rapid biological inventories 01

Bolivia: Pando, Río Tahuamanu

William S. Alverson,
Debra K. Moskovits, and
Jennifer M. Shopland, editors

MARCH 2000

Participating institutions

The Field Museum
Chicago Zoological Society
Universidad Amazónica de Pando
Herbario Nacional de Bolivia
Colección Boliviana de Fauna – Museo Nacional de Historia Natural
Armonía

Collaborating Institutions

Conservación Internacional – Bolivia
World Wildlife Fund – Bolivia

Funding

The John D. and Catherine T. MacArthur Foundation
Chicago Zoological Society
The Field Museum

Rapid Biological Inventories Reports are published by:

THE FIELD MUSEUM
Environmental and Conservation Programs
1400 South Lake Shore Drive
Chicago, Illinois 60605-2496 USA
312.665.7430, 312.665.7433 fax
www.fieldmuseum.org

Editors: William S. Alverson, Debra K. Moskovits, and Jennifer M. Shopland

Design: Costello Communications, Chicago
Maps: William S. Alverson and Margaret Metz
Cover photograph: Vincent Sodaro
Translations: Julia K. Kurtz, Angela Padilla, and Tyana Wachter

The Field Museum is a non-profit organization exempt from federal income tax under section 501 (c) (3) of the Internal Revenue Code.

ISBN 0-914868-50-0

This publication has been funded in part by the John D. and Catherine T. MacArthur Foundation

Suggested citation:
Alverson, W.S., D.K. Moskovits, and J.M. Shopland (editors). 2000. Bolivia: Pando, Río Tahuamanu. Rapid Biological Inventories Report 1. Chicago, Illinois: The Field Museum.

CONTENTS

PARTICIPANTS

FIELD TEAM

William S. Alverson (plants)
Environmental and Conservation Programs
The Field Museum, Chicago, IL, U.S.A.

John E. Cadle (amphibians and reptiles)
Department of Herpetology
Chicago Zoological Society, Brookfield, IL, U.S.A.

Stephanie Dammermann (primates)
New York University, New York, NY, U.S.A.

Robin B. Foster (plants)
Environmental and Conservation Programs
The Field Museum, Chicago, IL, U.S.A.

Leeann Haggerty (primates)
New York University, New York, NY, U.S.A.

Amy Hanson (primates)
Department of Ecology and Evolution
State University of New York, Stony Brook, NY, U.S.A.

Lois Jammes (birds; pilot, coordinator)
Armonía
Santa Cruz, Bolivia

Debra Moskovits (coordinator)
Environmental and Conservation Programs
The Field Museum, Chicago, IL, U.S.A.

Edilio Nacimento (large mammals; coordinator)
Cobija, Pando, Bolivia

Narel Paniagua Z. (plants)
Herbario Nacional de Bolivia
La Paz, Bolivia

Leila Porter (large mammals)
Department of Ecology and Evolution
State University of New York, Stony Brook, NY, U.S.A.

Carmen Quiroga O. (birds)
Colección Boliviana de Fauna
Museo Nacional de Historia Natural, La Paz, Bolivia

COLLABORATORS

Steffen Reichle (amphibians and reptiles)
Colección Boliviana de Fauna
Museo Nacional de Historia Natural, La Paz, Bolivia

Julio Rojas G. (plants; coordinator)
Carrera de Biologia, Universidad Amazónica de Pando
Centro de Investigación y Preservación de la Amazonia
Cobija, Bolivia

Thomas S. Schulenberg (birds)
Environmental and Conservation Programs
The Field Museum, Chicago, IL, U.S.A.

Vincent Sodaro (primates)
Primate Department
Chicago Zoological Society, Brookfield, IL, U.S.A.

Sandra Suárez (primates)
Department of Anthropology
New York University, New York, NY, U.S.A.

Gualberto Torrico P. (plants)
Carrera de Biologia, Universidad Amazónica de Pando
Centro de Investigación y Preservación de la Amazonia
Cobija, Bolivia

Juan Pablo Arce S. (coordinator)
Conservación Internacional – Bolivia
La Paz, Bolivia

Chelsea Specht D.
World Wildlife Fund – Bolivia
Santa Cruz, Bolivia

The Field Museum

The Field Museum is a collections-based research and educational institution devoted to natural and cultural diversity. Combining the fields of Anthropology, Botany, Geology, Zoology, and Conservation Biology, Museum scientists research issues in evolution, environmental biology, and cultural anthropology. Environmental and Conservation Programs (ECP) is the branch of the Museum dedicated to translating science into action that creates and supports lasting conservation. With losses of natural diversity worldwide and accelerating, ECP's mission is to direct the Museum's resources – scientific expertise, worldwide collections, innovative education programs – to the immediate needs of conservation at local, national, and international levels.

The Field Museum
1400 S. Lake Shore Drive
Chicago, IL 60605-2496
312.922.9410
www.fieldmuseum.org

Chicago Zoological Society

The mission of the Chicago Zoological Society is to help people develop a sustainable and harmonious relationship with nature. In so doing, the Society provides for the recreation and education of people, the conservation of wildlife, and the discovery of biological knowledge. The principal means of fulfilling this mission is through the operation of Brookfield Zoo – owned by the Forest Preserve District of Cook County – a zoological park near Chicago. The Society supports active research and field conservation programs, with formal research programs in genetics, behavior, ecology, nutrition, pathology, and veterinary medicine. The Society regularly supports field conservation projects in more than 20 countries around the world.

Brookfield Zoo
3300 Golf Road
Brookfield, IL 60513
708.485.0263
www.brookfieldzoo.org

Universidad Amazónica de Pando – Centro de Investigación y Preservación de la Amazonia

From two original departments at its founding in 1993, Biology and Nursing, the Universidad Amazónica de Pando (UAP) has grown to include Computer Sciences, Agroforestry, Law, Civil Engineering, and Aquaculture. The urgent need for an expert center in Pando to manage the rich natural resources of the region led to UAP's strong emphasis on Biology and to the development of the Center for Research and Preservation of the Amazon (CIPA). The University's maxim – The preservation of Amazonia is essential for the survival of life and for the progress and development of Pando – reflects this focus on conservation. CIPA heads the research for fauna and flora in the region and guides policies and strategies for conservation of natural resources in Amazonia.

Universidad Amazónica de Pando
Centro de Investigación y Preservación de la Amazonia
Cobija, Pando, Bolivia
591.8429710

Museo Nacional de Historia Natural – Colección Boliviana de Fauna

The Museo Nacional de Historia Natural (MNHN), a research and educational institution funded by the National Academy of Sciences of Bolivia, undertakes investigation of the flora, fauna, and paleontology of Bolivia. In 1989, MNHN, with the Institute of Ecology of the Universidad Mayor de San Andrés, established the Bolivian Collection of Fauna (CBF). The principal objective of CBF is to contribute to the basic knowledge of the biodiversity and distribution of Bolivia's fauna, and to promote the conservation and sustainable use of the fauna. CBF is the primary center for faunal collections in Bolivia.

Museo Nacional de Historia Natural
Calle 26 s/n, Cota Cota; Casilla 8706
La Paz, Bolivia
591.2795364

Herbario Nacional de Bolivia

The Herbario Nacional de Bolivia in La Paz is Bolivia's national center for botanical research. It is dedicated to the study of floristic composition and the conservation of plant species of Bolivia's different ecosystems. The Herbario was consolidated in 1984 with the establishment of a scientific reference collection observing international standards and a specialized library. The Herbario produces publications that advance the knowledge of Bolivia's floristic richness. Resulting from an agreement between the Universidad Mayor de San Andrés and the Academia de Ciencias de Bolivia, the Herbario also contributes to the training of professional botanists, as well as to the development of the La Paz Botanical Garden in Cota Cota.

Herbario Nacional de Bolivia
Calle 27 Cota Cota
Correo Central Cajón Postal 10077
La Paz, Bolivia
591.2792582

Armonía

Founded in 1993, and the Bolivian Partner of BirdLife International, Armonía is a volunteer-based, non-profit association dedicated to the study and conservation of birds. The conservation projects of Armonía reflect its vision that humans and nature are one. Armonía's main goals are (1) to conserve Bolivia's birds and their habitats through scientific investigation, training courses, and working agreements with other institutions; and (2) to diffuse information relating to the conservation of nature – with special emphasis on birds – at a national level to strengthen ecological awareness in Bolivia. In response to the great richness of Bolivia's biodiversity, Armonía is broadening its scope of interest to other areas of conservation and ecology, always with the aim of contributing directly to the conservation of natural resources.

Armonía
Casilla 3081
Santa Cruz, Bolivia
591.3371005
armonia@scbbs-bo.com

Conservación Internacional – Bolivia

Conservación Internacional – Bolivia (CI-Bolivia), based in La Paz, is a non-profit, non-governmental organization focused on conservation and biodiversity in Bolivia. CI –Bolivia's programs concentrate on (1) increase of scientific knowledge about biological diversity; (2) sustainable use of forests, such as ecotourism, non-timber forest products, sustainable agriculture, and others; (3) management of protected areas and development of models for conservation politics; and (4) community participation that demonstrates how human societies can live harmoniously with nature.

CI – Bolivia
Calle Macario Pinilla esquina 6 de Agosto
No. 291, segundo piso
La Paz, Bolivia
591.2434058
www.conservation.org

World Wildlife Fund – Bolivia

The World Wildlife Fund (WWF) Bolivia Program Office is based in Santa Cruz de la Sierra, Bolivia. The mission of WWF is to conserve nature, with special emphasis on 200 priority ecoregions that represent the biodiversity of the planet and that are uniquely threatened. Six of these priority ecoregions occur in Bolivia: Southwest Amazon, Yungas, High Andean Lakes, Beni Grasslands, Pantanal, and Chiquitano Forest. WWF – Bolivia is developing and implementing ecoregional-based conservation programs with colleagues and partners in Bolivia and in neighboring Peru and Brazil. Conservation strategies include strengthening of protected areas, promotion of sustainable resource management, environmental education, capacity building and policy development.

WWF – Bolivia
Calle Güemes #4, entre Av. San Martín y
Av. Enrique Finot
Barrio Equipetrol, Santa Cruz, Bolivia
591.3.365326 and 325416
www.wwf.org

ACKNOWLEDGEMENTS

The success of Rapid Biological Inventories depends on the efforts of a large group working tirelessly together before, during, and after the field expedition. We thank the many colleagues, partners, and friends who ensured that (1) the trip ran smoothly, (2) inventory participants were kept up to date on events in Pando, and (3) inventory results were put to immediate use. Leila Porter, Edilio Nacimento, Anita Christen, Sandra Suárez, Hannah Buchanan, and Teresa Tarifa are just a few of the workers who have been dedicated to biological issues in the Río Tahuamanu region in recent years. Their efforts, along with those of Julio Rojas, Mario Baudoin, Robert Wallace, Damián Rumiz, Juan Pablo Arce, Chelsea Specht, and James Aparicio, among others, set the stage for the conservation activities in the region and for this rapid inventory.

We are grateful to the many people who made possible a quick response to the inventory request. Monica Moscoso (CI-Bolivia) went beyond the call of duty to coordinate the complicated logistics. Tim Sullivan responded to the initial call for action from Bolivia; he organized the participation from the Chicago Zoological Society and remained central through the coordination of follow-up steps. Tyana Wachter and Sophia Twichell (The Field Museum) solved problems with magical efficiency and maintained the fast pace throughout the planning stage. Leila Porter and Edilio Nacimento took care of the details on the ground. Lois (Lucho) Jammes contributed his skills in the air (with excellent overflights) and also on the ground. Tim Killeen (Museo de Historia Natural Noel Kempff Mercado) provided satellite images. The people of Pando – from San Sebastián to Palmera to Pingo de Oro to Cobija – showed deep hospitality to our team.

We sincerely thank the Governor of Pando, Honorable Roger Pinto, for spending hours with us discussing conservation opportunities, as well as for organizing meetings in Cobija. We thank the former Diputado (current Mayor of Cobija), Honorable Miguel Becerra, who responded quickly to our calls from the field and arranged meetings with government officials. We are grateful to the President of the Senate, Honorable Leopoldo Fernandez Ferreira, for his interest, focus, and encouragement. Julio Rojas was our primary spokesperson in Cobija.

Juan Pablo Arce and Monica Moscoso (CI-Bolivia) arranged the meetings in La Paz. Mario Baudoin and Juan Pablo provided invaluable insights. Chelsea Specht (WWF-Bolivia) spearheaded subsequent negotiations with the logging company. We thank the owners and managers of Empresa Aserradero San Martín for their willingness to discuss the establishment of the Tahuamanu Ecological Reserve within their logging concession.

