve initiated	1983	Kleiman et al. 1986
Contraband <i>L. chrysomelas</i> first discovered in Europe	1983/1984	Mallinson 1984
First reintroduction of captive bred <i>L. rosalia</i>	1984	Kleiman et al. 1986
International Recovery and Management Committee (IRMC) for <i>L. chrysomelas</i> formed	1985	Mallinson 1987a
First contraband <i>L. chrysomelas</i> returned to Brazil	1986	Mallinson 1987a
International Committee for the Preservation and Management of <i>L. chrysopygus</i> formed	1987	
Preliminary International Studbook for <i>L. chrysomelas</i> published	1987	Mallinson 1987b
First International Studbook for <i>L. chrysopygus</i> published	1990	Valladares-Pádua & Simon 1990
<i>L. caissara</i> first discovered on Ilha do Superaguí, Paraná	1990	Lorini & Persson 1990
<i>Leontopithecus</i> Population Viability Analysis Workshop held at Belo Horizonte, Minas Gerais	1990	Seal et al. 1990
<i>Leontopithecus</i> Management Committees for <i>L. rosalia</i> , <i>L. chrysomelas</i> , and <i>L. chrysopygus</i> recognized by Brazilian Federal Law	1990	IBAMA 1990
International Preservation and Management Committee for <i>L. caissara</i> formed	1991	
Title of managed captive population of <i>L. rosalia</i> returned to people of Brazil (IBAMA)	1991	
The Lion Tamarins of Brazil Fund established	1991	
Management Committee for <i>L. caissara</i> recognized by Brazilian federal law	1992	IBAMA 1992
First annual meetings of the four <i>Leontopithecus</i> committees with IBAMA	1992	
First <i>Leontopithecus</i> symposium held at Poço das Antas Reserve with annual meetings of IRMC	1993	
All four species of <i>Leontopithecus</i> listed on the World Conservation Union Red Data List of threatened species	1993	Rylands 1993
Second <i>Leontopithecus</i> symposium held at Ilhéus, Bahia, followed by annual IRMC meetings with IBAMA	1994	Rylands & Rodrigues-Luna 1994
Third <i>Leontopithecus</i> symposium, second PHVA and IRMC meetings	1997	

(WAPT), an affiliate of the American Association of Zoological Parks and Aquariums (AAZPA), hosting a conference on saving the lion marmoset (Bridgwater 1972), which set the research and conservation priorities for the next two decades.

Golden Lion Tamarins

Because conservation efforts for *L. rosalia* have the longest and most complex history, as well as being a model in part for the other three species, we focus our historical discussion on golden lion tamarins. Rylands (1993-1994) provides greater detail on the other three forms.

In the late 1960s, WAPT selected the golden lion tamarin as one of the first zoo species to require a coordinated breeding and research program to prevent extinction. Following the 1972 conference (Bridgwater 1972), staff of the National Zoological Park (NZP) of the Smithsonian Institution, launched an intensive research program into the reproduction, social behavior, veterinary care, and husbandry of the golden lion tamarin in captivity. Responsibility for the International Golden Lion Tamarin Studbook (an inventory of all captive specimens) was transferred to the NZP. Application of the results of the research to captive management (Kleiman 1984; Kleiman et al. 1986) and the use of then available demographic and genetic principles in pairing individu-

als for breeding using the studbook resulted in a dramatic expansion of the captive population. From approximately 70 individuals in fewer than 20 institutions in 1973, the *L. rosalia* population grew to nearly 600 individuals by the mid-1980s. As of 31 December 1995, there were approximately 485 individuals being managed at zero population growth in over 143 zoos (Ballou & Sherr 1996).

By 1980, when the captive population was expanding rapidly, zoos owning specimens of *L. rosalia*, in an unusual decision for the time, agreed not to sell their stock so that golden lion tamarins would no longer enter the animal trade and be used for commercial gain. Then, in a second progressive decision, both the zoos that owned golden lion tamarins and those that had them on loan agreed to form a consortium and become signatories to an international cooperative research and management agreement for the golden lion tamarin, with all decisions concerning the management of the captive population being placed in the hands of an elected subgroup (Kleiman et al. 1986; Kleiman et al. 1990). Because none of the other forms of *Leontopithecus* had populations in zoos outside of Brazil, this ex situ cooperative management of golden lion tamarins became the prototype for managing the genus in zoos.

