

Perú: Megantoni

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DICIEMBRE/DECEMBER 2004

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(CIMA-Cordillera Azul)

LOS INVENTARIOS BIOLÓGICOS RÁPIDOS SON PUBLICADOS POR/
RAPID BIOLOGICAL INVENTORIES REPORTS ARE PUBLISHED BY:

THE FIELD MUSEUM

Environmental and Conservation Programs
1400 South Lake Shore Drive
Chicago, Illinois 60605-2496 USA
T 312.665.7430, F 312.665.7433
www.fieldmuseum.org

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ISBN 0-914868-59-4

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necessarily reflect those of The Field Museum.

Esta publicación ha sido financiada en parte por la
Gordon and Betty Moore Foundation./This publication has been
funded in part by the Gordon and Betty Moore Foundation.

Cita Sugerida/Suggested Citation: C. Vriesendorp,
L. Rivera Chávez, D. Moskovits and Jennifer Shopland (eds.).
2004. Perú: Megantoni. Rapid Biological Inventories Report 15.
Chicago, Illinois: The Field Museum.

Créditos Fotográficos/Photography Credits

Carátula/Cover: Megantoni fue nombrado por el meganto
(Machiguenga para Guacamayo Militar, *Ara militaris*). Foto de
H. Plenge/Megantoni is named for the meganto (Machiguenga
for Military Macaw, *Ara militaris*). Photo by H. Plenge.

Carátula interior/Inner-cover: Megantoni protege una gran
diversidad de hábitats desde las húmedas selvas bajas (500 m)
hasta la puna (4000 m). Foto de H. Plenge./Megantoni safeguards
a great diversity of habitats from humid lowlands (500 m) to
high-altitude grasslands (4000 m). Photo by H. Plenge.

Láminas a color/Color plates: Figs. 3C, 3K, 8A-H, M. Hidalgo;
Figs. 3D, 3F, 6B, 6P, C. Vriesendorp; Figs. 3E, 6F, 7A-C, 9E,
10A-B, 11A-C, 11E-F, 12A, H. Plenge; Figs. 3G-J, 4A-H, 5A-M,
6G-O, 6U, 6Y-DD, 6FF-GG, 6II, 6NN-VV, 12E, R. Foster;
Figs. 6A, 6E, 6Q-T, 6V-X, 6EE, 6HH-KK, 6MM, N. Salinas;
Figs. 6C, 9A-B, 9F-G, 11D, 13, G. Knell; Fig. 6D, J. Figueroa;
Figs. 9C, 9H, L. Rodríguez; Fig. 9D, A. Catenazzi;
Figs. 10C-E, D. Lane; Figs. 12B-D, L. Rivera



Impreso sobre papel reciclado./Printed on recycled paper.

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Machiguenga Communities

Matoriato
Timpía
Shivankoreni

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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. Another branch, the Center for Cultural Understanding and Change, works closely with ECP to ensure that local communities are involved in conservation in positive ways that build on their existing strengths. With losses of natural diversity accelerating worldwide, 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.

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Centro para el Desarrollo del Indígena Amazónico (CEDIA)

CEDIA is a non-governmental organization that has supported Amazonian indigenous peoples for more than 20 years, principally through land titling, seeking legal rights for indigenous groups, and community-based resource management. They have titled more than 350 indigenous communities, legally protecting almost four million ha for 11,500 indigenous families. With an integral vision of long-term territorial and resource management, CEDIA supports organizational strengthening of indigenous groups seeking to defend their territories and effectively manage their natural resources and biodiversity. They work with several indigenous groups including Machiguenga, Yine Yami, Ashaninka, Kakinte, Nanti, Nahua, Harakmbut, Urarina, Iquito, and Matsés in the Alto and Bajo Urubamba, Apurímac, Alto Madre de Dios, Chambira, Nanay, Gálvez and Yaquerana watersheds.

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Founded in 1936, Herbario Vargas protects and maintains plant collections from throughout the region, serving as the botanical reference for national and international researchers working in and around Cusco. The more than 150,000 collections, along with an extensive and specialized library, play an invaluable role in floristic, taxonomic, and ecological studies of Peru's diverse vegetation types. Herbario Vargas forms part of the Biological Sciences Division in the Universidad Nacional de San Antonio Abad del Cusco, a 312-year-old university, one of the oldest in Latin America.

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Founded in 1918, the Museum of Natural History is the principal source of information on the Peruvian flora and fauna. Its permanent exhibits are visited each year by 50,000 students, while its scientific collections—housing a million and a half plant, bird, mammal, fish, amphibian, reptile, fossil, and mineral specimens—are an invaluable resource for hundreds of Peruvian and foreign researchers. The museum's mission is to be a center of conservation, education and research on Peru's biodiversity, highlighting the fact that Peru is one of the most biologically diverse countries on the planet, and that its economic progress depends on the conservation and sustainable use of its natural riches. The museum is part of the Universidad Nacional Mayor de San Marcos, founded in 1551.

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CIMA-Cordillera Azul is a private, non-profit Peruvian organization that works on behalf of the conservation of biological diversity. Our work includes directing and monitoring the management of protected areas, promoting economic alternatives that are compatible with biodiversity protection, carrying out and communicating the results of scientific and social research, building the strategic alliances and capacity necessary for private and local participation in the management of protected areas, and assuring the long-term funding of areas under direct management.