For generous support of activities related to this Rapid Biological Inventory Report, we thank the John D. and Catherine T. MacArthur Foundation, the Chicago Zoological Society, and The Field Museum.

Why Pando?

The Department of Pando, in northern Bolivia (Figure 1), is very diverse biologically. Pando encompasses excellent examples of both black-water and white-water-river floodplain communities (predominant in the east and west, respectively). Its upland forests, dominated by Brazil-nut trees, are characteristic of the sandy-clay terraces that form a narrow band across the southwestern Amazon drainage. Many species that occur in Pando are rare elsewhere in Amazonia or are endemic (unique) to Bolivia, or both. Furthermore, many of the species assemblages in Pando occur nowhere else in Bolivia. Several species reach the southern limit of their distribution at the Río Madre de Dios; northeastern Pando marks the western limit for many species from the Brazilian Shield (flora and fauna that are being devastated to the east).

Rapidly expanding logging and ranching activities seriously threaten Pando's biological riches. Logging concessions now cover much of the Department, and cattle ranches – with their ecologically devastating practices – multiply apace as soon as areas have been logged for the more valuable timber. The need for effective conservation in the region has become critical, not only to establish, but also to manage protected areas. Differences in natural communities and species composition throughout Pando highlight the importance of protecting sites in all ecologically distinct regions of the Department.

Interest in the specific sites for this rapid inventory in western Pando began in 1997, when Leila Porter and Edilio Nacimento established a field station for a two-year study of the endangered Goeldi's monkey, *Callimico goeldii*, near the Río Tahuamanu (Figure 1). Inspired by their success in habituating and observing this little-known primate, Porter and Nacimento promoted long-term studies of the 13 other species of nonhuman primates in the area. The unusual richness in primate species around the Río Tahuamanu and the Río Muyumanu, a tributary to the southwest, further prompted Porter and Nacimento to coordinate efforts with Julio Rojas, of the Universidad Amazónica de Pando, Cobija, to develop a preliminary proposal for designation of the area as an Ecological Reserve (Rojas et al. 1998).

Investigation revealed that the area proposed for the reserve falls within two forestry concessions owned by a large Bolivian logging company, Empresa Aserradero San Martín. During initial contacts, the logging company demonstrated interest in negotiations for conservation if the area were shown to be of high biological value. However, the company revised its schedule for logging the area from the year 2005 to early 2000, marked thousands of individual trees, and cut a 10-km logging road through old-growth forest to begin removing timber at the beginning of the dry season (April 2000).

In response to the urgent need and the high potential for conservation, The Field Museum and the Chicago Zoological Society, in collaboration with Conservación Internacional-Bolivia and the Universidad Amazónica de Pando, organized a rapid biological inventory of the area. With circumstances dictating that the inventory be unusually fast, the fieldwork took place from 17 to 25 October 1999. We targeted two primary sites within the proposed Tahuamanu Ecological Reserve (north and south of the Río Tahuamanu, Figure 1) and focused on large mammals, birds, amphibians and reptiles, and plants. We sampled five sites (see Overview of Sites Sampled, in the Technical Report) and flew over the entire region.

Meetings with government officials immediately following the fieldwork generated much enthusiasm and support for conservation from the current Mayor of Cobija, the Governor of Pando, and the President of the Bolivian National Senate. Led by World Wildlife Fund-Bolivia, discussions have resumed with San Martín, with participation of Conservación Internacional-Bolivia, Universidad Amazónica de Pando, and several organizations in the United States and Bolivia. The current goal is to convert a portion of the logging concession into a protected core area with a biological field station, surrounded by an area managed for the sustainable production of nontimber forest products. The negotiations also have generated enthusiasm for development of a conservation and management plan for the whole western portion of the Department of Pando.

Contributors / Authors: Robin Foster, Leila Porter, Thomas S. Schulenberg, John E. Cadle, Steffen Reichle, Julio Rojas G., and Edilio Nacimento

OVERVIEW OF RESULTS

ECOLOGICAL PROFILE

The Río Tahuamanu region of northwestern Pando (Figures 1, 2) provides an excellent and typical sample of both white-water floodplain communities and the sandy-clay terraces of southern and southwestern Amazonia, characterized by a great abundance of Brazil-nut (castaña, *Bertholletia excelsa*) and rubber trees (siringa, *Hevea brasiliensis*). The primate fauna in the region is extremely rich, with 14 nonhuman species recorded – equaling the highest number reported from any area surveyed in the Neotropics and among the world's highest concentrations of primates in a single area. The composition of the flora indicates a relatively rich soil – unusual for Amazonian terra firme (upland forests) – and high productivity in the vegetation. These sandy-clay terraces are especially rich in tree species important to animals (such as figs and palms), including extractive resources for humans.

In Bolivia, many of the species assemblages encountered occur *only* in the Department of Pando. The rapid biological survey also revealed many new records for the country. Of the 615 species of vascular plants registered in the areas inventoried, approximately 50 are new records for Bolivia. The estimated number of plant species in the area of the proposed Tahuamanu Ecological Reserve, based on this survey, is 2,000. In addition to primates, the other large mammals in the region (37 species, with 1 new record for Bolivia, and 1 potentially new species or subspecies of deer), the birds (319 species, 1 new for Bolivia), and the amphibians and reptiles (55 species, 6 new for Bolivia) constitute a fauna characteristic of southern and southwestern Amazonia. We estimate the herpetological fauna (which needs to be re-inventoried during the more favorable, wet season) at 120 to 150 species. The richness of bird fauna at the selectively logged site (San Sebastián) was significantly lower (15-20%) than at the unlogged site (Pingo de Oro), both for the total number of species recorded at each site (163 versus 192) and for the forest-dwelling species only (151 versus 182). We estimate the number of bird species at each site to be over 300, with a regional total closer to 500.

UPLAND FORESTS (TERRA FIRME, FIGURES 2, 3A)

Dissected, sandy-clay terraces of Tertiary age, which rise 50 to 100 m above river level, characterize this region. These upland terraces, presumably derived from deposits in the giant lakebed that once covered much of the Amazon Basin, extend from southeastern Peru (near the rivers Heath and Tambopata), eastward in a band into Brazil, south of the Río Amazonas but north of the Brazilian Shield. The terraces range from high, flat-topped hills interrupted by steep-sloped ridges and ravines, down to low, flat hills and terraces barely above the floodplain. Most erosion is gradual, creating relatively gentle slopes. The streams have primarily sandy bottoms, with occasional hard rock exposed.

Nearly half of the old-growth upland forest is covered with high (40 m), continuous canopy that creates a shaded, open understory. On the highest ridges and hills the forest is drier and more subject to the effects of wind and occasionally severe droughts. Much of this drier forest has an open, discontinuous canopy (probably because of higher frequencies of treefalls) with a high density of lianas. In the western half of the terra firme between the Río Tahuamanu and the Río Muyumanu, much more open, tangled canopy was apparent from our overflights, even in the valleys. However, we do not know how soil characteristics, human activity, or other variables may reduce the amount of intact high canopy in that area.

The upland forest of this region seems fairly typical of terra firme throughout central and western Pando but differs in community and landscape characteristics from adjoining regions. For example, the terra firme of the Manuripi-Heath park in southern Pando has far fewer Brazil-nut and rubber trees and more species of canopy trees (judging from the canopy seen in the overflight), as well as spectacular palisades, cliffs, and steep ravine habitats along the Río Madre de Dios.

The northeast section of Pando (east of 66° E longitude) is considerably different than central or western Pando. This area, especially the lower drainage of the Río Negro and land further east, is on rock that is part of the ancient Brazilian Shield formation to the east. It has tall upland forest that is different in composition from that of western Pando; large stretches of dwarf, poorly drained upland hummock forest; and diverse black-water riverine forest. The soils are much sandier and more acidic than in the rest of Pando, with few Brazil-nut or rubber trees and few human settlements. Much of the flora and fauna in the northeast is absent in western Pando and is being eliminated to the east (on the other side of the Río Madeira, in Brazil), with the relentless, rapid destruction of the few remaining moist forests of the Brazilian Shield. The eastern boundary also includes the picturesque rapids of the Río Madeira, which played such an important role in the history of the region. This area of Pando is clearly appropriate for one or more strictly protected areas, in contrast to the upper Tahuamanu area discussed in this report, which is much more appropriate as an extractive reserve.

FLOODPLAIN FORESTS (LLANURA DEL RÍO, FIGURES 2, 3B)

Vegetation on the meanders of the Río Tahuamanu is typical of white-water rivers, with five recognizable successional stages: (1) annual herbs on the beach; (2) *Tessaria-Gynerium* thickets; (3) *Cecropia* stands; (4) *Ficus-Cedrela* forest, up to 150 years old and usually with high (>35m), closed canopy on the higher levees near the river; and (5) old forest (older than 150 years but still occasionally inundated).

Much of the older forest in the Tahuamanu floodplain is extremely open and swampy, appearing lower and more poorly drained than the younger stages on more recent river levees. In the backwater areas with the least drainage, at least three recognizable vegetation types, or some combination of them, cover large expanses: (1) floating or emergent herbs and shrubs; (2) “ghost forests” (recently dead, widely separated trees covered with vines); and (3) stands of *Mauritia flexuosa* palms (Figures 2, 3d). These plant communities are typical of the floodplains of the Tahuamanu, Manuripi, and Orthon rivers; understanding the conditions that give rise to these communities is critical to any management plan for the floodplains of Pando.

In the area of the Río Tahuamanu proposed as a reserve, the backwater floodplain communities are small and relatively poorly developed, in contrast to the spectacular diversity and extent of comparable communities on the Río Manuripi in the Manuripi-Heath National Park (Figures 3e, 3f). Along the Manuripi are extensive arroyos such as Lago Bay with its chains of blackwater lagoons, huge areas of *Mauritia* palm swamp, herbaceous meadows, and ghost forest; in the areas just southwest of Puerto Rico are extensive seasonal swamps dominated by *Macrolobium acaciifolium* trees. The Manuripi-Heath National Park is the only place in Bolivia and the southwestern Amazon Basin where such important communities can be protected.

The floodplain of the upper Río Tahuamanu, though small, is nevertheless an important ecological complement to the terra firme forest, because many animal species (especially large mammals) make use of both habitats seasonally. Above the current floodplain and parallel to it, however, are extensive stretches of unusual, seasonally flooded forests (Figures 2, 3c). These flat “frying-pan” forests (sartenejales) are not flooded by the river; rather, they grow on impermeable clay and apparently are the remnants of a much older and higher floodplain. The sartenejales are dwarf forests, usually less than 10 m tall, with an abundance of *Vochysia* and a palm that appears to be *Oenocarpus batahua* (noticeable from the overflights). A narrow band of low, sandy terra firme forest separates most of the older sartenejales from the current floodplains. Although this poorly studied vegetation type appears rare elsewhere in Pando (as well as throughout the Amazon Basin), at least one large expanse of sartenejal and several smaller ones lie in the proposed reserve.

The floodplain of the smaller Río Muyumanu – with its steep-banked, slow-moving river channel and its highly irregular, short levees and depressions – is very different from the floodplain of the Tahuamanu. When enclosed by terra firme, these small tributaries have a slow-moving meander system with few beaches (lined with *Alchornea castaneifolia* on the expanding banks, and with a mixture of *Inga* species and liana tangles on the eroding banks). When these smaller tributaries cut across the current floodplain of the Tahuamanu, they create small levees frequently lined with *Xylopia cuspidata* and *Virola* cf. *surinamensis*. A very similar vegetation occurs along the Río Nareuda, the principal tributary of the Tahuamanu north of the proposed reserve.

BAMBOO FORESTS (GUADUALES, FIGURE 2)

In our records, dense clumps of bamboo (*Guadua* cf. *weberbaueri*) are relatively infrequent in the eastern part of the proposed reserve and usually are associated with second growth from recent human clearings. In the western part, however, along the border with Peru, bamboo dominates the understory and canopy openings in large expanses of many square kilometers. This is the southeastern edge of the greatest bamboo patch in South America, extending from western Pando up to 500 km north and west into Peru and Brazil. In the northwestern corner of Pando, settlements in the proposed Yaminahua-Machineri Indigenous Reserve also are surrounded by extensive stands of bamboo, suggesting at least an indirect relationship to human activity for hundreds of years.

INFERRED HISTORY OF HUMAN IMPACT: OLD, SUSTAINABLY MANAGED FORESTS?