The fusion of the captive and field conservation efforts into a metapopulation management program began when A. F. Coimbra-Filho and D.G.K. jointly coordinated the first endeavors to develop (1) long-term field studies on the golden lion tamarin in the Poço das Antas Biological Reserve (the only reserve in Brazil for the species) to determine its conservation requirements, (2) a reintroduction project using zoo-born tamarins, and (3) a community conservation education program in the municipalities bordering the reserve.

Over the next decade these efforts evolved into the multidisciplinary, multinational Golden Lion Tamarin Conservation Program (GLTCP), an informal group of professionals that led the species' recovery effort by overseeing different teams responsible for (1) the management of zoo populations of golden lion tamarins (Ballou & Sherr 1996), (2) ecological and behavioral studies of wild golden lion tamarins (Baker et al. 1993; Dietz & Baker 1993), (3) a reintroduction (Beck et al. 1991) and translocation (Kierulff & Oliveira 1994) program for golden lion tamarins in and around the Poço das Antas Reserve, (4) field studies of the fauna and flora of the Mata Atlântica within the region occupied by golden lion tamarins (Kierulff et al. 1991), (5) conservation education programs for the local communities (Dietz & Nagagata 1995), (6) professional training of conservation biologists (Kleiman et al. 1990), and (7) a forest protection and restoration program within the remaining forests of the Mata Atlântica (Pessamílio 1994). Expansion of the activities of the GLTCP occurred by inviting professionals to initiate new projects and providing them

with seed money for these activities, with the understanding that they would eventually raise their own funds. This in part explains the large budget, large number of projects, and large total staff involved with golden lion tamarin conservation.

These functions and activities of the GLTCP support its defined missions, developed at a retreat following the 1990 PVA. The missions are to (1) maximize the probability of survival of naturally evolving populations of golden lion tamarins; (2) expand and apply current research techniques in the development of conservation biology; (3) increase public awareness of golden lion tamarins and their habitats; (4) enhance professional training in biology and conservation, with preference for Brazilians; and (5) multiply conservation impact and increase effectiveness and efficiency through integration with other conservation programs with similar missions, particularly those working with *Leontopithecus* (Kleiman et al. 1990). Since 1990, the team leaders of the GLTCP have regularly organized mini-retreats to reexamine program priorities, based on new information, and to reevaluate and alter activities as necessary, with IRMC oversight.

Although the Golden Lion Tamarin Management Committee was developed to oversee management of zoo populations only, the 1990 PVA shifted the conservation focus. The committee was eventually reconstituted as an IRMC and recognized by IBAMA as the official technical committee overseeing both the in situ and ex situ management and conservation of the species.

Historically, the National Zoological Park of the Smithsonian Institution acted as the coordinating agency and home to the informal GLTCP, composed mainly of non-Brazilians. Recently, a nonprofit NGO, Associação Mico Leão Dourado (AMLD), was established whose purpose is to assume the ultimate responsibility and authority for coordinating golden lion tamarin research and conservation activities in Brazil. (The GLTCP has had as a long-term objective the transfer of programmatic authority to Brazil, just as ownership of all golden lion tamarins was returned to Brazil [Table 1]). The formation of the AMLD and definition of its relation to the GLTCP was facilitated through several retreats organized by staff of the World Wide Fund for Nature (WWF). The assistance of consultants in this process has been crucial to its success.

Golden-Headed Lion Tamarins

From 1983 to 1984, large numbers of golden-headed lion tamarins were illegally exported from Brazil and found their way into the hands of animal dealers and private exotic animal collections, mainly in Belgium and Japan. When the illicit trade in golden-headed lion tamarins resulted in many specimens being offered for sale by animal dealers, the Brazilian government's then Institute of Forest Development (Instituto Brasileiro de Desenvolvimento

Florestal—IBDF, now IBAMA) asked Jeremy Mallinson to form and chair an IRMC for the golden-headed lion tamarin. The initial objective of the committee was to repatriate to Brazil the contraband animals. Some were returned to Brazil (Table 1). The captive *L. chrysomelas* exhibited an explosive population growth; the current international captive population of approximately 650 animals needs to be reduced and maintained at zero population growth (H. de Bois, personal communication). Mallinson (1984, 1987b, 1994) has summarized the recent history of the ex situ conservation efforts for this species.