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ACKNOWLEDGMENTS

Although too numerous to thank individually, we are deeply grateful to each and every person who made our work in Megantoni possible, and to all who then translated our results into the creation of a new National Sanctuary in Peru, the Santuario Nacional Megantoni.

The indigenous communities that neighbor the now Santuario Nacional Megantoni, worked for 22 years with CEDIA to protect these spectacular mountains and their extraordinary cultural and biological riches. We congratulate these communities for their perseverance and we thank them for inviting us to inventory the scientifically unexplored mountains. We especially thank the communities of Timpía, Matoriato, and Shivankoreni, who participated in the preparations, logistics, and execution of the inventory.

The success of a rapid inventory in such remote and inaccessible sites depends largely on the unwavering resolve of the logistics team. We were blessed with an energetic group who saw no challenge as insurmountable. Leading the advance team—which set up ground logistics, heliports, campsites, trails—was Guillermo Knell, with José-Ignacio (Pepe) Rojas and Aldo Villanueva. Heading the intricate transportation logistics was expert problem solver and superb helicopter pilot, Dario Hurtado. The staff of CEDIA stepped in with coordination and other help at every step, from support with radio communications to provision of last-minute supplies. We thank the Hostal Alto Urubamba and the Police Headquarters (*Comisaría*) in Quillabamba, especially Major Walter Junes, for generously going out of their way a number of times to support the team. Fritz Lutich and pilots Roberto Arias and Ricardo Gutierrez (Helisur) facilitated the entry of the advance team. The Peruvian National Police helped with storage and logistics in-between flights. Pilot Daniel de la Puente and engineer Juan Pablo San Cristobal (Copters Peru) tried hard not to leave us stranded too often. And we owe special thanks to Ing. Funes, of Techin, SA, for rescuing us when we did get stranded, sending one of his busy helicopters to move us from Kapiromashi (Camp 1) to Katarompanaki (Camp 2).

The first campsite, Kapiromashi, and trails were masterfully set up under the coordination of Pepe Rojas and the work of Timpía residents Filemon Olarte, Gilberto Martinez, Javier Mendoza, Jaime Dominguez, Martin Semperi, Francisco Garcia, and Beatriz Nochomi (cook). Guillermo Knell, with the

help of Dani Rivera, coordinated the stunning campsite on the mossy plateau of the second camp, Katarompanaki, with the skilled work of Jose Semperi, Valerio Tunqui, Felipe Semperi, Cesar Mendoza, Antonio Nochomi, Wilber Yobeni, Pedro Korinti, Rina Intaqui (cook), and Adolfo Nochomi, also residents of Timpía. We thank the chief of Timpía, Camilo Ninasho, for his support. The third and highest campsite, Tinkanari, was the masterwork of Aldo Villanueva and his team from Matoriato—Roger Yoyeari, Gilmar Manugari, Bocquini Sapapuari, Luis Camparo, Samuel Chinchiquiti, Yony Sapapuari (cook), Patricio Rivas, and Ronald Rivas—and from Shivankoreni, Miguel Chacami and Esteban Italiano. We thank Delia Tenteyo and René Bello for keeping all of us well fed in the field.

For help in species identification, the botany team thanks Eric Christenson, Jason Grant, Charlotte Taylor, Lucia Lohmann, James Luteyn, Andrew Henderson, Stefan Dressler, Lucia Kawasaki, Bil Alverson, Jun Wen, Nancy Hensold, Paul Fine, John Kress, and David Johnson. For help in drying specimens, we thank Marlene Mamani, Karina Garcia, Natividad Raurau, Angela Rozas, Vicky Huaman, William Farfan, Javier Silva, Walter Huaraca, Darcy Galiano, and Guido Valencia. In Chicago, Sarah Kaplan processed many of the images, and Tyana Wachter lent her help and magic every step along the way.

Francois Genier helped identify dung beetles. Richard Vari, Scott Schaefer, Mario de Pinna, and Norma Salcedo helped with fish identifications, and Hernán Ortega reviewed the fish manuscript. We thank Charles Myers, William Duellman, David Kizirian, Roy McDiarmid, Michael Harvey, Diego Cisneros, and especially Javier Icochea, for help in identification of reptiles and amphibians. Dani Rivera actively participated in the herpetological fieldwork, especially in Camp Katarompanaki. Guillermo Knell, as always, participated in fieldwork and in the photographing of the herpetofauna.

Constantino Auca, Nathaniel Gerhart, Ross McLeod, John O'Neill, J. V. Remsen, Thomas Schulenberg, Douglas Stotz, Thomas Valqui, Barry Walker, and Bret Whitney all contributed valuable comments to the bird manuscript. We thank Paul Velazco and Marcelo Stucchi for their revisions of the mammal chapter.

The editors thank all authors for their efforts in writing their chapters quickly and, especially, for their fast production of summary charts as soon as we arrived in Cusco. These summaries

ACKNOWLEDGMENTS

became the core of the presentation for requesting Santuario Nacional status for the biologically rich mountains of Megantoni. CEDIA's team (especially Jorge Rivera) and Sergio Rabiela, Dan Brinkmeier, and Kevin Havener were extremely helpful in producing the maps for the report.

We thank Heinz Plenge (who joined us in the first camp) for the use of his gorgeous photographs and Guillermo Knell for his excellent videos in the field.