Even without archeological data, we can infer the human interactions with the vegetation of this area, at least for the terra firme. Two features, in particular, stand out. First is the most conspicuous characteristic of the vegetation of this region: the predominance of giant floodplain trees (e.g., *Dipteryx micrantha* and *Ceiba pentandra*) all over the terra firme. To become established and grow large, these species require large areas of exposed soil and many years of low competition for light and soil resources (Foster et al. 1986; Foster 1990; Foster and Hubbell 1990). These giants normally get their start on the levees formed from the beaches on river meanders,

under the thin shade and weak root development of the earliest successional species. The only other natural situations where these conditions are met come from large landslides, which are infrequent in this area. Human clearing and burning of terra firme forests, however, also create such conditions. These emergent trees in the Tahuamanu area are of approximately the same size as 500-year-old trees in human-modified forests elsewhere in Latin America. Our findings strongly support the idea that the area's terra firme is covered by first-generation forest that has grown back from what must have been patchy but widespread human clearings until shortly after European colonization, when the spread of disease, massacres, and enslavement drastically reduced the indigenous populations.

The second noticeable feature is the high frequency of species of potential value to indigenous communities. The composition of the emergent trees in the Tahuamanu is reminiscent of the forests around the Maya ruins of the Petén in Guatemala, which are considered cultivated forests of economically important species. Like the forests of the Petén, the forests of Pando have an abundance of trees with nutritious seeds (*Bertholletia*, *Dipteryx*, *Brosimum*); latex (*Hevea*, *Manilkara*); cotton-producing seeds (*Ceiba pentandra*, *C. samauma*, and *Ceiba* [*Chorisia*] *insignis*); easily workable, rot-resistant wood (such as *Cedrela*); and edible, sweet fruits (*Pouteria*). Also encountered on the hills were huge individuals of *Chrysophyllum caimito*, considered native to the Caribbean Islands and introduced into South America as a cultivated fruit tree.

The area between the Muyumanu and Tahuamanu Rivers has patches of secondary forest of various ages, although most patches appear to be less than 30 years old. These secondary forests apparently are the result of small-scale agriculture associated with the recent camps of the Brazil-nut gatherers (castañeros) and rubber tappers (seringueros). This continuing practice of clearing widely separated plots of 2 ha every few years is not by itself a threat to the forest in the region.

The most recent disturbance in the region occurred in August and September, 1999, the two months preceding our survey, with the cutting of timber inventory lines northwest of the Río Muyumanu. These 2 m-wide lines in the understory are not trivial: hundreds of kilometers of them were cut every 100 m east-to-west, and every 500 m north-to-south, thus destroying more than 2% of the forest understory.

TREE SPECIES OF ECONOMIC IMPORTANCE

The most important economic trees in the region are Brazil nut (castaña, *Bertholletia*), rubber tree (siringa, *Hevea*), cedro (*Cedrela*), and roble (*Amburana*).

Although the techniques used in the collection of Brazil nuts have minor direct impact on the parent trees themselves, the potentially serious effect of seed collection on the recruitment of Brazil-nut seedlings and saplings is under investigation in Peru (Enrique Ortiz, Alton Jones Foundation). Juvenile trees are extremely rare in the forests around the Tahuamanu. During the overflights, we noticed that many of the larger, presumably older trees are gradually dying; they exhibited a dieback pattern typical of old or stressed trees, i.e., missing branches and many, leafless, dead branchlets in their crowns. Some intervention and active management (e.g., planting of seeds or seedlings in the small agricultural clearings found throughout the forests) probably will be necessary to maintain future populations.

Rubber tappers in the area currently manage their *Hevea* trees very well. The trees are healthy and reproductive, and the population of rubber trees appears to be self-sustaining. In contrast, in areas with denser populations of rubber trees (seringales), such as at Ingavi, downriver on the Río Orthon, the trees have been overexploited and most are fungus-infected and not reproductive.

Densities of mahogany (mara, *Swietenia macrophylla*) and roble (*Amburana cearensis*) are not significant in this region. The density of mahogany seems low compared to densities in the other forestry concessions of lowland Bolivia that we have visited (e.g., Santa Cruz, the Chimanes forest in Beni, and northern La Paz). In contrast, the density of cedro appears average or even high for terra firme forests, with populations of both the floodplain species (*Cedrela odorata*) and the terra firme species (*Cedrela fissilis*). All the juveniles seen were of the latter species, though *C. odorata* is likely colonizing patches of second growth.

Brosimum alicastrum apparently has been overlooked in terms of its potential as a sustainable source of food and fodder for local populations and as a possible export crop (for its seeds).

WILD FRUIT RESOURCES

In addition to other large Moraceae, many species of fig (*Ficus*) – often with huge individual trees – occur at greater densities in the terra firme forests surveyed than we have seen anywhere else in the Neotropics. This key group of plants provides fruit for animals throughout the year. Palms (Arecaceae) also are a major food resource for vertebrates in these forests.

PRIMATES AND OTHER LARGE MAMMALS

Pando has an extremely rich primate fauna. We detected a total of 14 nonhuman species in the areas surveyed, equal to the highest concentration of primate species known anywhere in the Neotropics. The Río Tahuamanu acts as a natural barrier to the distribution of some primates; protecting sites on *both* sides of the river is crucial. Populations of the larger primates suffer from hunting pressure in the region, which appears to differ in intensity between our survey sites (see below).

In addition to primates, we recorded 37 species of large mammals in the region, nearly all of the megafauna known for this part of the Amazon Basin. Of these, only the giant river otter (*Pteronura brasiliensis*), reported by one resident interviewed, seems to be locally endangered or nearly extirpated; the Palmera site along the Río Muyumanu may contain some of the last Bolivian populations of this species. Green acouchi (*Myoprocta pratti*), a first record for Bolivia, appears to occur in high densities throughout the region. We observed one deer that resembles the gray brocket deer (*Mazama gouazoubira*) but has yellow and black lines below its eyes; it may be a new species or subspecies of Cervidae. Most of the mammal species observed appear to be relatively common in the region, except for white-lipped peccary (*Tayassu pecari*), which is rare to the north of the Río Tahuamanu; jaguarundi (*Herpailurus yaguarundi*), which was observed only once in two years (S. Suárez, pers. obs.); and short-eared dog (*Atelocynus microtis*), which was seen only once, at San Sebastián, and seems to be rare throughout the region.

BIRDS, REPTILES, AND AMPHIBIANS

The avifauna and the herpetofauna of the sites surveyed are typical of southwestern Amazonia. During this rapid biological survey, we recorded 319 bird species throughout the region (exclusive of Cobija). This total includes species in different types of forests, along rivers and oxbow lakes (cochas), and in large clearings and pastures. Most (254 species, or 80%) were species associated primarily with forests and dependent on forests for their survival. At the historically unlogged site (Pingo de Oro) the bird fauna was notably richer in species and more intact than at the selectively logged site (San Sebastián); equivalent sampling effort yielded 15-20% more species at the unlogged site.

We recorded the following reptile and amphibian species: 7 snakes, 11 lizards, 32 frogs, 3 crocodilians, and 2 turtles. The species composition we found is similar to that of several well-known sites in southwestern Amazonia, particularly in southern Peru. However, in Bolivia this fauna is probably restricted to parts of the departments of Pando and La Paz, north and west of the Río Beni. Six species of frogs that we encountered are new records for Bolivia: *Eleutherodactylus* sp. 1 (*unistrigatus* group), *Eleutherodactylus* sp. 2 (*unistrigatus* group), *Epipedobates femoralis*, *E. trivittatus*, *Ischnocnema quixensis*, and *Phrynohyas resinifictrix*. All 6 are

common in southern Peru, and most elements of this southwestern Amazonia fauna probably extend at least to the Río Beni, in Bolivia. The discovery of 6 species new to the country during poor conditions for herpetofaunal surveys (see below) is significant; it suggests that many more species new to the Bolivian herpetofauna remain to be discovered in the region.

Because of the dry sampling conditions, our results are low estimates for the richness of the herpetofauna in the area of the proposed Tahuamanu Ecological Reserve. Based on similar but better-known sites in southern Peru (Manu, Tambopata, and Cuzco Amazónico), which are further north, less seasonal, and somewhat moister, we predict that amphibian and reptile species richness of the Tahuamanu area is approximately 120 to 150 (since latitude, seasonality, and humidity all influence overall species diversity or composition). A more complete survey of these assemblages (from rainy season to early dry season, approximately January to June) would raise the accuracy of this estimate.

CONSERVATION TARGETS

Because of (1) their global or regional rarity, (2) their influence on community structure or dynamics, or (3) their indication of relatively intact habitats or significant ecosystem functions, the following species and communities should be the primary foci for conservation in the proposed Tahuamanu Ecological Reserve.

Organism Group	Conservation Targets
Plant communities	Old-growth forest on terra firme All successional stages of major and minor floodplains
Tree species	Brazil-nut tree (*Bertholletia excelsa*) Rubber tree (*Hevea brasiliensis*) Figs (*Ficus* spp.), palms (Arecaceae), and other primate foods
Reptile and amphibian communities	Southwestern Amazonian herpetofaunal community
Bird communities, species assemblages, and individual species	Southwestern Amazonian bird community Bamboo specialists (especially *Lophotriccus eulophotes*) Large raptors (*Harpia harpyja, Leucopternis kuhli*) Large gamebirds (*Penelope*) Range-restricted species (*Nonnula sclateri, Formicarius rufifrons*)
Primates	IUCN Red List (vulnerable) species: *Callimico goeldii* (rare, patchy distribution; also CITES I), *Lagothrix lagothricha* (critically endangered locally) *Alouatta sara* (endemic to Bolivia) All other co-occurring primates
Other large mammals	CITES I species: *Herpailurus yaguarundi, Leopardus pardalis, L. wiedii, Lontra longicaudis, Panthera onca, Priodontes maximus, Pteronura brasiliensis, Puma concolor, Speothus venaticus* CITES II species: *Myrmecophaga tridactyla, Tapirus terrestris, Tayassu pecari, T. tajacu*

THREATS

The primary threat to the natural riches of the region is large-scale conversion of forest to cattle ranching, agriculture, and human settlement. The secondary threats are timber cutting and overharvesting, burning, and elimination of fruit and seed dispersers.

CLEARING OF FOREST

Patches of secondary forest exist throughout this area, though less frequently than in much of Pando, a condition appropriate for the establishment of an extractive reserve with Ecological Reserve protection status in the region. Most of the clearings (chacos) are made by Brazil-nut gatherers and rubber tappers and are not a problem for forest regeneration. Because most chacos are less than 200 m wide, plant and animal recolonization is possible through natural dispersal from the surrounding forest. However, if crop agriculture becomes an end for commercial trade, rather than a means to provide for the local needs of the Brazil-nut gatherers and rubber tappers, it will pose a serious threat to the plant and animal communities. In contrast, some large areas of northwestern Pando outside the proposed Tahuamanu Ecological Reserve already have been cleared for pasture or for contiguous-crop farms. Even if these large, cleared areas are allowed to regenerate, biological diversity will be devastated for a century or more. Local and regional clearing of land also affects the microclimates and microhabitats for amphibians and reptiles, resulting in a decrease of overall species richness.

LOGGING

Selective logging operations, as traditionally managed in Bolivia, cause soil erosion from the roads and accelerate breakup of the forest canopy. The opening of thousands of small holes in the canopy increases the dominance of lianas and bamboo on a large scale. Once lianas and bamboos become well established, the forest gradually loses much of its structural diversity and the canopy may not close again for several hundred to a thousand years. Other methods of logging, such as strip cutting, are better at protecting the plant and animal communities, but we see no indication that these alternative techniques will be adopted soon in Bolivia.

Logging already has begun around San Sebastián and Rutina; we predict serious impact (20% decrease) on the species richness of the bird fauna. Potentially intensive logging at the other sites is imminent. Logging south of the Río Tahuamanu would destroy a large tract of old-growth forest, with major impact on the animal populations and species assemblages. Because of concomitant effects on microclimates and moisture regimes, intensive harvesting of timber (including trails cut for surveying timber resources) is detrimental to the herpetofauna, even to species and populations remote from the center of timber harvest.

Logging roads themselves become a threat, primarily because of greater accessibility of the forest to ranchers, colonists, and hunters. Reserves or other protected areas set aside must be large enough to prevent insular effects from perturbing the herpetofaunal assemblage, as well as other sensitive animals and plants.