As with golden lion tamarins, the golden-headed lion tamarin conservation effort uses a metapopulation management approach and is divided into different tasks, overseen by teams. For this species, in addition to the captive management and research program, there is currently an active conservation education program in Bahia (Nagagata 1994), a landowner's environmental education program, and a field study of ecology and behavior in the Federal Una Biological Reserve (Dietz et al. 1994b). A survey of the remaining forest fragments and a census of numbers of golden-headed lion tamarins outside the Una Reserve was recently completed (Pinto 1994; Pinto & Tavares 1994). More detail on conservation efforts for *L. chrysomelas* is given by Rylands (1993–1994).

Black Lion Tamarins

Black lion tamarins were first brought into captivity in the 1970s and maintained at the Rio de Janeiro Primate Center. In the mid-1980s, new wild-caught animals were added to the ex situ breeding program in the São Paulo Zoo from a rescue operation initiated because of the flooding of the Morro do Diabo State Reserve after the construction of a dam. More recently, the first black lion tamarins were exported from Brazil for captive breeding. For unknown reasons the captive breeding program for this species has not been as successful as those for golden and golden-headed lion tamarins. Until very recently there were no clear objectives concerning the purpose and function of the captive population as part of a metapopulation management strategy (Rylands 1993–1994).

In the mid-1980s field studies of the ecology of wild black lion tamarins were initiated through the São Paulo Forestry Institute (Instituto Florestal—IF), a state organization (Carvalho & de Carvalho 1989; de Carvalho et al. 1989; Keuroghlian 1990). Shortly thereafter another field team, led by Valladares-Pádua, initiated separate in situ research efforts on black lion tamarins in Morro do Diabo (Valladares-Pádua 1993; Valladares-Pádua & Cullen 1994). The latter studies are ongoing and include a community conservation education (Pádua 1994) and conservation training program, all coordinated through the NGO Instituto de Pesquisas Ecológicas (IPE). Recent surveys by this field team have revealed additional small

populations of black lion tamarins on private farms and in other state reserves; activities currently focus on metapopulation management of the very disjunct populations through translocation of individuals (Valladares-Pádua et al. 1994).

The International Committee for the Preservation and Management of Black Lion Tamarins was formed in part to decide on the fate of the animals rescued from Morro do Diabo, but also because progress in black lion tamarin conservation was being impeded by conflicts between state and federal control and by competition between teams of different origin. Because Morro do Diabo belonged to the state (unlike Una, Superagüi, and Poço das Antas, which are federal), the São Paulo IF claimed responsibility and authority for all research and conservation efforts. The federal environmental agency (then IBDF) claimed the same authority because, as an endangered species, the black lion tamarin comes under federal protection. The committee was therefore formed by IBDF to permit all involved parties to contribute to decision making and to improve coordination of in situ and ex situ management of the species.

The Black-Faced Lion Tamarin—Caissara

The black-faced lion tamarin was first described by a team from the Museu de História Natural “Capão da Imbuia,” Curitiba and the Museu Nacional of Rio de Janeiro (Lorini & Persson 1990). At the time it was thought to be restricted to the island of Superagüi in the state of Paraná near the São Paulo state border. Within 2 to 3 years populations of black-faced lion tamarin were discovered in forests along the coast in the state of São Paulo. There has still not been a complete survey done of black-faced lion tamarin numbers although two teams have conducted censuses separately in the two states. Only recently has a field study involving radio-collared individuals been initiated (C. Valladares-Pádua, personal communication). The IRMC for the black-faced lion tamarin was established shortly after the species was described and a conservation action plan was developed following the PVA (Table 1). Because protection of the wild population is of the greatest importance, the establishment of a captive breeding population of the black-faced lion tamarin is currently a low priority.

Population Viability Analysis

By 1990 there were multiple teams working on *Leontopithecus* conservation and three committees that had been formed for diverse reasons and that functioned separately. The first *Leontopithecus* PVA workshop (Seal et al. 1990) reviewed the status of all four species and was critical in developing scientifically-based priorities,

goals, missions, and initial action plans for each of the IRMCs, including management of both zoo and wild populations (Rylands [1993–1994] summarizes the principal recommendations for action from the *Leontopithecus* PVA). It was also the first formal, joint meeting of the IRMCs and motivated IBAMA to recognize the committees legally as technical advisors to the Brazilian government. Additionally, the PVA started a common process for setting goals, making decisions, and sharing and integrating knowledge.