For invaluable help in final edits we thank Douglas Stotz, and throughout the inventory, we thank Jorge Aliaga and Malaquita Vargas in CIMA (Lima), and Tyana Wachter, Brandy Pawlak, and Rob McMillan at The Field Museum (Chicago). Tyana was also wonderful help with the translations. As always, Jim Costello gave completely of himself to capture the essence of this inventory in his design of the report. John W. McCarter, Jr. continues to be a strong believer in, and supporter of, our conservation programs. We thank the Gordon and Betty Moore Foundation for their grant supporting this inventory.

The goal of rapid biological and social inventories is to catalyze effective action for conservation in threatened regions of high biological diversity and uniqueness.

Approach

During rapid biological inventories, scientific teams focus primarily on groups of organisms that indicate habitat type and condition and that can be surveyed quickly and accurately. These inventories do not attempt to produce an exhaustive list of species or higher taxa. Rather, the rapid surveys 1) identify the important biological communities in the site or region of interest, and 2) determine whether these communities are of outstanding quality and significance in a regional or global context.

During social asset inventories, scientists and local communities collaborate to identify patterns of social organization and opportunities for capacity building. The teams use participant observation and semi-structured interviews to evaluate quickly the

assets of these communities that can serve as points of engagement for long-term participation in conservation. In-country scientists are central to the field teams. The experience of local experts is crucial for understanding areas with little or no history of scientific exploration. After the inventories, protection of natural communities and engagement of social networks rely on initiatives from host-country scientists and conservationists.

Once these rapid inventories have been completed (typically within a month), the teams relay the survey information to local and international decisionmakers who set priorities and guide conservation action in the host country.

REPORT AT A GLANCE

Dates of fieldwork

April 25-May 13, 2004

Region

The 216,005 hectares of intact forest in the Zona Reservada Megantoni (ZRM) are situated along the eastern slopes of the Andes, in the department of Cusco (province of Convención, district of Echarate) in the central part of the Urubamba valley. The terrain is steep and spectacular, crossing different altitudinal gradients ranging from deep, humid canyons to the highland grasses of the puna, with forests growing on a heterogeneous mix of uplifted rocks, steep slopes, jagged mountain ridges, and middle-elevation tablelands.

Two steep mountain ranges traverse stretches of the Zona Reservada, descending from east to west. In the southwestern corner, the Río Urubamba bisects one of these ranges, creating the mythical canyon, Pongo de Maenique. Three of the Urubamba's tributaries—the Río Timpía and the Río Ticumpinía from the north and the Río Yoyato on the southern limit—run haphazardly through the deep valleys in the Zona Reservada, carving a path among the towering ridges above them.

Sites surveyed

We surveyed three sites between 650-2,350 m. Although lowland forests harbor many more species, higher elevations tend to support more endemic species and species with restricted ranges. We chose the most inaccessible and isolated sites possible.

Kapiromashi Camp (bamboo in Machiguenga): This was the only inventory site in a large river valley. Our camp was situated in a regenerating landslide, along a small creek about 200 m from the Río Ticumpinía. The Río Ticumpinía, one of the largest rivers in the ZRM, reaches widths of 150 m or more during the rainy season. Similar to other areas in Megantoni, bamboo is pervasive at this site. We surveyed forests growing at elevations between 650-1,200 m.

Katarompanaki Camp (*Clusia* in Machiguenga): At the heart of Zona Reservada Megantoni, several massive tablelands rise between two tributaries of the Río Ticumpinía. These tablelands are obvious on satellite images and do not appear in either Parque Nacional Manu or the Vilcabamba conservation complex. Our second campsite was on the highest of these tablelands, and we explored both this higher tier and another platform 400 m below it. This campsite was christened Katarompanaki for the *Clusia* tree species that dominates the canopy on the top tier of the tablelands. At this camp we surveyed elevations between 1,300-2,000 m.

REPORT AT A GLANCE

Sights Surveyed
(continued)

Tinkanari Camp (tree fern in Machiguenga): Our third inventory site was in the eastern corner of the Zona Reservada, close to its border with Parque Nacional Manu. Throughout the Andes and in parts of the Zona Reservada, this elevation contains some of the steepest slopes. This site was atypically flat, however, with water pooling in several places in the forest, and even forming a small (20-m diameter) blackwater pond that was not visible on the satellite image. The headwaters of the Río Timpía and the Río Manu originate several hundred meters above this site, and our trails crossed dozens of small creeks with moss-covered rocks. At this camp, we surveyed between the elevations of 2,100 and 2,400 m.

Organisms studied

Vascular plants, dung beetles, fishes, reptiles and amphibians, birds, and large mammals.

Results highlights

The biological communities in Zona Reservada Megantoni are an interesting mix of species from north and south, east and west. Prior to our fieldwork, we expected to find a mix of components from the adjacent protected areas, Parque Nacional Manu and Cordillera Vilcabamba. The avifauna fit our expectations, and was a mix of these areas, but the other organisms were more closely related to communities in Manu, and some species occur exclusively in Megantoni. During our three-week field survey, we found more than 60 species new to science (more than 20 were orchids)—which is extraordinary. Habitat diversity in the Zona Reserva is extremely high.

Plants: The team registered more than 1,400 species, and we estimate that 3,000-4,500 plant species occur in the entire Zona Reservada, including lowland forest and puna species. In just 15 days, we found a surprising number of species new to science: 25 to 35. Great habitat diversity exists in the region and several plant species have very restricted ranges, confined to a certain type of soil or bedrock; these conditions may in part drive speciation. Orchids and ferns are especially diverse in the Zona Reservada and represent one quarter of all the plant species observed. Approximately one fifth of the flowering orchids we found were new to science (20 of 116 species).