HUNTING

Subsistence hunting poses a threat to many of the animal conservation targets, especially the larger primates, other large mammals, gamebirds, and at least a few reptiles. Hunting is the most likely cause for the absence of the large spider and woolly monkeys (*Ateles* and *Lagothrix*), for the low abundance of howler monkeys (*Alouatta*) in the area around San Sebastián, and for the rarity of *Ateles* and *Lagothrix* around Pingo de Oro. We saw hunters returning with freshly killed guans (*Penelope*), although this commonly hunted species remains fairly common at both San Sebastián and Pingo de Oro, where it was recorded daily in small numbers during this survey. We have no records from either site of curassows (*Crax*), which are much more vulnerable to hunting pressure. Although we have no certain records of curassows from these sites prior to recent human occupation, they are widely distributed in southwestern Amazonia.

We identified overhunting as a specific threat for two species of turtles: *Podocnemis unifilis* (tericayo or charapa) and *Geochelone denticulata* (motelo). For *Podocnemis*, the primary threat is harvesting of eggs and nesting females, which are consumed locally and also sold to restaurants in Cobija and perhaps other towns. *Geochelone* is consumed locally by Brazil-nut gatherers; a longtime resident of San Sebastián told us that this species was once very common in the area but has been nearly extirpated locally as the human population density increases in the region.

We suspect that either hunting or wanton killing has reduced populations of *Caiman* in the area, but more survey data are needed. We saw few individuals during day surveys of the rivers, and none during night surveys at Rutina (in both the Río Tahuamanu and the large oxbow lake) and at Palmera (Río Muyumanu). We observed single individuals of *Paleosuchus trigonatus* at San Sebastián and in the oxbow lake at Rutina. These small crocodilians are more secretive and nocturnal than the larger species of *Caiman* and may escape detection for longer periods. However, populations of *Paleosuchus* appear small in this region.

The prevalence of game hunting associated with the Brazil-nut gatherers and rubber tappers is certain to influence both availability of dispersal agents for some plant species and herbivory on other species. Hunting pressure increases with the temporary influx of people during logging activities and during collection of Brazil nuts from December through March each year.

PET TRADE

Although primate and parrot pets are frequent in the area, current pressure from the pet trade does not seem intense. However, if the pet trade increases, it will become a threat for primates and parrots, and potentially for other animals. Populations of macaws and other large parrots seemed low throughout the area, compared to those in southern Madre de Dios, Peru, but we do not know if this scarcity reflects a prior history of bird trapping or results from other causes.

PROXIMITY TO COBIJA

San Sebastián is near Cobija, the capital of Pando, and is accessible by road throughout the year. The likelihood of increased settlement and ranching, with the associated increase in habitat destruction and hunting, threatens the area unless protected status for the region converts the proximity to Cobija into an opportunity for ecotourism and education.

CONSERVATION OPPORTUNITIES

The proposed Tahuamanu Ecological Reserve would protect an excellent example of the Brazil-nut-dominated, sandy-clay terraces and white-water floodplain forests and wetlands of Bolivia. Immediate action will advance significantly the conservation of an unlogged portion of the old-growth forest south of the Río Tahuamanu. The location of the proposed reserve provides a sound basis for protection: the Río Muyumanu forms a natural boundary to the east and south, and the border with Peru forms an artificial but significant boundary to the west. Interest in the area already is high among scientists because of the continuing research focused on primates. This interest will grow considerably with protected status of the area, with further development of a research station, and with creation of associated educational and scientific resources, such as trail guides and pictorial field guides. Because the site is so easily accessible from Pando's capital city of Cobija (a three-hour drive from the international airport), it offers tremendous potential both for activity in the research station – with engagement of students and faculty from the Universidad Amazónica de Pando – and for careful development of an ecotourism initiative.

The proposed Tahuamanu Ecological Reserve is a critical site for the conservation of Amazonian primates: the number of species that occurs in the area is remarkably high, surpassing the total for the long-term research site in Manu, Peru. San Sebastián is particularly important for the conservation of *Callimico goeldii*. *Callimico* have a patchy and sparse distribution throughout their range and are difficult to observe where they occur. In San Sebastián, not only have *Callimico* been documented more consistently than they have been recorded elsewhere in their historical range, but also individuals have been habituated to human observers. The Pingo de Oro site may be particularly important for conservation of the woolly monkey (*Lagothrix*) in Bolivia. This rapid inventory's sighting of the species is the first in Bolivia in perhaps 50 years.

The proposed Tahuamanu Ecological Reserve also will protect populations of nearly all large mammals known for this part of Amazonia, including several species listed as CITES I and II (see Conservation Targets). Populations of several of these species are relatively high at the unlogged site of Pingo de Oro, and Palmera (on the Río Muyumanu) may contain remnant populations of the giant otter, *Pteronura brasiliensis*.

The departments of Pando and La Paz are the only areas in Bolivia where the bird and herpetofaunal species assemblages that we recorded occur. If Bolivia is to maintain its full national heritage, portions of the forests in this region must be protected from high-impact use. The proposed reserve also harbors populations of *Podocnemis unifilis* and *Caiman crocodylus*, species whose populations have been reduced in many areas throughout Amazonia.

RECOMMENDATIONS

Participants in this rapid biological survey, and their conservation partners, already have made plans to derive recommended goals and strategies through a process of conservation design. The rapid survey has laid the groundwork through identifying the region's ecological context, biological values, threats, and conservation opportunities. Our inventory results also suggest some preliminary recommendations, the most urgent of which concern the protection and management of this biologically rich but endangered landscape.

PROTECTION AND MANAGEMENT

- **Establish a large core reserve, the Tahuamanu Ecological Reserve,** including a buffer strip along the eastern shore of the Río Muyumanu so that river fauna receive protection on both sides of the river.
- **Promote research on management techniques for the ecologically sensitive harvest of nontimber forest resources.** For generations – possibly for hundreds of years – local residents have been managing many nontimber forest resources in ways that seem compatible with the native biodiversity of the region.
- **Prohibit timber harvest, and hunting of some species, within the Reserve.**
- **Ensure participatory management of the Reserve and its buffer zone by local communities.** Residents, including Brazil-nut gatherers and rubber tappers, will contribute valuable expertise in the design and implementation of a conservation and management plan, with elements of research, monitoring, inventory, training, and public involvement.

RESEARCH

- **Establish a research center in the Reserve, with facilities for Bolivian university students and professional scientists, as well as for international researchers.**
- **Determine the effects of hunting on several target species, especially primates, other large mammals, gamebirds, and several reptiles; develop reliable population data, e.g., life tables, for these species.**
- **Investigate the potential of *Brosimum alicastrum* for local subsistence (food and forage) and for export.**
- **Initiate a long-term study of fruiting phenology to monitor variation in fruit production, and develop a fruit- and seed-collection program and reference collection.** The results of these studies would lay the foundation for management of food resources for animal conservation targets and for compatible uses of fruits and seeds by human residents.
- **Diagnose the potential for local and international ecotourism in the Reserve and buffer zone.**
- **Promote further research on the ecology and behavior of primates in the Reserve, particularly *Callimico goeldii* and *Lagothrix lagothricha*.**
- **Encourage detailed studies of bird distribution at the local scale, in different habitat types and structures.** Given the intricate patchwork of forest types within the region (in part because of the many regenerating clearings), the site would be excellent for these studies, of which very few exist for South American birds. Such studies will play an important role in advancing our understanding of bird distribution in Amazonia at a local scale and will be critical in development of effective conservation plans in the Tahuamanu region and throughout Amazonia.

FURTHER INVENTORY

- **Map the distribution of secondary forests in the area.**
- **Produce rapid, simple guidebooks to the plants and animals of the proposed reserve.**
- **Inventory the small-mammal fauna.**
- **Conduct a more intensive and complete survey of the herpetofauna during the rainy to early dry season,** to provide better information on species richness and to compare local richness with that of other areas of Amazonia.
- **Inventory the flora more completely.**
- **Investigate and identify the tracks of an unknown mammal,** discovered southwest of Rutina (see Other Large Mammals, below).
- **Verify the status of the giant otter in the region.**
- **Conduct further inventory of the Cervidae in the area to determine if a new species or subspecies is present,** as was suggested by this survey (see below).

MONITORING

- **Periodically census the demography of Brazil-nut trees and rubber trees to be sure that they are reproducing successfully in the region.**

TECHNICAL REPORT

OVERVIEW OF SITES SAMPLED

We targeted two sites for intensive surveys: San Sebastián and Pingo de Oro, both on upland terraces several kilometers inland from the nearest river (Río Tahuamanu and Río Muyumanu, respectively), and drained by several streams or small rivers (Figures 1, 2). We also inventoried three other, nearby sites along the Ríos Tahuamanu and Muyumanu: Rutina, the Rutina-Palmera logging road, and Palmera.

San Sebastián (11° 24' S, 69° 01' W, ca. 280 m elevation; surveyed 16-18 October 1999) has an extensive trail system that extends in virtually all directions from camp and that includes Brazil-nut-gatherer trails and a grid cut at 100 m intervals over a 150-ha study area established by primatologists. Areas to the north, west, and south of camp are on well-drained terrace and ridge; areas to the southeast are lower and wetter. Bamboo occurs in small patches to the northwest and in more extensive areas just to the south of camp. We surveyed all habitats and made supplemental observations (1) at the edges of the two clearings in San Sebastián and (2) at the larger clearing of Casa Callimico about 1 km to the south (at the end of the road from Cobija). During the last decade, the area was logged for cedro (*Cedrela odorata*), mahogany (mara, *Swietenia macrophylla*), and assaí (*Euterpe precatoria*).

Pingo de Oro (11° 31' S, 69° 06' W, ca. 280 m elevation; 20-23 October 1999) also has an extensive trail system, developed and maintained by local rubber tappers. Pingo de Oro is a rubber-tapper camp in old-growth forest, with scattered, regenerating clearings of various sizes and ages. Rubber tappers and Brazil-nut gatherers have used the forest for centuries (see Inferred History of Human Impact, above), and the area has not been logged. Until late 1999, with the construction of a major logging road, Pingo de Oro had been accessible only by river. A recent (September 1999) network of forestry-survey trails was cut in a grid of 100 m east-to-west and 500 m north-to-south; we rarely used those trails. We made supplemental observations at the edge of the clearing at the rubber-tappers' camp. We found no patches of bamboo at the site.

Rutina (11° 25' S, 69° 00' W; 19, 24-25 October 1999) is the site of a sawmill of Empresa San Martín, currently inactive, on the north bank of the Río Tahuamanu. It consists of a large clearing with some second growth near the river. An oxbow lake (cocha), bordered by forest, lies just to the west of the compound. We spent a few hours walking a trail along this cocha on 19 October, and part of the team made additional observations late on 24 and early on 25 October.

Rutina-Palmera logging road was constructed between August and September 1999 by the Empresa San Martín. It connects the sawmill at Rutina with the forests at Palmera/Pingo de Oro. The road ends at the Río Muyumanu, directly opposite Palmera. Several members of the team walked the road on the afternoon of 23 October and from midmorning to evening on 24 October 1999. The road crosses seasonally flooded floodplain forest, an old clearing, and extensive terra firme.

Palmera (11° 30' S, 69° 03' W; 19, 23-24 October 1999) is a clearing along the Río Muyumanu. River-edge forest contains thickets of bamboo. Incidental observations were made on the evening of 19 October. A few members of the rapid survey team also took a brief trip by small boat (peque peque) for about an hour up the Río Muyumanu from Palmera on the afternoon of 23 October. We had a few hours there on the morning of 24 October.

FLORA AND VEGETATION

Participants/Authors: Robin Foster, Julio Rojas G., Narel Paniagua Z., William S. Alverson, Gualberto Torrico P.

Conservation targets: (1) Old-growth forest on terra firme; (2) all successional stages and habitats of major and minor floodplains; (3) Brazil-nut and rubber trees, and other species with fruits edible to birds, humans, and other primates.

METHODS

Flora Sampling

Collections: We made ad hoc collections of flowering and fruiting plants along existing trail systems, using 12 m pruning poles and occasional tree climbers, with emphasis on plants not immediately known to species. We also took vouchers (mostly leaf collections of adults or juveniles) along transects. We collected 314 species on this trip; another 17 species were added from earlier collections by Leila Porter. Duplicates of the specimens are deposited in the Herbario Nacional de Bolivia (LPB, La Paz), The Field Museum (F, Chicago), and the Universidad Amazónica de Pando (UAP, Cobija) under the collection numbers of Narel Paniagua Z.

Photographs: We photographed species likely to be identified by the picture alone, as well as those that could be used for creating color guides to the species of the area. We took approximately 400 photos of 300 species.

Species notes: In the field and during overflights, we noted easily recognizable species or species not accessible for collection or photograph.