International Recovery and Management Committees

Organization and Function

The IRMCs see their joint and interdependent responsibility as metapopulation management (in situ and ex situ) of the four species; priorities currently focus on habitat preservation and survival of wild populations. The ultimate purpose of the IRMCs is to guide, unify, and motivate individuals and teams in setting and implementing science-based objectives and to turn conservation goals into policy. The IRMCs for *Leontopithecus* currently provide IBAMA with recommendations concerning (1) demographic and genetic management of the captive populations—for example, approval for new zoos to receive specimens, transfer of specimens between zoos, and regional management plans (most tamarins under the Committees' jurisdiction belong to the Brazilian people through the government agency IBAMA, which for *L. rosalia* and *L. chrysomelas*, involved a global renunciation of ownership of zoo specimens); (2) research proposals for both the captive and wild populations; (3) major new conservation initiatives that might affect the wild or captive populations (e.g., translocation, education, or reforestation projects); (4) community conservation education programs; and (5) expansion of protected areas through land acquisition, enlargement of existing conservation units, or establishment of new conservation units (e.g., reserves and national parks). The committees also lobby appropriate agencies to support new legislation, increase habitat protection, and eliminate threats to the viability of the habitat or species (e.g., removal of squatters). Finally, they may gather support and request lobbying for conservation initiatives from overseas organizations and agencies, a technique that occasionally provides momentum in resolving issues being considered by the government.

The current IRMCs are international in composition, with members from diverse disciplines and backgrounds, including conservationists, field biologists, zoo biologists, educators, administrators, and staff from IBAMA. All directors of federal conservation units (e.g., reserves and national parks) for a lion tamarin species are perma-

nent voting members of the relevant IRMC. Some, but not all, committee members are team leaders or team members involved in different conservation functions and activities. All of the IRMCs are now more than 50% Brazilian in composition. Each committee has two co-chairs, and all IRMC chairs serve as voting members on the other committees, thus ensuring communication and consistency across the committees. Each of the IRMCs also has appointed technical advisors who provide information and participate in meetings but who are not voting members. Elections to IRMC membership and to the co-chair positions occur every 3 years. Despite each committee having been developed at different times and for different reasons, the current integration and interdependence of activities is unusual for species recovery programs.

Decision-Making Processes

Clark and Brunner (1996) summarize the use of the decision process for endangered species recovery programs as promulgated by Lasswell (1971). We review how the IRMCs for *Leontopithecus* function in the context of this paradigm, following the questions outlined by Clark and Brunner (1996).

(1) Intelligence: How is information about a problematic situation gathered, processed, and brought to the attention of decision makers? The IRMCs meet annually, but material may be distributed to committee members for discussion and a vote at any time. All individuals, teams, and organizations involved with lion tamarin species are expected to prepare an annual report of their activities—a single annual report form has recently been developed for all IRMCs—and to bring important issues to the table during the annual meeting. Proposals for future conservation, education, research, and habitat preservation activities are also discussed and reviewed at this time. The IRMCs traditionally meet at different sites near lion tamarin habitat in order to share knowledge, permit greater participation by local employees and students, and gain a better understanding of local issues facing each of the species. This practice also provides an opportunity for sharing ideas which aids problem solving for all groups.

Both educational and scientific research provide the foundations for IRMC decisions and were integral to the establishment of priorities at the 1990 PVA. Nearly all major biological decisions derive from the results of scientific studies, the earliest being the development and application of models for the management of captive populations (Kleiman et al. 1982). The golden lion tamarin reintroduction project is a classic example of an organization that has applied the results of its studies to changing and improving its methodology, thus acting as a “learning organization” (Senge 1990) with “adaptive management” (Beck et al. 1991; Lee 1993).

(2) *Promotion: Based on available information, how are recommendations promoted and made?* All proposals and issues are considered in light of the priorities for conservation set by the 1990 PVA. Open discussions at the annual meetings are followed by a vote either to approve, not approve, or delay the decision, pending further information. Chairs of the IRMCs have leadership responsibilities, but they rarely exhibit a "top-down" management style because important decisions are reached by consensus or majority vote.