Dung beetles: The team registered 71 of the 120 estimated dung beetles for the Zona Reservada. We found very few species in more than one site (and when we did, the species abundance was much greater in one site than the other). Species richness is exceptionally high in the region, even more so than in similar elevations in the Valle Kosñipata (Parque Nacional Manu). The two highest elevations we surveyed had great abundance of large dung beetles, which are more vulnerable to extinction. Secondary forests and bamboo forests had fewer species. Many of the species found have restricted elevational (and probably

REPORT AT A GLANCE

Results Highlights (continued)

geographic) ranges and are most likely endemic to the region. Some of the *Pharaeires* species found were just recently described for science, some are rare, and some are new to science. In ecological terms the larger species are especially important because they recycle waste, control parasites, and disperse seeds.

Fish: In the Río Ticumpinía and numerous smaller creeks, the team registered 22 fish species. We estimate that the ichthyofauna in Zona Reservada Megantoni exceeds 70 species, the majority living in the waters of lowland forests (< 700 m) not visited during this inventory. Some of the highland species (*Astroblepus* and *Trichomycterus*) appear endemic to the area, with unique morphological adaptations to the turbulent waters of the region. All sampled aquatic habitats are in an excellent state of conservation, free of the introduced rainbow trout (*Oncorhynchus mykiss*) that has displaced (and in some cases, driven to extinction) native fauna in other sites in the Peruvian Andes.

Reptiles and amphibians: The herpetologist team registered 32 amphibian species (anurans) and 19 reptiles (9 lizards and 10 snakes) in three inventory sites between 700 and 2200 m. Based on previous inventories along the same altitudinal transect in the Valle Kosñipata (Parque Nacional Manu), we estimate 50-60 amphibians occur within Zona Reservada Megantoni. We found some species in unexpected elevations (*Phrynopus* lower than expected and *Epipedobates macero* higher) and some outside of their expected geographic ranges (e.g., *Syncope* further south, *Liophis problematicus* further north). Zona Reservada Megantoni shares some of the herpetofauna with neighboring Parque Nacional Manu, but more than a fifth of the species we recorded are unique to Megantoni. We found 12 species new to science (7 amphibians, 4 lizards, and 1 snake).

Birds: The ornithologist team registered 378 species in the three inventory sites. Including species from unvisited habitats (lowland tropical forest, high montane forest, and puna) and migratory species, we estimate 600 bird species occur within Zona Reservada Megantoni. The avifauna was a mix of species from the central Peruvian Andes, some only recorded west of Cordillera Vilcabamba, and species from the Bolivian Yungas, some only recorded from Puno or on the eastern side of Parque Nacional Manu. Protecting this area would preserve the remarkably high densities of guans and macaws we observed during this inventory. In other parts of Peru, hunting of large birds, like guans and tinamous, has seriously reduced their abundance. Even in our first camp (Kapiromashi), we found signs of hunting and guans were notably scarcer. Extremely rare and local species such as Black Tinamou (*Tinamus osgoodi*), Scimitar-winged Piha (*Lipaugus uropygialis*) and the Selva Cacique (*Cacicus koepckeae*), which are vulnerable to extinction

REPORT AT A GLANCE

Results Highlights (continued)

(Birdlife International) and inhabit few sites worldwide, would be protected in Megantoni.

Mammals: Of the 46 expected species, the team registered 32 large and medium mammal species (belonging to 7 orders and 17 families) during the inventory. Five of these species are considered endangered and 12 are considered potentially threatened according to the Convention on International Trade in Endangered Species (CITES). In the three sites we found a large number of tracks and other signs of the spectacled bear (*Tremarctos ornatus*), indicating the presence of healthy populations and further stressing the importance of protecting the Megantoni corridor. The Zona Reservada Megantoni is likely an extremely important corridor for other migrating species, such as *Panthera onca* and *Puma concolor*. Conservation targets include mammals listed on CITES, Appendix I: *Tremarctos ornatus*, *Panthera onca*, *Leopardus pardalis*, *Lontra longicaudis* and *Priodontes maximus*; and on CITES Appendix II: *Myrmecophaga tridactyla*, *Dinomys branickii*, *Herpailurus yagouaroundi*, *Puma concolor*, *Tapirus terrestris*, *Alouatta seniculus*, *Cebus albifrons*, *Cebus apella*, *Lagothrix lagothricha*, *Tayassu pecari* and *Pecari tajacu*.

Human communities

There are 38 native communities representing four distinct ethnicities in the upper and lower Urubamba river basins, north and south of Megantoni. The Machiguenga, Ashaninka, Yine Yami, and Nanti have lived in these forests for thousands of years hunting, fishing, and cultivating their small farms. For many of them, their spiritual roots are centered in Megantoni, especially in the turbulent waters of Pongo de Maenique—the sacred place where spirits travel between this world and the next, and where the world was created. Twenty-two years ago, the indigenous people of the region formed an alliance with CEDIA to promote effective natural resource management and protect their land, its biodiversity, and the center of their spiritual world. South of Megantoni, more than 150,000 colonist settlers live in the Alto Urubamba drainage.