Vegetation Sampling

Transects: We used variable transects (Foster et al. ms.) to sample composition and relative abundance of different classes of plants. Variable transects provide a quick, quantitative description that supplements anecdotal description of the vegetation. These transects are not standardized to a specific area or width; rather, they sample the number of individual plants that can be inventoried in the limited time available to a rapid field survey team. With large enough samples, these variable transects allow accurate comparisons of diversity between study sites (Condit et al. 1998). They are not specifically designed to be revisited for future monitoring, but they are suited ideally for very rapid inventories (such as our seven days of fieldwork in five different sites during this trip) or for inventories of very large areas. For emergent trees (>60 cm DBH/DAP) and canopy trees (>30 cm DBH) we checked all the individuals encountered along 20 m-wide strips. For medium-sized, subcanopy trees (10-30 cm DBH), we used 5 m-wide strips; for shrubs (<10 cm DBH), we used 1 m-wide strips; and for herbs, we used 1 x 5 m segments, with each species represented only once per segment (in recognition of cloning by most herbaceous forest plants).

Data from these transects are summarized here. At San Sebastián, we sampled 248 individual plants in two transects. One transect had 20 canopy trees (>30 cm DBH), 20 medium trees (10-30 cm DBH), 20 shrubs (1-10 cm DBH, including juvenile trees), and 43 herbs in 20 5 m segments. The second transect included 25 emergent trees (>60 cm DBH) and 120 shrubs in 6 segments over the same distance. Because of our limited time, we sampled only emergent trees and shrubs in the other sites, given the importance of the former and the ease of sampling of the latter. At Pingo de Oro, we sampled 385 individuals in two transects, totaling 207 emergent trees and 178 shrubs in 7 segments over approximately the same distance. Likewise, at Palmera we sampled 140 individuals in a single transect of 40 emergent trees, and 100 shrubs in 5 segments over the same distance.

Vegetation Notes: We took anecdotal observations during overflights and in the field, focusing on (1) differences in species composition between hills and ravines, canopy and understory, and young and old-growth forests; (2) frequency of open versus closed canopy; (3) patchiness of targeted species; and (4) forest dynamics, including regeneration from windthrow, landslide, fire, and clearings for small-scale agricultural plots.

FLORISTIC RICHNESS, COMPOSITION, AND DOMINANCE

General

We provide descriptions of the upland (terra firme) and floodplain (llanura del río) habitats above, in the Overview of Results section.

Our sample of the flora of the proposed Tahuamanu Ecological Reserve is biased in favor of freestanding woody plants. We recorded 615 different plant species in 97 families in the area during the seven days of this rapid survey (Appendix 1). An estimated 50 of these species never before have been registered in Bolivia. We estimate that the vascular plant flora of the proposed Tahuamanu Ecological Reserve is probably in the vicinity of 2,000 species. In sum, 296 species are in botanical collections (46 from San Sebastián, 188 from Pingo de Oro, and 62 from the floodplains in Rutina and Palmera); 249 species were represented by the 774 individuals sampled in transects; 150 species were sampled only by photograph; and 134 species were registered only from notes.

In the 615 species we recorded for the area, 5 of the families stand out: Fabaceae (with 71 species), Moraceae (47), Rubiaceae (27), Arecaceae (26), and Euphorbiaceae (24). The genera with most species represented are *Ficus* (24), *Inga* (17), *Piper* (13), and *Pouteria* (11). The species with the greatest number of individuals are almost inevitably those of small stature and occurring at high densities, such as *Rinorea*, *Siparuna*, and *Geonoma*, but by far the most abundant plant is the common *Adiantum* fern, which occurs on almost every square meter of mature forest in the terra firme. This *Adiantum* might be a candidate for the species with the largest, essentially contiguous population in tropical forests of the world.

The diversity of plant species in the area is high, particularly for emergent trees (>60 cm DBH) in the terra firme. The diversity is probably typical of most of the Amazon Basin, and, as expected, is not as high as in the moister areas closer to the Andes.

In small samples of the same size on the upper slopes at San Sebastián, the emergent trees (18 species in a sample of 20 individuals) and shrubs (16 species per 20 individuals) appear to be more diverse than the canopy-level trees (14 species per 20) and medium understory trees (15 species per 20). The lowest diversity appears to be in the herbaceous plants. However, herbaceous plants were, from observation, much more diverse and abundant in the moist areas near stream bottoms, which were not sampled.

In the terra firme of Pingo de Oro, the sample of emergent trees (76 species per 207 individuals) are less diverse than the shrubs (77 species per 178), probably because sampling in all habitats – valley bottoms as well as hilltops – increases the number of small species that are more concentrated in the moister areas. In the high, older floodplain of Palmera, both the sample of emergent trees (23 species per 40 individuals) and the sample of shrubs (30 species per 100) appear to be lower in diversity than in the terra firme.

Upland Forests (Terra Firme)

The differences between terra firme forest at San Sebastián and at Pingo de Oro seem so slight that we have combined the data of the two in our results and discussion. The flora of these unflooded areas is, in general, typical of rich soil. The presence of large numbers of Moraceae, especially *Ficus*, and the high density of lianas are characteristic, as are the conspicuously low densities of Chrysobalanaceae and *Protium* trees, Melastomataceae shrubs, *Monotagma* herbs, etc.

The floristic composition is somewhat different between the high ridges and slopes but not dramatically so. The most conspicuous difference of the vegetation covering the ridges and hilltops is the greater abundance of *Tetragastris altissima* and *Celtis schippii* in the canopy, and greater density of *Geonoma* palms and *Piper* spp. in the shrub layer. Species diversity is greater in the valley bottoms, especially those surrounded by steep ridges. The ravines and lower slopes are much richer in epiphytes, ferns, and other monocotyledonous herbs such as Marantaceae, *Heliconia*, *Costus*, and *Renealmia*. This floristic composition is typical of all but the wettest areas of Amazonia because the juveniles of many species cannot survive the periodic severe droughts on the ridgetops. Epiphytes are relatively scarce, both in the canopy (bromeliads and orchids) and on tree trunks (aroids and ferns), though they are somewhat more common in the ravines. This scarcity indicates that sparse condensation overnight and long periods of low humidity exacerbate the effects of soil desiccation during dry spells.

The composition of the flora and the high productivity in the vegetation are unusual for terra firme. Productivity is surely not as high as on well-drained floodplain soils but is probably orders of magnitude higher than on the widespread acidic, sandy soils on the north side of the Amazon. The clay here is relatively rich in nutrients and the sandiness of the soil provides a much better structure (for root aeration and penetrability) than the deep, pure clays of terra firme.

We sampled 232 emergent trees in the terra firme transects, representing 86 species. Of these, rubber (*Hevea brasiliensis*, with 24 individuals) was by far the most abundant, but only because of sampling bias: several of the trails we used as transects were trails used by the rubber tappers collecting the latex. *Hevea* is nevertheless very abundant, especially on the lower hills; it certainly ranks in the top 10 most abundant trees in the area. Excluding this species, the most abundant emergents are *Brosimum alicastrum*, arbol de vaca (14 individuals); *Ceiba* [*Chorisia*] *insignis*, toboroche (14); *Pterygota amazonica* (13); *Tachigali vasquezii*, palo santo (11); *Bertholletia excelsa*, castaña (10); *Dipteryx micrantha*, almendrillo (7); *Clarisia racemosa*, murure (7); *Tetragastris altissima*, isigo colorado (6); *Apuleia leiocarpa*, almendrillo amarillo (5); and *Alseis* cf. *peruviana*, gabetillo blanco (5).

Most striking is that throughout the Amazon basin, 7 of these 11 most common emergent trees are more characteristic of floodplain forests than they are of terra firme. The presence of a few enormous individuals of *Ficus insipida* on top of the hills also was surprising, given that it is usually the first high-canopy tree in the river meander succession of the floodplain (see History of Human Use, below).

Another surprise was the abundance of *Pterygota amazonica*, a species with only one specimen in the Bolivian National Herbarium and with no common name in the *Arboles de Bolivia* (Killeen et al. 1993). The abundance of the monocarpic *Tachigali vasquezii* (which flowers once, then dies) and the presence of four other *Tachigali* species suggest that these trees will continue to play an important role in the dynamics of these forests. *Tachigali* trees appear to be one of the key species in disrupting continuous-canopy forests: the trees usually die at a younger age than their surrounding canopy and emergent cohorts of similar size, and the resulting gaps initiate a domino effect over many years, contributing to the erosion of continuous canopy. *Tachigali* do not tend to accumulate many lianas because of their fast growth, and the gaps they form are usually “clean” of dense vine tangles. Recently dead *Tachigali* accounted for many of the recent treefalls

along the trails that we walked.

We sampled 318 shrubs, representing 122 species, in all terra firme transects combined. Of these, *Rinorea* "lf"* (with 38 individuals) and *Geonoma deversa* (29) were by far the most abundant, followed by *Siparuna cervicornis* (13), *Siparuna decipiens* (12), and "rutac longlf"* (12). Almost all of the shrubs and juvenile trees sampled were species characteristic of terra firme, not floodplain. Approximately 44% of the individuals in these samples were juveniles of medium and large trees, not shrubs per se. This result is not unusual. The true shrubs accounted for more than 168 individuals, representing more than 45 species.

The frequency of patches of explosively dispersed species in the shrub layer is typical of almost all terra firme in the Amazon Basin. These are mainly species in the following groups: Violaceae, e.g., *Rinorea*; all lowland genera of Rutaceae, except *Zanthoxylum*; Euphorbiaceae, e.g., *Acalypha*, *Aparisthmium*, *Croton*, *Mabea*, and *Pausandra*; and Annonaceae, e.g., *Anaxagorea*. In particular, patches of Rutaceae and Violaceae can be extremely dense and crowd out other species, significantly lowering the understory diversity of areas from 10 m to hundreds of meters in diameter.

Phenakospermum, the giant (10 m) banana/bird of paradise relative, occurs in dense understory clumps all over but is most frequent on the slopes rather than the hilltops or ravine bottoms. The 15 m-tall bamboo *Guadua* cf. *weberbaueri* occurs in dense but less frequent clumps. The bamboo clumps are much more abundant in the areas of recent second growth. Our overflights in Bolivia and in Peru indicated that the bamboo understory is much more frequent to the west and north, in Peru and in Brazil.

Floodplain Forests (Llanura del Río)

The Tahuamanu floodplain was sampled along a single transect, on the new road from Rutina to Palmera. The floodplain's species composition of trees, lianas, shrubs, and herbs is very similar to that of other white-water-river floodplains of the upper Amazon. Only in the extensive backwater swamps and sartenejales did we see aquatic species uncommon in or absent from most of the rich floodplains to the north and west.

In our very limited sample of 40 emergent trees from the high levees of the narrow Muyumanu floodplain, *Pouteria* "med" (6 individuals), *Hevea brasiliensis* (4), and *Gallesia integrifolia* (palo de ajo, 4 individuals) were common. More striking is that we also found 13 of these same 23 species of emergents (including *Bertholletia*) in the terra firme, even though they are species characteristic of the floodplain.

Of the 100 shrubs sampled in floodplain habitat, nearly half were *Rinorea lindeniana* (48 individuals); *Rinorea* "lf" (9) and *Bactris concinna* (5) were occasional. *Rinorea lindeniana* showed the strongest dominance by a single species in the region, other than the *Adiantum* in the terra firme herb layer and the several dominant species of young successional stages of the Tahuamanu floodplain.

WILD FRUIT RESOURCES

Many of the forest animals depend on fruit directly, or indirectly, by feeding on frugivores. We found dramatic differences in the kinds of fruit and seeds produced at different heights in the forest. Most of the emergent trees (84%) produce seeds that are dispersed by wind or by mammals. Among the shrubs, most disperse seeds explosively or via birds. Among the subcanopy and midstory trees, the large majority (more than 90%) disperse seeds through mammals or birds. This pattern, which seems common in the Amazon Basin, is much less pronounced in the wetter, less seasonal areas.

* These names represent morphospecies that as of the date of this report have not been identified fully to species (e.g., *Rinorea* "lf") or genus (e.g., "rutac longlf"). Current identifications for specimens collected on rapid biological inventories will be posted periodically to our Web pages at www.fieldmuseum.org/rbi.

A few conspicuous exceptions we observed include, among the emergents, the giant *Hura crepitans*, which disperses explosively, and, among the shrubs, the *Piper* species, which are bat-dispersed, and the treeferns, the spores of which are wind-dispersed.

Successional forests on meanders of the Río Tahuamanu have species similar to those along river meanders in adjacent southeastern Peru. Canopy trees in these forests in Peru are wind- or bat-dispersed, with increasing amounts of bird fruits and mammal fruits in the understory as the forest ages (Foster et al. 1986).