(3) *Prescription: How are general rules prescribed?* All proposals must first comply with Brazilian laws and regulations concerning the specific activity and must support the priorities of the PVA. Second, protocols developed for particular activities must be followed. For example, all zoos wishing to obtain any of the lion tamarins for exhibit or for breeding must follow specified application procedures and demonstrate that they can and will comply with husbandry and management guidelines approved by the committees.

The sharing of technical expertise between the teams reporting to the four IRMCs is strongly encouraged. For example, golden lion tamarin personnel have trained numerous others in trapping, handling, and marking methodology. Black lion tamarin education personnel have organized several training workshops in community conservation efforts and have recently opened a training center in São Paulo state. The AMLD organized a recent workshop with the Instituto de Estudos Sócio Ambientais do Sul da Bahia (IESB) in which IBAMA legal personnel explained to local landowners from both Bahia and Rio de Janeiro states how the recent 1990 legislation, providing tax relief for creating conservation units from privately owned land, can benefit them. The golden lion tamarin studbook keeper has acted as consultant for the two newer studbooks and provided considerable assistance with population management. The use of long call playback techniques for censusing wild populations was developed and shared (Kierulff et al. 1998). The black lion tamarin team was the first to see the benefits of starting an NGO, and they formed IPÊ. As a result, research, management, and educational methodologies for both the wild and zoo populations are relatively standardized, which in future will promote easier cross-species comparisons, especially with respect to the measurement of success in conservation activities.

There are also unwritten norms that guide the activities of the IRMCs. All individuals are treated with respect and are expected to behave similarly to colleagues. Individuals are given equitable treatment so that everyone can feel that their side of an issue has been heard. All disciplines participate equally in the committee meetings and discussions. Communication is encouraged, and all meetings are bilingual (Portuguese/English). Finally, there is flexibility in problem solving because the ultimate goal is to achieve the conservation objectives. Thus, when

situations have arisen that did not fit into a preconceived format, the IRMCs have looked elsewhere for alternative methods of accomplishing goals.

(4) *Invocation: How are the rules invoked against challengers in specific cases?* IBAMA provides ultimate permission to enter federal reserves and other conservation units and to carry out research and conservation activities for Brazilian endangered species. They also are the agency responsible for overseeing CITES and thus provide permits for any imports or exports of endangered species and their parts under CITES. Most conservation and research proposals for lion tamarins therefore must have final approval from IBAMA. For scientific research proposals initiated overseas, additional permission must come from the Brazilian scientific agency Conselho Nacional de Pesquisa e Tecnologia (CNPq). Thus, individuals or groups who choose not to follow the committee's recommendations can have their permission to enter conservation units revoked and can be denied access to facilities and animals. Ultimately, they may also lose or not be granted funding because most funding agencies require a letter of endorsement from a government agency or the IRMCs to consider an application for support.

One project has slowly lost committee support and funding over several years for the following reasons: (1) not following committee recommendations concerning management of captive animals; (2) not providing annual reports or material that could be used to evaluate the project; (3) not cooperating with other neighboring projects and individuals; and (4) not providing written proposals for new initiatives and attempting to force an IRMC vote in the absence of sufficient information.

For all four species, the least progress has occurred when there has been the most personal conflict and competition between teams. In the case of the caissara, competition and antagonism between teams from the two states that were conducting censuses likely retarded the initiation of a field study for the species by 1–2 years. This is a good example of the concept that traditional science alone cannot solve conservation problems because ultimately species endangerment and species preservation are human endeavors (Brewer & Clark 1994).

Teams that do not resolve conflicts or ignore committee decisions are subjected to considerable peer pressure at annual meetings of the committees. Such pressure usually begins with informal encounters and attempts to resolve problems outside of the official meetings by the committee chairs. This informal mediation involves starting where there is common ground. Major conflicts are often defused because the mediators are considered fair, consistent, and objective (Lee 1993). Some conflicts have never been resolved and one person or team has withdrawn.

(5) *Applications: How are disputes in specific cases decided or resolved?* Many disputes are easy to resolve by deciding which team or person's activities are in support of the ultimate priorities and goals of the IRMC pro-

gram, as defined originally in the PVA. The committees also tend to resolve issues by supporting collaboration rather than competition, by being inclusive rather than exclusive, and by encouraging the maximum number of approaches to solving problems.