Main threats

Along both sides of the lower Urubamba there is substantial deforestation, with larger slash and burn plots obvious on the satellite image, and evidence of colonization disappearing only at the boundary of the proposed reserve. Upriver of the Pongo de Maenique, and along the Río Yoyato on the southern side of the proposed Zona Reservada, the colonization threat from higher in the Andes is even greater, with the canyon appearing to provide at least a partial barrier to deforestation. In addition to habitat destruction, uncontrolled hunting within ZRM could threaten much of its fauna. We observed evidence of hunting impacts in our first camp, Kapiromashi.

REPORT AT A GLANCE

Antecedents to Zona Reservada Megantoni

In 1988, CEDIA (Centro del Desarrollo del Indígena Amazónico) and COMARU (Consejo Machiguenga del Río Urubamba) appealed to the Ministry of Agriculture to declare Megantoni a protected area (210,000 ha). In 1992, they prepared a technical document calling for the creation of a strictly protected area in Megantoni, “Santuario Nacional Machiguenga Megantoni.” In 1998, INRENA passed responsibility to the Dirección Regional Agraria de Cusco (Regional Agricultural Office in Cusco) to produce information about species listed by CITES, and describe the lands neighboring the proposed protected area.

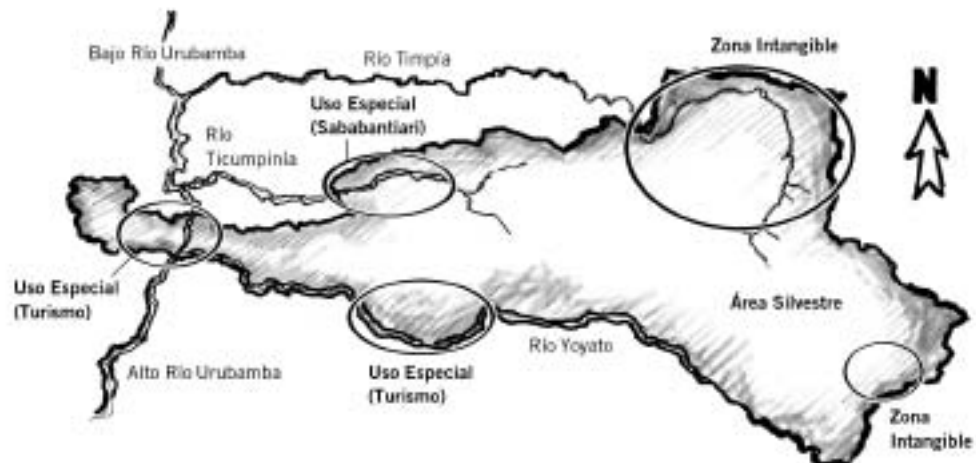
Between 1997 and 1998, the Inca Region, now known as the Cusco Regional Government, assembled local institutions to form a sustainable development plan for the entire Lower Urubamba drainage. This assembled groups strongly urged completing all pending studies before officially declaring Zona Reservada Megantoni a protected area.

In March 2004, 16 years after CEDIA began its work to protect the area, the government passed Ministerial Resolution Number 0243-2004-AG creating Zona Reservada Megantoni and incorporating it into the National System of Natural Protected Areas (SINANPE).

Current Status

The results of this inventory provided biological support for maximum protection of the Zona Reservada (a temporary designation with limited protection). On August 11, 2004, Supreme Decree Number 030-2004-AG created the new Santuario Nacional Megantoni based on the technical documents prepared by CEDIA, incorporating our findings. The Santuario is now an essential component of Peru’s extensive, protected biological corridor that starts in Vilcabamba, crosses Manu and Bahuaja-Sonene and then continues into Bolivia.

Megantoni



REPORT AT A GLANCE

Principal recommendations for protection and management

- 01 **Zona Reservada Megantoni should be granted the strongest protection status possible** to conserve its valuable cultural and biological resources, including species potentially endemic to Megantoni's mountains, and to maintain the extremely important corridor between Parque Nacional Manu and Cordillera Vilcambamba. *[Note: This recommendation has already been implemented, with the creation of the Santuario Nacional Megantoni as this report was being finalized.]*
 - A. Within the new conservation area, we propose the following zoning recommendations:
 - i. Protect the area where indigenous people in voluntary isolation live, for their exclusive use (Usó Exclusivo)
 - ii. Create a special use (Usó Especial) area for the indigenous people living in Sababantiari that allows them to continue their traditional use of the forest. In this area, we recommend implementing a participatory community program, to monitor the impact of hunting, and if necessary, to manage hunting practices accordingly.
 - iii. The isolated puna habitat in the southeastern corner of Megantoni (see map above) should be strictly protected. Because it is isolated from the more extensive and interconnected puna habitat in other parts of Megantoni and PN Manu, it could harbor endemic and rare species.
 - iv. Promote and ensure possibilities to research intact puna habitats along the Zona Reservada's southern border; these studies could eventually help restore and manage degraded puna in nearby areas.
 - v. Promote a low-impact tourism zone around Pongo de Maenique and other possible entrance points (e.g., north of the Estrella highway) to benefit neighboring communities (see map).
- 02 **Promote the completion of the physical and legal land titling in the areas next to the Zona Reservada Megantoni.**
- 03 **Prevent public works or infrastructure construction within the fragile Zona Reservada.**
- 04 **Develop engaging and effective ways for neighboring populations to participate in the protection and management of the new protected area.**

REPORT AT A GLANCE

Long-term conservation benefits

There are very few pristine areas like Zona Reservada Megantoni connecting puna to lowland tropical forest. These types of continuous corridors not only contain an impressive richness of both endemic species and species of restricted altitudinal range, but they are extremely important for fauna, especially when considering global issues of climate change and deforestation.