Food is available for animals at all levels in the forest, at least some of the year. But nearly 40% of the emergents are wind-dispersed, as are nearly all the canopy lianas. These species provide food only for animals that destroy the seeds and that can tolerate the toxins associated with them. Seeds of 30% of the shrubs disperse explosively and rarely are consumed by birds or mammals. Although the midstory has the highest concentration of species with animal-dispersed seeds, the higher production of fruit from the larger crowns of the emergents and canopy trees probably make that the primary layer for fruit consumption in large quantities. The tremendously abundant figs (at least 24 species of *Ficus* recorded) and other large Moraceae (at least 10 species) are a primary source of food for animals in the terra firme forests. The abundant palms (Arecaceae, 26 species recorded) also are a major source of food in these forests. The importance of the stratification to various animals depends to a large extent on the seasonal availability of the fruit.

HISTORY OF HUMAN USE

The most conspicuous feature of the vegetation is the predominance of the giant floodplain trees all over the terra firme. Second is the frequency of species of high potential value to indigenous communities.

Giant floodplain trees – starting with *Ficus insipida* and *Cedrela odorata* (representing the fourth stage of ecological succession) and continuing with *Ceiba pentandra*, *Luehea cymulosa*, *Dipteryx micrantha*, *Apuleia leiocarpa*, *Hura crepitans*, *Clarisia racemosa*, *Brosimum alicastrum*, *Manilkara inundata*, *Pterygota amazonica*, etc. (of the fifth stage of succession) – normally get their start on the levees formed from the beaches on river meanders, under the thin shade and weak root development of the earliest successional species. Clearing and burning on the terra firme by humans also create such conditions. Studies in Panama (Foster and Brokaw 1982) and Peru (Foster et al. 1986) indicate that many floodplain species identical or closely related to those of the Tahuamanu thrive as emergents on the terra firme even 500 years after human clearing. Our findings in the Tahuamanu area, where the emergent trees are approximately the same size as those in Panama, strongly support the idea that the terra firme is a first-generation forest, growing back from what must have been considerable, patchy human clearing until shortly after the European colonization.

The composition of the emergent trees is very reminiscent of the forests around the Maya ruins of the Petén in Guatemala, which are considered forests of economic plants. The dominant tree in the Petén, *Brosimum alicastrum*, is also apparently the most abundant large tree in the Tahuamanu area. Although a different subspecies, the *Brosimum* in the Petén is considered a cornucopia plant, i.e., the fresh leaves can be fed directly to domestic animals, the milky latex is palatable, the fresh fruits are sweet and edible, and the seeds when roasted are as delicious as cashews. Other trees concentrated in the Petén forests provide latex and wood of high quality, oils, spices, and edible fruits.

Although all tropical forests have a spectrum of species that are useful to indigenous people, the Petén forests seem to have undergone human selection and management to promote the most useful species. The forests of Pando seem similar. The importance of abundant trees such as *Pterygota* and *Apuleia* is not immediately obvious, although we cannot rule out possible uses as important medicines, resins, or fish poisons (e.g., *Hura*). The extreme rarity of juveniles of such an abundant tree as *Bertholletia* suggests that it may have been planted or otherwise promoted by humans hundreds of years ago. Alternatively, the current rarity of juvenile *Bertholletia* could be explained by overharvest

of seeds in recent decades (or centuries), or by other phenomena antagonistic to reproduction, or to some combination of these mechanisms. When combined with animal resources from the forest and rivers, as well as small shifting food plots with maize and manioc, this terra firme forest seems to have been an excellent place – in terms of food production – to support relatively large indigenous populations.

The arrival of Fitzcarraldo and the rubber boom more than a century ago probably brought the next big disturbance to the area. We do not know whether the intense rubber tapping during this period had any major effect on the forest, or whether hunting by rubber tappers then was any more intense than it is now. Nor do we know the extent of Brazil-nut gathering before the current export industry developed.

The area between the Ríos Muyumanu and Tahuamanu has patches of secondary forest of various ages, but most appear to be less than 30 years old and the result of small-scale agriculture associated with the recent camps of the Brazil-nut gatherers and rubber tappers. This continuing practice probably has the effect of maintaining more species in the area than would have been there prior to the arrival of human settlements.

In the terra firme forest near San Sebastián, we saw only very recent patches of secondary vegetation. The apparently more homogeneous mosaic of forest ages at this site, compared to that at Pingo de Oro, likely affects animal populations. This forest has suffered some logging of *Swietenia*, *Cedrela*, and *Amburana*; however, the logging was apparently not very thorough, since we encountered on our transects individuals of the latter two species with diameters greater than 60 cm.

The near absence of *Cedrela odorata* along the river-meander succession suggests that this species already has been thoroughly logged from the Tahuamanu floodplain. Terra firme in the Pingo de Oro area apparently has not been logged. We encountered one large-diameter mahogany (*Swietenia*) with a very short bole and another average-sized individual. Several other individuals, which at first appeared to be *Swietenia*, later proved to be *Cabralea canjerana* (cedro macho). *Cabralea* produces timber of lesser value. Given the area that we covered on trails, the density of *Swietenia* seems low compared to the other forestry-concession areas of lowland Bolivia (e.g., in Santa Cruz, Beni, and northern La Paz). The density of cedro appears to be average or even high for terra firme, apparently because of the presence of the floodplain species, *Cedrela odorata*, along with the normal terra firme species, *Cedrela fissilis*.

The most recent disturbance in the region has been in the last year (1999), with the cutting of timber inventory lines north of the Río Muyumanu. More than 2% of the forest understory already has been chopped down during this recent inventory process.

REPTILES AND AMPHIBIANS

Participants/Authors: John E. Cadle and Steffen Reichle

Conservation targets: Reptile and amphibian communities of southwestern Amazonia.

METHODS

Because of the short duration of sampling at each site, we used only transect sampling for amphibians and reptiles; we did not attempt to use any trapping methods. We noted species occurrences based on visual encounters, voice recognition for frogs (some calls were tape-recorded for later verification), and specimen collection. We sampled old-growth forests on upland terraces, seasonally flooded and floodplain forests, secondary forests and clearings, riparian forests and river edge, rivers, and swamps. We used the following types of transects: (1) trails through old-growth and secondary forests; (2) stream edges; and (3) rivers (visually sampled by boat). We targeted specific habitats where particular species were likely to occur. These included swamps, small forest streams, and lake and river edges where aquatic species or breeding frogs tend to aggregate.

We sampled transects by walking slowly and attentively, surveying most habitats both by day and at night. We did not attempt a quantitative assessment of species abundance because we were sampling during a very dry spell at the end of the dry season (see comments below). Our results are only a *qualitative* indication of the composition of species in the communities of amphibians and reptiles in the region.

Our sampling events, from 16 to 24 October 1999, included 12 morning transects, 11 afternoon transects, 11 night transects, and 2 river transects. Each transect consisted of 2 to 3 person-hours. The survey at San Sebastián took place from 16 to 18 October and included 4 morning, 3 afternoon, and 6 night transects. The survey at Pingo de Oro occurred from 20 to 23 October and included 8 morning, 8 afternoon, and 5 night transects.

RESULTS OF THE HERPETOLOGICAL SURVEY

We recorded 7 species of snakes, 11 species of lizards, 32 species of frogs, 3 species of crocodilians, and 2 species of turtles (not including those recorded from a previous collection from the vicinity of Cobija; see below). We collected 3 snakes, 4 lizards, and 37 frogs, which are deposited in the Colección Boliviana Nacional de Fauna, in La Paz, under the collection numbers of S. Reichle.

In Tahuamanu we found that the composition of the species assemblage of amphibians and reptiles (Appendix 2) was similar to that of several other, well-known sites in southwestern Amazonia, particularly in southern Peru (e.g., Cuzco Amazónico, Tambopata Reserve, and lowland Manu National Park, all in Madre de Dios Department, Peru). However, in Bolivia this fauna probably is found only in parts of Pando and La Paz Departments north and west of the Río Beni. Because few herpetofaunal collections have been made in this part of Bolivia, we are as yet unsure if this assemblage extends through a broader area of these two departments or has a more restricted distribution in the region. This similarity between our Pando collections and others from southern Peru is substantiated by a small collection of reptiles (examined by J. Cadle) from the immediate vicinity of Cobija, which had been assembled by Oscar Teran, a student at the Universidad Amazónica de Pando (Appendix 2B). This Cobija collection again shows a strong regional relationship to other sites in southwestern Amazonia. One species in particular, the anguid lizard *Diploglossus fasciatus*, of which we had only a sight record, has a known distribution that encompasses extreme southeastern Peru, adjacent parts of Bolivia, and part of the Río Mamoré drainage in adjacent Brazil.

The sampling period for this inventory (16-24 October) was not optimal for sampling the herpetofauna in this part of Amazonia. Our survey coincided with the late dry season, which is probably the least opportune time to obtain a representative sampling of amphibians and reptiles. Activity patterns of reptiles, and especially amphibians, are strongly tied to rainfall patterns; the dry season in this part of Bolivia normally lasts from approximately June to November (with some year-to-year variation). According to the primatology research group at San Sebastián, no steady rain of even short duration had fallen since the end of September. Rains for several weeks prior to this were sporadic and of low intensity. We encountered few breeding species of frogs in our survey, although we did hear several species calling (Appendix 2). Tadpoles were present only in a small pool within a tree hollow on the ground (probably a dendrobatid frog).

We discovered no new species or species endemic to this region. However, 6 of the frog species that we observed are new country records for Bolivia. These include *Eleutherodactylus* sp. 1 and sp. 2 (both of the *unistrigatus* group), *Epipedobates femoralis*, *E. trivittatus*, *Ischnocnema quixensis*, and *Phrynohyas resinifictrix*. All of these are common species of herpetofaunas of southern Peru. Their occurrence in Pando could be expected because most elements of this fauna probably are distributed at least to the Río Beni in Bolivia. However, the discovery of 6 species new to the Bolivian fauna (17% of the frog species we encountered), especially considering the poor conditions for herpetofaunal surveys, is significant. This discovery suggests that many more species new to the Bolivian herpetofauna probably remain to be registered in this area.

Our impression is that both *Caiman crocodylus*

and *Podocnemis unifilis* – species whose populations have been reduced in many areas – are now uncommon in parts of the Río Tahuamanu and Río Muyumanu: we saw only three *C. crocodylus* and five *P. unifilis* along these rivers during approximately four hours of river travel. However, aside from the 3 species that probably have suffered significant losses from subsistence hunting pressure (the 2 above, plus *Geochelone denticulata*), current impact on the region's herpetofauna seems low.

San Sebastián

We collected specimens of 3 lizards and 27 frogs at this site. Several of the species we recorded are new country records for Bolivia, including *Eleutherodactylus* sp. 1 and sp. 2 (*unistrigatus* group), *Epipedobates femoralis*, *E. trivittatus*, *Ischnocnema quixensis*, and *Phrynohyas resinifictrix*.

Pingo de Oro

We collected specimens of 2 snakes, 1 lizard, and 10 frogs at this site, including 4 of the 6 new country records for Bolivia first seen at San Sebastián.

THREATS AND RECOMMENDATIONS

The population status of locally exploited species should be ascertained more precisely. These include the turtles *Podocnemis unifilis* and *Geochelone denticulata* and the three species of crocodilians known from the area (*Caiman crocodylus*, *C. niger*, and *Paleosuchus trigonatus*). Surveys should include not only counts of individuals, but also estimates of the age structure (and, thus, of potential future reproduction and ability to recover from decline) of all populations.

We suspect that one of the locally exploited turtles, *Podocnemis unifilis*, has the *potential* for sustainable use as local food. A strong caveat is that present populations along the sections of the Río Tahuamanu and Río Muyumanu that we surveyed cannot withstand the pressure of harvesting, and we question whether the current level of exploitation is sustainable over the long term. After a thorough population study, we encourage the investigation of potential long-term, sustainable harvesting of eggs, adults, or both, using a population modeling approach. Any program of harvesting must be initiated only after present population levels are sufficient to sustain it. A pilot program should be conducted to field-test any results from modeling approaches. Of course, any sustainable harvest program depends on the population density of people to whom the fruits of harvest are being distributed. We strongly suspect that neither *Podocnemis* nor other species of reptiles in this region can sustain commercialization of harvesting for export to major population centers, such as Cobija. Any harvesting program must have in place strict controls. We suspect that the other locally exploited turtle, *Geochelone denticulata*, cannot be harvested sustainably. Its reproductive potential is very low, and population densities are unlikely to reach sustainable levels, even with mild exploitation.

In sum, the forests we surveyed in the area of the proposed Tahuamanu Ecological Reserve are still relatively undisturbed and probably harbor intact assemblages of reptiles and amphibians. This fauna is probably restricted to parts of Pando and La Paz Departments in Bolivia, and extends north into southern Peru.