The committees have no jurisdiction in resolving certain types of larger disputes, such as those between government agencies. But, they can and do lobby with government agencies responsible for dispute resolution. One ongoing problem involves the presence of Indians destroying the environment within Superagüi National Park (home of the black-faced lion tamarin). FUNAI, the agency responsible for overseeing Indian affairs, argues for their right to continue (Vivekananda 1994). The co-chairs of the *L. caissara* IRMC have written letters to the appropriate agencies requesting that the Indians (who originate from Argentina) be removed from the national park.

Some of the problems faced by the lion tamarin IRMCs involve illegal activities that jeopardize the survival of species. For example, reintroduced golden lion tamarins have been stolen and sold in the illegal animal markets of Brazil; hunting occurs in many of the protected areas; and, in the case of the black-faced lion tamarin, researchers' lives have been threatened and an assistant murdered by individuals illegally collecting hearts of palm (palmito) from protected areas (Mallinson 1995). The IRMCs in such cases can only pressure IBAMA and federal and local law enforcement officials to find and prosecute the responsible individuals.

(6) *Appraisal: How are the rules and the decision process appraised?* There have been no formal appraisals of the efforts and outcomes of recommendations made by the IRMCs, but the committee process, as it now functions, has existed only since 1990. A second population and habitat viability analysis (PHVA) workshop occurred during 1997, at which time the original priorities were reviewed and altered—where appropriate—in the context of more recent activities and findings.

Following the PHVA, the GLTCP and AMLD had a formal detailed evaluation of their activities to determine whether goals had been achieved in a cost-effective manner and whether the criteria for success are reasonable. There have been regular internal reviews of this program, however, and emphasis and methodology have changed as data have been analyzed. The following two cases provide examples. During the early years of the GLTCP activities in Brazil, the conservation education program centered on students and teachers in the local schools and the larger local community. After the PVA it was recognized that education efforts were not reaching the local landowners who possessed and continued cutting down the majority of remaining forest. The focus changed, and much more attention has been devoted to working with the landowners in recent years, with the result that considerably more forest is now under protection.

After analyzing the survivorship of reintroduced zoo-

born golden lion tamarins as a function of different preparation techniques prior to and after release into the wild, the reintroduction project changed its methodology to reduce pre-release, labor-intensive training efforts and to focus on post-release training and supplementation (Beck et al. 1991). This has resulted in greater survival of reintroduced golden lion tamarins at a lower overall cost.

(7) *Termination: How are the rules and process terminated or modified?* All four species of lion tamarins continue to be endangered (Rylands 1993–1994), so it is likely that none of the IRMCs will be discontinued in the near future. With the knowledge accumulated during the past 6 years, however, priorities and goals were redefined during the 1997 PHVA.

Team Activities and Functions

The implementation of research and conservation activities for the four species of *Leontopithecus* is through small teams. The majority of these teams have common characteristics that make them “high-performance” teams (Clark & Westrum 1989; Clark & Cragun 1994). They are semi-autonomous, each with one or two leaders, and tend to raise their own funds. They are relatively free to develop and implement action plans (within international standards, IRMC recommendations, and Brazilian law) and are encouraged to take risks and to be creative problem-solvers. They are usually not organizationally based or hierarchical in structure and thus are, for the most part, informal, flexible, and nonbureaucratic in their decision-making processes. Within the golden and black lion tamarin conservation programs, most of the current teams are interdependent and collaborate closely. Team leaders communicate well and share information freely, although there are always occasional problems of miscommunication. These organizational characteristics are more likely to be successful in endangered species recovery efforts because activities are focused on the task and not the process (Clark & Cragun 1994).

Funding and the Lion Tamarins of Brazil Fund

Teams reporting to each of the IRMCs have traditionally funded their own activities from profit and nonprofit national and international agencies, both governmental and nongovernmental, including organizations focusing on zoos, science, education, conservation, and development. Institutions providing major support for *Leontopithecus* conservation are listed in the acknowledgments section and underscore the breadth of the support for these collaborative conservation activities.

The Brazilian government agency IBAMA supports the infrastructure for the national parks, reserves, and other conservation units, occasionally with difficulty due to changing economic conditions in Brazil. It also funds the participation (travel and housing) of Brazilian committee members at the annual meetings of the four IRMCs. For three of the four species, the PVA process (Seal et al. 1990), using available data from field studies and censuses, suggested that the long-term survival and viability of the wild populations would require that remaining forest receive further protection and that the amount of protected habitat be augmented. In 1990 Brazil passed novel legislative approaches to habitat protection that will provide tax relief for land owners who create private reserves. But additional money must eventually be raised to purchase land such that enough habitat will exist to ensure the long-term viability of the lion tamarin populations. Land acquisition is the most expensive of any of the IRMC activities. From 1991 to 1993, for example, several international organizations jointly raised funds to purchase 1731 ha to expand the Una Reserve in Bahia, at a cost of US \$221,000.