Zona Reservada Megantoni represents a unique opportunity to expand some of the most globally important biological and cultural reserves: the Parque Nacional Manu and the protected areas of the Cordillera Vilcabamba. Immediate protection of these approximately 200,000 ha would provide an intact, forested link between two tremendously important national parks, making the total effective area of protection double the size of each individual park (a total area of more than 2.6 million ha).

Elevating the status of the Zona Reservada to Santuario Nacional Megantoni would ensure protection of thousands of species, prevent advancing deforestation, and create the only secure and intact corridor for animals migrating between Manu and Vilcabamba. The forests of Santuario Nacional Megantoni will also support and provide shelter to the Machiguenga, Ashaninka, Yine Yami and Nanti (Kugapakori) people. These indigenous people have lived in Megantoni's forests and valleys for thousands of years and today they survive cultivating root crops, and hunting in the traditional manner of their ancestors. A strictly protected area would also preserve their cultural heritage.

Why Megantoni?

Megantoni is a critical piece of the conservation puzzle in southeastern Peru. Seated on the eastern slopes of the Peruvian Andes, it fits snugly between two of the largest protected areas in Peru: Parque Nacional Manu (1.7 million hectares) and the conservation complex in Cordillera Vilcabamba (Reserva Comunal Machiguenga, Parque Nacional Otishi, Reserva Comunal Ashaninka: total area 709,347 hectares).

With 216,005 hectares Megantoni may appear small compared to its neighbors, but in rugged terrain spanning 500-4,000 meters in elevation, along steep slopes marked by massive landslides, in waters flowing through deep river gorges, on jagged mountain ridges and in nearly impenetrable patches of native bamboo, the wilds of Megantoni harbor an astonishing diversity of life. Conservative estimates place Megantoni's plant diversity between 3,000-4,500 species, indicating that its forests may contain almost a quarter of the plant species in Peru. Many birds and mammals threatened elsewhere in Peru and South America find refuge here, and endemic species abound, around 20% of the frogs and fishes living in Megantoni do not occur anywhere else in the world.

According to the mythology of the traditional inhabitants of the region — the Machiguenga, Ashaninka, Nanti, and Yine Yami (Figure 12) — the abundant flora and fauna are protected by *Tasorinshi Maeni*, the spectacled bear (*Tremarctos ornatus*, Figure 11B). Indigenous peoples have lived in these forest valleys for millennia by cultivating root crops and hunting with bows and arrows, and their lives and fates are intimately linked to Megantoni's wildlife and forests.

Megantoni offers the unique opportunity to link two biodiversity giants, securing protection not only to the diverse biological and cultural communities of Megantoni, but to a continuous expanse of more than 2.6 million hectares. Ill-planned colonization from the south, and gas exploration and deforestation in the north threaten the Megantoni corridor. This one-time chance to preserve intact one of the richest portions of the world depends on the fast action and long-term vision of Megantoni's local inhabitants, its supporting organizations, and the Peruvian government.

Overview of Results

Before setting foot in the forests of Zona Reservada Megantoni (ZRM) on the eastern slopes of the Andes, we knew that our rapid inventory would focus on some of the most diverse biological communities on the planet. The Andes shelter nearly 15% of the world's plant diversity and almost 20% of the world's terrestrial vertebrates (~3,200 species). These mountain ranges are known not only for their species richness but also for their unique and undescribed taxa: close to half of the Andean flora and fauna is considered endemic, i.e., occurring nowhere else on Earth.

Megantoni fits the Andean mold. During our rapid inventory of its forests in April-May 2004, we catalogued nearly 2,000 species: many endemic to the region, several threatened or vulnerable in other parts of their range, and 60-80 new to science. Herpetologists found 7 new species of frogs; ichthyologists discovered endemic fishes clinging to rocks in turbulent streams; entomologists uncovered at least 30 new species of dung beetles; and botanists catalogued 1,400 plant species, including more than 400 species of orchids and ferns, with some 25 species new to science. Animals threatened in other parts of South America—including spectacled bears, tapirs, and jaguars—commonly roam the Megantoni landscape. Game birds, such as guans and tinamous, are remarkably abundant.

In the following sections we summarize the principal results of our rapid inventory within ZRM. We highlight the new species discovered in Megantoni and, for known species, the range extensions we documented during the inventory. Starting from the lowest site and moving uphill, we describe our findings at the three inventory sites, integrating information from all organisms sampled. Finally, we outline the region's assets, and the threats to its biological and cultural riches.

NEW SPECIES AND RANGE EXTENSIONS

NEW SPECIES

Before our inventory, Megantoni was almost entirely unknown to scientists, and during our rapid inventory, we encountered many of the species we suspected would live here. However, some of our finds were entirely unexpected (Table 1). For every 100 plant species we recorded, 2 are probably species new to science; for every 10 dung beetles, 1 to 4 are probably new; for every 10 fishes, 1 or 2

are probably new; for every 10 amphibians or 10 reptiles, 2 are probably new. For a 15-day inventory, these are impressive numbers and hint at the species richness that remains to be documented in the wilds of Megantoni.