BIRDS

Participants/Authors: Thomas S. Schulenberg, Carmen Quiroga O., Lois Jammes, and Debra Moskovits

Conservation targets: Bird communities of southwestern Amazonia, large raptors, gamebirds, bamboo specialists, range-restricted species.

METHODS

The basic protocol for the survey involved walking trails through the forest to locate and identify bird species. Each observer was in the field from first light (or very shortly thereafter). Observers did not always return to the camp for lunch because some of the trail systems at this site were very long; those who did were in the field again from early to midafternoon until dusk. We made an effort to survey all habitats in the area. Each ornithologist walked the trails separately from the other observers and walked different trails on different days. T. Schulenberg, C. Quiroga, and L. Jammes carried portable cassette tape recorders and directional microphones to record the songs and calls of bird species encountered. We did not conduct transects or point counts, but Schulenberg daily tallied the number of individuals he observed for each bird species, to aid in the assessment of relative abundances.

RESULTS OF THE BIRD SURVEY

We recorded 319 bird species throughout the region (exclusive of Cobija, Appendix 3). At the two sites most intensively surveyed, San Sebastián and Pingo de Oro, we recorded 163 and 192 species, respectively. These lists include not only forest bird species, but also species associated primarily with large clearings or the borders of forest. Consequently, the forest bird community (including species associated with treefalls, stream edges, and other small, natural clearings) recorded at San Sebastián and Pingo de Oro were 151 and 182 species, respectively, equivalent to 93% and 95% of the bird species recorded. Similarly, the total number of species recorded during the survey includes not only species of large clearings or pastures but also species primarily associated with rivers, oxbow lakes (cochas), and other habitats. Overall, about 254 species, equivalent to 80% of the total, were associated primarily with forests (of all types).

The bird fauna at Pingo de Oro was more intact and notably richer than the one at San Sebastián, with 15-20% more bird species encountered with equivalent sampling effort. Of the dominant families of birds in the forest (the suboscines), Pingo de Oro again showed higher species diversity, e.g., Furnariidae (7 species recorded at San Sebastián versus 12 at Pingo de Oro), Thamnophilidae and Formicariidae (24 versus 28), and Tyrannidae (24 versus 28). Also, the populations of some species present at both sites clearly were greater at Pingo de Oro. We rarely heard a *Columba* at San Sebastián, whereas we heard both species of forest *Columba* commonly throughout the Pingo de Oro area.

Perhaps the single most notable bird species recorded during the survey was *Harpia harpyja*. We made two separate sightings of this huge raptor, one at Pingo de Oro and the other along the logging road south of Rutina. This low-density species requires a large home range, as well as ample populations of monkeys and other large arboreal mammals for food; its presence indicates a forest with excellent conservation potential. A feather we found in Pingo de Oro probably came from *Leucopternis kuhli*, another raptor with a low population density, but we did not directly observe this species.

Myrmotherula iheringi was a common member of the understory, *Thamnomanes*-dominated mixed-species flocks at Pingo de Oro. Ours appears to be the first record for this species in Bolivia. At Rutina (on both banks of the Río Tahuamanu), we recorded *Formicarius rufifrons*, a species previously known in Bolivia only from a single record from the Río Nareuda. This species otherwise is known only from Madre de Dios, Peru, and had been considered globally threatened because of its extremely restricted distribution. A singing *Nonnula sclateri*, at the edge of the San Sebastián clearing, was another unusual record. This species is known from no more than 10 localities in a restricted area between the upper Purus and Madre de Dios Rivers in southeastern Peru (Ucayali and Madre de Dios), northern Bolivia (Pando), and southwestern Brazil (Acre). The only *Nonnula* recorded on the south bank of the Río Tahuamanu was the widespread species *N. ruficapilla*, which we found at Pingo de Oro and at Palmera. We found another species with a distribution very similar to that of *Nonnula sclateri* – the small flycatcher *Lophotriccus eulophotes* – in bamboo at San Sebastián, at forest edge and near treefalls at Pingo de Oro, and at forest edge near Rutina. We are not aware of any records for either of these two range-restricted species from any protected area, although both may tolerate forest with a fair amount of disturbance.

The bamboo at San Sebastián contained

several of the species expected in this microhabitat: *Simoxenops ucayalae*, *Drymophila devillei*, *Ramphotrigon fuscicauda*, *Ramphotrigon megacephala*, and *Hemitriccus flammulatus*. The bamboo at Palmera had most of these species, along with several others also commonly associated with bamboo: *Cymbilaimus sanctaemariae*, *Percnostola lophotes*, and *Myrmeciza goeldii*.

Penelope, a large gamebird, occurred both at San Sebastián and at Pingo de Oro, even very near human settlements. No macaws were seen at San Sebastián, and only a few at Pingo de Oro.

Based on this rapid survey, the region contains a rich Amazonian avifauna, with examples of species that indicate relatively low levels of human disturbance (e.g., *Harpia harpyja*) or that are range-restricted and potentially threatened (e.g., *Nonnula sclateri*, *Formicarius rufifrons*, *Lophotriccus eulophotes*). The forests surveyed revealed a good representation of the forest bird community of Pando, which is typical of southwestern Amazonia.

San Sebastián

We arrived in the early afternoon on 16 October, with time only for incidental observations on that date. We were in the field all of 17-18 October and left early on 18 October, with about an hour at Casa Callimico on that date. Schulenberg also spent about 1.5 hours on the trail from Casa Callimico to San Sebastián on the morning of 25 October.

We recorded 163 bird species during the survey at San Sebastián. Of these, about 12 species are associated primarily with large clearings or the borders of forest. We registered 151 species of forest birds (including species associated with treefalls, stream edges, and other small, natural clearings).

Penelope was present in the forest. Large parrots, especially macaws, were very few. Large pigeons (*Columba*) were scarce (or not vocal), with only one or two detections per day. The number of mixed-species flocks (both of the understory and the canopy) was low. In general, the species diversity of the site seemed low for an Amazonian forest. Of the ovenbirds (Furnariidae), one of the dominant bird families in Amazonia, we found only 7 species. The foliage-gleaners (*Philydor*, *Automolus*) were especially scarce, with only a few of the expected species present and apparently none common. Several species of antbirds expected (e.g., *Thamnophilus aethiops*) also were absent. Although we had very few observations of army ants (*Eciton*) at this site, we found two species of regular army-ant followers (*Gymnopithys salvini* and *Rhegmatorhina melanosticta*). The bamboo contained several of the species expected in this microhabitat, such as *Simoxenops ucayalae*, *Drymophila devillei*, *Hemitriccus flammulatus*, *Ramphotrigon fuscicauda*, and *R. megacephala*.

Although the bird community at San Sebastián seemed depauperate relative to those at other sites in southwestern Amazonia, we detected some notable species, including *Nonnula sclateri* and *Lophotriccus eulophotes*.

Pingo de Oro

We arrived at midday on 20 October, with a few hours in the afternoon to begin making observations. We were in the field all of 21-22 October. Quiroga and Jammes remained for all of 23 October as well. Schulenberg and Moskovits were present only for the morning of that day.

We registered 192 bird species during the survey at Pingo de Oro. Of these, about 10 species are associated primarily with large clearings or borders of forest, so the assemblage of forest birds (including species associated with treefalls, stream edges, and other small, natural clearings) was 182 species.

Penelope was present in the forest, even near the rubber tappers' house at Pingo de Oro. A few macaws were present, but the populations of these birds seemed very low. In contrast to San Sebastián, large pigeons (*Columba*) were common and vocal throughout the forest. As expected, among the most diverse families were the suboscines, such as the ovenbirds (Furnariidae: 12 species), antbirds (Thamnophilidae and Formicariidae: 28 species), and tyrant flycatchers (28 species). In contrast to San Sebastián, we regularly saw army ants (*Eciton*) at this site but have no records of any species of regular army-ant-following birds.

We found several areas of bamboo near the Río Muyumanu at Palmera and along the trail between Palmera and Pingo de Oro. The avifauna in the bamboo was somewhat richer than in the same habitat at San Sebastián, containing all of the "bamboo specialist" species found there, as well as additional species such as *Cymbilaimus sanctaemariae* and *Percnostola lophotes*.

The species richness at Pingo de Oro is high, but lower than the richest sites in southwestern Amazonia, such as Cocha Cashu, or along the Río Tambopata (both in Peru). It is probably comparable to that of forests along the Ríos Palma Real and Heath (Peru), or elsewhere in Pando.

THREATS AND RECOMMENDATIONS

We did not record all species present at the site; a more comprehensive survey of the avifauna would be valuable. However, we know that the bird community at San Sebastián is less diverse than that at Pingo de Oro. We know, as well, that the forest at San Sebastián has been logged in the last decade. Given the extensive scale of logging that is expected to occur throughout Pando, the effects of this activity on the fauna must be researched. We cannot confirm that the differences in the bird community structure between San Sebastián and Pingo de Oro are due to the effects of logging, because no avifaunal inventories existed before logging took place. To measure the possible impacts of past logging and to establish a baseline, we recommend a comprehensive bird survey as soon as possible. A monitoring program for bird populations could then document changes in the bird community as the forest regenerates. With so little information about birds in Pando, the forest at Pingo de Oro offers an excellent opportunity for a more complete inventory of the avifauna of the region.

Future studies also should focus on the impact of subsistence hunting on the populations of gamebirds, like *Penelope*, to determine sustainable levels. Research on the impact of the pet trade and hunting on the parrot population will suggest adequate management measures.

PRIMATES

Participants/Authors: Sandra Suárez, Amy Hanson,

Vincent Sodaro, Stephanie Dammermann, and Leeann Haggerty

Conservation targets: All nonhuman primate species, but primarily the IUCN Red List vulnerable species (*Callimico goeldii* [also CITES Appendix I] and *Lagothrix lagothricha* [critically endangered if not locally extirpated]), and *Alouatta sara* (endemic to Bolivia).

METHODS

Extensive research on several primate species has been conducted at San Sebastián for more than two years, through the combined efforts of the team members listed above, Edilio Nacimento, and Leila Porter. Although our general knowledge of the primate species at the San Sebastián field site is enough to estimate primate densities, we spent two days conducting formal transect surveys at the site, both to confirm our impressions and to collect data for comparisons with our surveys at Pingo de Oro. At both locations, we walked singly along established trails, at a rate of approximately 1 km/hr, and recorded all primate groups seen or heard. We conducted formal transect surveys between 0630 and 1030, and between 1400 and 1700. We also noted primates that we, or other members of the rapid survey team, saw or heard at other times of the day. Each team member selected a trail that transected an area not likely to overlap with that of other surveyors; the group sampled five trails simultaneously. At Pingo de Oro we surveyed each trail twice daily for three consecutive days. During surveys we recorded the following data for each primate group seen or heard: (1) time; (2) location of observer along the transect when the group was detected; (3) species, and number of individuals in the group; (4) distance from the observer to the center of the group; (5) angle from the center of the group to the transect line; (6) height of the group in the canopy; (7) diameter of the group when detected; (8) activity of the group at first sighting; (9) forest type; (10) substrate type; and (11) mode of detection.

We divided the number of groups of each species detected (by sight or sound) during formal transect walks by the number of person-hours (see chart, below) for each site surveyed. We also assigned relative abundance categories (abundant, common, uncommon, rare) for each species at the two sites. We derived relative abundance categories from formal and informal species encounters, our personal knowledge of the primate communities, and interviews with local people. We assigned the categories primarily by relative frequency of encounters among species at the same site, and secondarily by frequency of encounters of the same species at different sites.

Between 17 and 23 October 1999 we sampled old-growth forest (see Flora and Vegetation, above), secondary forest, recent secondary forest (with *Cecropia* or successional growth of bamboo), and forest along stream edges. Of 133 hours of observation, we devoted 38 to the surveys at San Sebastián (ca. 200 ha, 17-18 October) and 95 to the surveys at Pingo de Oro (ca. 150 ha, 21-23 October). During a study of other mammals in the area, L. Porter and E. Nacimento walked portions of logging roads between Rutina and Palmera from midmorning to midafternoon on 24 October 1999 and recorded the species of primates observed.