The Lion Tamarins of Brazil Fund (LTBF) was established via an appeal to all holders of lion tamarins outside of Brazil requesting donations in support of in situ conservation work. The first appeal raised just over US \$10,000, which was evenly distributed among the four programs in support of surveys, environmental education, ecological studies, and translocations. To date, the appeal has raised over \$70,000.

The committees will continue to appeal on an annual basis for donations to the LTBF. In this way, zoos that are already participating in the development of the scientifically managed captive populations of lion tamarins can also contribute funds to aid the conservation of the remnant wild populations of *Leontopithecus*.

The LTBF currently provides only a small proportion of the total budgets for *Leontopithecus* conservation activities, but it seeds important new initiatives. Real annual budgets are difficult to estimate because the salaries of many team coordinators are paid by their respective agencies, and most do not work solely on lion tamarin conservation because they are employed by NGOs, universities, and zoos. The GLTCP/AMLD, with the largest annual budget for expenditures in Brazil, had approximately \$400,000 in 1996, with the majority of grants arising from 10 different sources. This recent dramatic increase in funds is due to the formation of the AMLD and the beginning of several major initiatives: the development of corridors between forest fragments, the start of a community-based development program to support local ecotourism and agroindustry, and the translocation of isolated golden lion tamarin groups. Finally, the AMLD has recently assumed full responsibility for the salaries and benefits of our Brazilian staff of 30, in keeping with Brazilian fair labor practices and standards.

Measures of Success

Animals and Habitat

The reintroduction program for *L. rosalia* has increased the amount of protected Atlantic coastal forest in the state of Rio de Janeiro by about 38% (B. B. Beck, personal communication) because most reintroduced tamarin groups have been placed on private ranches whose owners have agreed to protect their remaining forest (Beck et al. 1991). Reintroduced golden lion tamarins and their descendants now make up about 25% of the approximately 700 wild golden lion tamarins. But the protected wild population is still only about 30% of what is required for the long-term survival of this species (Seal et al. 1990). Current IBAMA efforts to create a new reserve for translocated golden lion tamarins, if successful, will increase the amount of protected habitat even more and provide additional habitat into which isolated and threatened groups of golden lion tamarins can be moved. The global captive population is secure and well-managed, and it has contributed significantly to the wild population's increase.

International and Brazilian organizations have raised sufficient funds to increase by 32% the size of the Una Biological Reserve, the major protected area for *L. chrysomelas* in the state of Bahia (Mallinson 1994). More protected land is needed, however, because forests that had been left to provide shade for cacao plantations are now being rapidly cut as cacao producers implement high-technology methods of production. Also, recent research results suggest that *L. chrysomelas* territories are significantly larger than those of *L. rosalia*, upon which the estimates of habitat required by *chrysomelas* were made at the 1990 PVA. Thus, habitat requirements for golden-headed lion tamarins are greater than previously believed (Dietz et al. 1994b). Since its inception, the captive population has grown and stabilized and can act as a genetic resource if reintroduction proves necessary.

Black lion tamarin conservation efforts have also shown great success. With the discovery of several small, isolated forest fragments on private land, followed by a carefully constructed environmental education program, landowners have agreed to participate in the conservation effort and preserve the remaining forest, increasing protected habitat by about 5000 ha (Valladares-Pádua & Cullen 1994). Most recently, IPÊ, the NGO overseeing much of the recent black lion tamarin conservation activity, has opened a training center in conservation biology, a major new initiative.

Efforts to increase the amount of protected habitat for *L. caissara* through governmental processes may be nearing success, including land purchases and the enlargement of the Superagüi National Park.

Although the ultimate measures of success for these four programs is protecting enough habitat for geneti-

cally viable populations to survive, other quantitative yardsticks provide some information about a program's functioning. For example, it is assumed—although not necessarily proven—that community conservation education programs can support and contribute to programmatic goals. In the black lion tamarin program, an average of 1500 students a month visit the education center; the Education Center in Bahia has received nearly 15,000 visitors (56% students, 40% tourists). All of the programs also support undergraduate and graduate training. The GLTCP/AMLD usually funds about 20 interns a year and has supported the research of 14 individuals who have completed higher degrees (9 of the 14 are Brazilian). Currently, 8 students are working toward tertiary degrees, of which 4 are Brazilian.