Table 1. Species richness (observed and estimated) and the number of species potentially new to science for each group sampled during the 25 April-13 May 2004 rapid inventory in Zona Reservada Megantoni, Peru. Missing records are represented with a dash (-).

Organism	Number of Species		
	Observed	Estimated	Potentially New
Plants	1,400	3,000-4,000	25-35
Dung Beetles	71	120	10-30
Fishes	22	70	3-5
Amphibians	32	55	7
Reptiles	19	-	5
Birds	378	600	-
Mammals	32	45	-

We discovered almost all of the potentially new species at our two higher-elevation campsites, with the exception of 1 *Osteocephalus* frog and ~8 new dung beetles that were found in the lowlands. For plants, the bulk of potentially new species are orchids; preliminary impressions suggest that perhaps 20 of the 116 fertile orchids collected are new to science (see Flora and Vegetation, Figure 6). Based on digital photographs we took in the field, specialists have tentatively identified 9 additional plant species, from 9 different families, as new to science.

Many of the 22 fish species we registered during the inventory are endemic to Megantoni. In particular, some species in the families Astroblepidae and Trichomycteridae have almost certainly undergone speciation within the isolated watersheds of Megantoni. At least 3 species we collected are new to science, including *Cetopsis* sp. (Figure 8G), *Chaetostoma* sp. B (Figure 8A), and *Astroblepus* sp. C (Figure 8D). Several species within the Trichomycteridae are potentially new as well.

We encountered 51 species of amphibians and reptiles. Slightly more than 20% are new to science: 7 anurans, 4 lizards, and 1 snake. The new amphibian

species include an *Osteocephalus* (Figure 9E), a *Phrynopus*, at least 1 new species of *Eleutherodactylus*, a *Centrolene* (Figure 9H), a *Colostethus*, a *Gastrotheca* (Figure 9F), and a *Syncope*. We also discovered a new species of snake (*Taeniophallus*, Figure 9D) on the mid-elevation slopes and 4 new species of lizards (*Alopoglossus* [Figure 9C], *Euspondylus*, *Neusticurus*, and *Proctoporus*) living on the isolated tablelands in the heart of Megantoni.

RANGE EXTENSIONS

Our inventory in Megantoni registered some species that were previously known only from areas more than 500 km away, as well as some species at much higher or lower elevations than previously recorded. Other groups are so poorly known for the rest of the region (e.g., dung beetles, fishes) that more data need to be collected before we can draw conclusions about endemism or range extensions.

For plants, amphibians, reptiles, birds, and mammals, we can compare some of our Megantoni findings to records from other sites in Peru and elsewhere in South America. As we continue to examine our collections and to research published reports from other sites, we expect to uncover even more geographic and elevational range extensions within the biological communities of Megantoni.

Plants

For plants, several collections in Megantoni extend the known ranges of species hundreds of kilometers farther south. At our low-elevation campsite, Kapiromashi, we registered *Wercklea ferox* (Malvaceae) for the first time in southern Peru. At the two higher campsites, we found *Ceroxylon parvifrons* (Arecaceae), *Tapeinostemon zamoranum* (Gentianaceae, Figure 4B), *Sarcopera anomala* (Marcgraviaceae), *Macleania floribunda* (Ericaceae), *Miconia condylata* (Melastomataceae), and *Peltastes peruvianus* (Apocynaceae, Figure 4D), all previously known only from northern Peru.

Our collection of *Heliconia robusta* (Heliconiaceae) fills a large gap in the knowledge of its distribution. Known mostly from Bolivia, it has been collected only a handful of times in Peru, always in sites north of Megantoni. This *Heliconia*, with triangular green and red bracts and yellow flowers, dominated parts of the naturally disturbed forest around Kapiromashi.

Amphibian and reptiles

Our inventory increased the known geographic and elevational distributions of several species and even a few genera. At Megantoni we noted the southernmost distributional record in Peru for *Syncope*, and the lowest elevation recorded for *Phrynopus* and *Telmatobius*. We also registered an apparently undescribed species of *Neusticurus*, recorded previously from Santa Rosa (~800 m asl), in the Inambari basin, Puno Department, some 230 km southeast of Megantoni.

At Kapiromashi we found *Epipedobates macero* (Figure 9G), a rare poison dart frog restricted to the Río Purús in Brazil, Parque Nacional Manu, and the rivers in the Urubamba valley. This record extends its elevational range to 800 m from the previous record of 350 m where the species was described in Manu. While sampling in the leaf litter, we discovered a small *Phrynopus* cf. *bagrecito*, known from higher elevations in Manu but never before reported from such low elevations (~2,200 m asl).

Birds

We encountered bird species outside their published elevational ranges at every inventory site. Our records in Megantoni extend distributional limits for some species farther south, for others farther north. Three birds deserve special mention: Scimitar-winged Piha (*Lipaugus uropygialis*, Figure 10D), Selva Cacique (*Cacicus koepckeae*, Figure 10E), and Black Tinamou (*Tinamus osgoodi*, Figure 10C). All three species are remarkably abundant in parts of Megantoni, although exceedingly uncommon worldwide. Our records substantially increase our understanding of the distribution of these rare birds.

Our record of Scimitar-winged Piha is the second for Peru; it was previously known only from Abra Marancunca in Puno Department. From Puno,

the species occurs eastward along the humid Bolivian *yungas* to Cochabamba Department (Bryce et al., in press). Our record is a range extension of more than 500 km to the northwest and suggests the species may occur along other mountain ranges in Cusco and Puno Departments, such as within Parque Nacional Manu.