RESULTS OF THE PRIMATE SURVEY

We detected 14 species of nonhuman primates in the two areas surveyed: 11 species at San Sebastián and 12 at Pingo de Oro. Twelve of the 14 species were observed definitively. One species, *Ateles chamek*, was not seen by our team but was determined to be in the area based on interviews with local residents. *Lagothrix lagothricha* was glimpsed only briefly, and its status in the area needs to be confirmed (see below). Our sighting of *Pithecia irrorata* at Pingo de Oro is the first documentation south of the Río Tahuamanu in Bolivia and may indicate a range extension. L. Porter and E. Nacimento also observed 6 species during their mammal survey along the logging road between Rutina and Palmera, including C*allicebus* cf. *brunneus*, *Cebuella pygamea*, *Cebus apella*, *Saguinus fuscicollis*, *Saguinus imperator*, and S*aimiri boliviensis*. Interviews with local people conducted in the 1970s indicate that C*allimico* occur south of the Río Tahuamanu (Izawa 1979). However, no actual sightings of the species in the region have been published, and our rapid survey found no evidence that *Callimico* occur in the vicinity of Pingo de Oro.

Below we list the species of primates recorded during this rapid inventory, numbers of groups encountered during our formal transect surveys, and supplementary information from local residents and our own experience (see Appendix 4 for common names).

The distribution of *Callicebus* spp. throughout South America is not yet clearly known, and more research is needed to determine which species occur in the region. Names follow Buchanan-Smith et al. (in press).

Species	San Sebastián: # groups seen per hour	San Sebastián: Informal obs. and interviews	Pingo de Oro: # groups seen per hour	Pingo de Oro: Informal obs. and interviews
Alouatta sara	0.026	—	0.095	heard frequently
Aotus nigriceps	0	seen, heard	0.01	seen, heard
Ateles chamek	0	—	0	sighted within last 6 months
Callicebus cf. *brunneus*	0.089	—	0.295	—
Callimico goeldii	0	seen	0	—
Cebuella pygmaea	0	seen	0	seen
Cebus albifrons	0	seen	0	seen
C. apella	0.026	—	0.053	—
Lagothrix lagothricha	0	—	0	possible sighting
Pithecia irrorata	0.079	—	0	seen
Saguinus fuscicollis	0.158	—	0.116	—
S. imperator	0	do not occur	0.021	—
S. labiatus	0.184	—	0	do not occur
Saimiri boliviensis	0.026	—	0.021	—

Below we list the species of primates encountered during this rapid survey, our estimates of relative abundance at each site, and notes on status.

Species	San Sebastián	Pingo de Oro	Special Status
Alouatta sara	rare	common	endemic to Bolivia
Aotus nigriceps	common	common	—
Ateles chamek	none	rare	locally endangered
Callicebus cf. *brunneus*	common	abundant	endemic to Bolivia
Callimico goeldii	uncommon	undocumented	vulnerable, edge of range
Cebuella pygmaea	uncommon	uncommon	edge of range, restricted to Pando in Bolivia
Cebus albifrons	uncommon	uncommon	—
C. apella	common	common	—
Lagothrix lagothricha	none	rare	locally critically endangered or extirpated
Pithecia irrorata	uncommon	rare	edge of range, likely restricted to Pando
Saguinus fuscicollis	abundant	common	edge of range
S. imperator	none	uncommon	edge of range
S. labiatus	abundant	none	edge of range, restricted to Pando in Bolivia
Saimiri boliviensis	uncommon	uncommon	—

The complement and relative abundance of primate species differ between the San Sebastián and Pingo de Oro sites, underscoring the importance of protecting sites on *both* sides of the Río Tahuamanu. The river itself acts as a natural barrier to the distribution of some primate species (*Saguinus imperator*, *S. labiatus*, and possibly *Callimico*). The more frequent occurrence of the larger primates (*Alouatta*, *Ateles*, and *Cebus apella*) at Pingo de Oro may result from less hunting pressure at that site than at San Sebastián. The higher densities of some of the smaller primates (*Saguinus fuscicollis*, *S. labiatus*, and *Callimico*) at San Sebastián likely reflects the ability of these species to thrive in younger, secondary forest habitats, which are more common at that site.

We had one possible sighting of *Lagothrix lagothricha*, the common woolly monkey, which has not been reported from Bolivia for as many as 50 years. The species had been considered extirpated from Bolivia by hunting and habitat disturbance. However, the sighting at Pingo de Oro suggests potential for recovery of the species with adequate conservation measures. Woolly monkeys are highly sensitive to habitat degradation, and protection of the old-growth forests will be critical for re-establishment of the species in Bolivia.

THREATS AND PRELIMINARY RECOMMENDATIONS

Wholesale conversion of forest to pasture is the most devastating threat to the primates in the region. Imminent logging poses an immediate threat to primates at Pingo de Oro. Subsistence hunting affects several species and is likely the cause for the near extirpation of *Lagothrix* as well as the low abundance of the other two large primates, *Ateles* and *Alouatta*. Another potential risk is the capturing of primates for the pet trade, although it does not yet pose a serious problem.

We recommend that widespread timber harvest, removal of forest canopy, and hunting of primates be excluded from the proposed Tahuamanu Ecological Reserve and its buffer zone. However, ecotourism and the sustainable extraction of nontimber forest products, such as Brazil nuts and natural rubber, are likely to be compatible with conservation of the primate populations.

OTHER LARGE MAMMALS

Participants/Authors: Leila Porter and Edilio Nacimento

Conservation targets: Mammals classified as CITES I (threatened with extinction) and CITES II (potentially endangered if no action is taken). CITES I animals include *Herpailurus yaguarundi*, *Leopardus pardalis*, *L. wiedii*, *Lontra longicaudis*, *Panthera onca*, *Priodontes maximus*, *Puma concolor*, and *Speothus venaticus*; the giant otter (*Pteroneura brasiliensis*) is also reported as present in the region. CITES II animals include *Myrmecophaga tridactyla*, *Tapirus terrestris*, *Tayassu pecari*, and *T. tajacu*. (Names follow Emmons 1997.)

METHODS

We used two methods to evaluate species richness at the sites sampled. One consisted of a long-term survey: we noted all mammals observed during the course of a two-year study on primates at San Sebastián (150-ha study area; October 1997-October 1999). We believe the list for San Sebastián (Appendix 5) portrays a full representation of the large mammals at the site. The second method was rapid: we surveyed Pingo de Oro, Palmera, and the Rutina-Palmera road between 20 and 24 October 1999. We searched during daytime and nighttime hours for mammals and mammal tracks along existing trails, riverbanks, and logging roads. We sampled old-growth forests, selectively logged forests, secondary forests adjacent to current and abandoned houses and their agricultural plots, and seasonally flooded forests along the Ríos Muyumanu and Tahuamanu. We paid particular attention to mud banks, where animals are known to eat soil, and to river edges and wet forests, where tracks were easier to distinguish and identify. We also recorded species from skulls and other hunting remains, and interviewed local residents better to estimate species composition at these sites.

RESULTS OF THE LARGE-MAMMAL SURVEY

We recorded 37 large nonprimate species of mammals in this area (Appendix 5). The giant otter (*Pteronura brasiliensis*), a species nearly extirpated in the region, was reported by one local resident interviewed. The identification of the green acouchi (*Myoprocta pratti*) is the first record for Bolivia; it occurs at high densities throughout the area. In addition, we observed one deer resembling *Mazama gouazoubira* (at San Sebastián), but with yellow and black lines below its eyes, which may represent a unique species or subspecies of Cervidae.

San Sebastián

We found 35 species of large mammals during the two years at the site (Appendix 5). Mammals such as tapir (*Tapirus terrestris*) that provide preferred meat appear to be at low densities. A disease epidemic in the 1970s, combined with hunting pressure, also may have eliminated white-lipped peccary (*Tayassu pecari*), a species historically present in the area. However, the area continues to maintain a high species richness of large mammals, including a number of carnivores. San Sebastián contains 8 of the CITES I species and the 4 CITES II species listed above as conservation targets.

Pingo de Oro

A skull found outside a rubber-tapper's home confirmed the presence of *Tayassu pecari* at Pingo de Oro. Although

we recorded only 14 species during our three-day survey (Appendix 5), interviews with local residents suggest that all of the megafauna observed in San Sebastián also occurs at this site. We found evidence of 3 large mammals classified as CITES I (*Leopardus pardalis*, *Priodontes maximus*, and *Puma concolor*) and 2 species classified as CITES II (*Tayassu pecari* and *T. tajacu*). The presence of *Tayassu pecari*, and the many tracks of *Tapirus terrestris*, indicate that the site is likely to have a greater abundance of large mammals than the forests to the north, near San Sebastián. This region has fewer human inhabitants and has undergone less hunting pressure and habitat destruction than has the area north of the Río Tahuamanu.

Palmera

We sampled old-growth and secondary forest habitats adjacent to Palmera (on foot), and riverine forest along the banks of the Río Muyumanu (by boat), on the afternoon of 23 October 1999. Species observed include *Agouti paca*, *Hydrochaeris hydrochaeris*, *Mazama americana*, and *Tapirus terrestris*. *Hydrochaeris* appears to be abundant along the Río Muyumanu. Large numbers of tracks along the banks of the Río Muyumanu suggest that this is an important area for the protection of *Tapirus terrestris*. *Pteronura brasiliensis* was thought extinct in this area because of hunting for fur (in the 1950s), but local residents reported that they had seen this species more recently along the Río Muyumanu.

Rutina-Palmera Logging Road

We walked portions of the recently opened logging road between Rutina and Palmera on 24 October 1999, from midmorning to midafternoon. We also walked sections of the older logging road. In addition to 6 species of primates (reported above), we identified 4 mammal species including *Agouti paca*, *Dasyprocta variegata*, *Mazama americana*, and *Priodontes maximus*. We also encountered tracks of one large mammal that need further investigation for identification.

THREATS AND PRELIMINARY RECOMMENDATIONS

Further research in the proposed Tahuamanu Ecological Reserve should include investigation and identification of the unknown mammal tracks discovered southwest of Rutina (above), as well as further study of the Cervidae in the area. Studies of the effects of hunting on populations of large mammals are critical for the development of appropriate management plans. Hunting regulations will have to be coordinated with local residents and seasonal workers (many enter during the season of Brazil-nut harvest) to protect threatened species, such as peccaries and tapirs, from overhunting. An inventory of small mammals also is lacking for the region.

LITERATURA CITADA/LITERATURE CITED

Buchanan-Smith, H. M., S. M. Hardie, C. Caceres, and M. J. Prescott. In press. Distribution and forest utilization of *Saguinus* and other primates of the Pando Department, northern Bolivia. International Journal of Primatology.

Condit, R., R. B. Foster, S. P. Hubbell, R. Sukumar, E. G. Leigh, N. Manokaran, S. Loo de Lao, J. V. LaFrankie, and P. S. Ashton. 1998. Assessing forest diversity on small plots: calibration using species-individual curves from 50 ha plots. Pp. 247-268 in F. Dallmeier and J. A. Comiskey (eds.), Forest Biodiversity Research, Monitoring and Modeling, MAB Series Volume 20. Paris: UNESCO.

Emmons, L. H. 1997. Neotropical Rainforest Mammals: a field guide. Second edition. Chicago: University of Chicago Press.

Foster, R. B. 1990. Long-term change in the successional forest community of the Río Manu floodplain. Pp. 565- 572 in A. H. Gentry (ed.), Four Neotropical Rain Forests. New Haven: Yale University Press.

Foster, R. B., J. Arce B., and T. Wachter. 1986. Dispersal and the sequential plant communities in Amazonian Peru floodplain. Pp. 357-370 in A. Estrada and T. H. Fleming (eds.), Frugivores and Seed Dispersal. Dordrecht, Netherlands: W. Junk Publishers.

Foster, R. B. and N. Brokaw. 1982. Structure and history of the vegetation of Barro Colorado Island. Pp. 67-81 in E. G. Leigh, A. S. Rand, and D. M. Windsor (eds.), The Ecology of a Tropical Forest. Washington, D.C.: Smithsonian Press.

Foster, R. B. and S. P. Hubbell. 1990. Floristic composition of the Barro Colorado forest. Pp. 85-98 in A. H. Gentry (ed.), Four Neotropical Rain Forests. New Haven: Yale University Press.

Izawa, K. 1979. Studies on peculiar distribution patterns of *Callimico*. Reports of New World Monkeys (1979): 1-19. Kyoto University Primate Research Institute.

Killeen, T. J., E. García E., and S. G. Beck. 1993. Guía de Arboles de Bolivia. La Paz and St. Louis: Herbario Nacional de Bolivia and the Missouri Botanical Garden.

Rojas G., J. A., L. M. Porter, and E. Nacimento B. 1998. Propuesta de creación y desarrollo de la Reserva Natural de Vida Silvestre Tahuamanu – Pando, Bolivia: fase de evaluacion. Unpublished 9 pp. document. Cobija: Carrera de Biología, Universidad Amazónica de Pando.