Scientific, scholarly output is another quantitative measure of success. The GLTCP/AMLD has produced over 125 publications, beginning in the early 1970s. Currently, a behavioral ecology study by J. M. Dietz and A. J. Baker is the longest-running field investigation of any callitrichid monkey.

It is difficult to gauge the impact on the general public, in terms of raising consciousness about conservation issues and achieving conservation goals, of public relations and outreach efforts. In 1995 the GLTCP/AMLD was mentioned or featured in 25 articles in journals, magazines, and newspapers.

Comparison of Programs

A comparison of the relative success of the four programs is not easy. There are dramatic differences in the size, budget, program duration, and resources available to each. There are also major differences in the relative degree of threat faced by each species. The GLTCP has the longest history and the most non-Brazilians involved. It also has traditionally had a more centralized organization. The other lion tamarin programs have a more recent history (black-faced lion tamarins were, after all, discovered only in 1990) and were started with fewer resources and a more limited institutional backing. There has also been less integration of activities and, in some instances, separate teams competing for control over the entire conservation program or not collaborating closely. Finally, the conservation requirements have differed and the means to achieve these have varied. For example, the black lion tamarin program, through IPÊ, has focused on increasing protection of remaining forest, community conservation education, student training, studies of behavioral ecology, and translocation of tamarins; there has been less need to consider a forest rehabilitation or reintroduction program. Reintroduction and forest rehabilitation are also not yet relevant to the conservation of golden-headed and black-faced lion tamarins.

Benefits and Limitations of the IRMC Process

In our opinion, the *Leontopithecus* IRMCs have successfully promoted lion tamarin conservation for a number of reasons. The IRMCs are recognized by the government of Brazil as technical advisors. Meetings occur annually, and the sharing of expertise and knowledge is encouraged. The core values expressed by the committee chairs are inclusive rather than exclusive and focus on conservation objectives, equitable treatment, and communication. The reliance on high-performance teams that function without central control, with shared decision making, and with flexibility to carry out conservation activities permits greater creativity in problem solving and risk taking. Conflict resolution occurs as necessary and usually through informal mediation by committee chairs.

Because the IRMCs are international in composition, they represent an excellent mix of local knowledge and influence as well as the potential for international peer pressure when a certain type of government lobbying is needed. Also, the number of donors and partnerships dramatically expands available expertise and influence. The IRMCs also provide a focus for public relations and education programs and enhance media access to all of the teams and issues. The IRMCs' use of the flagship species strategy to publicize the plight of these remnant lion tamarin populations has fostered considerable public attention and support.

The IRMCs have limitations, the first and foremost being the lack of a formal budget. The IRMCs can develop priorities and action plans, but they rely on teams, individuals, or conservation-oriented NGOs to raise the money to implement their recommendations. Thus, the IRMCs cannot contract to have specific tasks accomplished. The LTBF, although small, has the important function of providing seed money for IRMC priorities before larger grants are secured.

There is also no official staff for the IRMCs because all members have other responsibilities. Thus, no single individual is devoted full time to making sure that the committees are functioning and that communication proceeds smoothly. The IRMCs only meet annually. Given the rapidity with which new issues arise, this meeting schedule is likely not frequent enough. The IRMCs have global political influence and have effected change through lobbying activities and international petitions, but they are only technical advisors to the Brazilian government through IBAMA, and this lack of authority limits their effectiveness.

Conclusions

Although there are limitations to the IRMCs' structure, functioning, and ability to effect change, we believe that the coordinated work of the *Leontopithecus* committees

has been integral to the achievements aiding both species survival and habitat preservation. These programs represent excellent examples of what can be accomplished through a diverse, multidisciplinary, multinational, and team-based approach involving science, interactive management of in situ and ex situ populations, politics, environmental education, and habitat preservation and restoration (Brewer & Clark 1994). Clark et al. (1994) provide numerous examples of recovery programs that have had enormous problems. We believe that the *Leontopithecus* IRMCs, even with some drawbacks, have elements that other recovery programs could emulate.

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