At Kapiromashi we registered Selva Cacique, a species described from Balta, Ucayali Department, by Lowery and O'Neill in 1965, and essentially unknown until rediscovered by Gerhart near Timpía (Schulenberg et al. 2000; Gerhart, 2004; Figure 1, A13). Ours is one of a handful of sightings, and the highest elevational record for the species.

Black Tinamou has a highly spotty distribution in the Andes, with scattered records from Colombia, Ecuador, Peru, and Bolivia. This species was common at our two high elevation sites, and our records fill one of the many large gaps in our knowledge of its distribution.

Mammals

We observed a group of four brown capuchin (*Cebus apella*) individuals at an elevation of 1,760 m. This record is 260 m higher than the elevational range reported by Emmons and Feer (1999).

FINDINGS AT EACH INVENTORY SITE

During our 15-day inventory, we explored three sites ranging from 650 to 2,400 m in elevation, all different from one another in topography, geology, and species composition. As expected, we encountered the greatest species richness in our low-elevation site, Kapiromashi, (Table 2), and, as we climbed higher, we recorded more endemics and more new species. Collectively our findings sketch a preliminary picture of a highly diverse and heterogeneous region, where habitat types vary on scales small enough that one can walk through stunted, epiphyte-laden forests on rock outcrops, to tall forests on fertile soils, in less than an hour.

In the following sections we present a summary of our major findings, focusing on each inventory site,

rather than on individual taxonomic groups as in the Technical Report (page 171). Although our inventory covered only a subset of the topographic and geological diversity in Megantoni, we believe that our inventory sites are representative of other areas within ZRM, and that the differences among them are representative of larger-scale patterns within the region.

Table 2. Species richness at each campsite, for all organisms sampled in the Zona Reservada Megantoni, Peru

Organism	Kapiromashi	Katarompanaki	Tinkanari
Plants	~650-800	~300-450	~300-450
Dung Beetles	41	32	14
Fishes	17	3	5
Herpetofauna	20	19	16
Birds	243	102	140
Mammals	19	10	11

Lower mountain slopes

(Kapiromashi, 650-1,200 m)

At this site in the Río Ticumpinía valley, we camped 200 m from the main river channel and explored the forested slopes on either side of the river, the large river island, the river itself, and several of its tributaries. Recent landslides, and forests regenerating on old landslides, are obvious features of the landscape. They reminded us that the area is geologically active and that natural disturbance to biological communities is frequent throughout the region. Lower-elevation sites exist in the ZRM (~500 m). Kapiromashi (650-1,200 m), however, was the lowest elevation we sampled.

We found the highest species richness for all organisms here (Table 2). Lowland and upland species overlapped at this site: species more typical of lower elevations reached their upper elevational limits, and upland species occurred at atypically low elevations, presumably because of the humidity trapped within the narrow river valley. In comparison to other sampled groups, we recorded few lowland species of fishes. Enormous waterfalls separate this part of the Río Ticumpinía from the Bajo Urubamba and presumably prevent most lowland fishes from reaching this site.

Numerous patches of large-stemmed bamboo (*Guadua* sp., Poaceae; known locally as *paca*) irregularly occur throughout Megantoni, and are especially dense in Kapiromashi. In bamboo patches, the species richness of plants, dung beetles, birds, and mammals is markedly depressed compared to that of patches free of bamboo. Clumps of bamboo, however, can harbor species that have evolved to specialize on this habitat. Such species include at least 1 amphibian (*Dendrobates biolat*, expected but not encountered during the inventory) and nearly 20 birds (17 recorded during the inventory).

We encountered a small patch of 8-9 plantains and old hunting trails on the southern slope of the valley, indicating that the inhabitants of Sababantiari, a community one day of travel downriver, likely hunt in this area. The near absence of several mammal species, including both species of peccaries (*Tayassu pecari*, *Pecari tajacu*) and several large primates (*Alouatta seniculus*, *Lagothrix lagothricha*), may reflect either large-scale seasonal migrations or overhunting in the area. Gamebirds, principally guans (Cracidae), were less common at this site than at the other two and, when sighted, appeared more apprehensive about our presence than the almost tame individuals spotted at our higher-elevation sites. Despite local hunting, we recorded healthy populations of large carnivores (jaguar, *Panthera onca*) and large ungulates (tapirs, *Tapirus terrestris*).

Mid-elevation tablelands

(Katarompanaki, 1,350-2,000 m)

Only 12 km east of Kapiromashi, broad tablelands rise between two tributaries of the Río Ticumpinía. Our second campsite was on the highest of these tablelands, and we explored both this higher tier and another platform 400 m below it. Radically different vegetation grows on each tier: on the higher platform short-statured, low-diversity vegetation grows on hard acidic rock; the lower tier supports taller, higher-diversity forest on much richer soils. We observed differences in composition and richness between the two platforms in all organisms. Richness was greater on the lower platform; in many groups, a more specialized community lives on the upper platform.

Specialization was most obvious in fishes. Fast-flowing streams feed the dramatic waterfalls that pour over the sheer edge of the tablelands into the river gorges below. Few fish species live in these streams, but the three endemics we registered during the inventory are abundant and uniquely adapted to the turbulent waters, using their adhesive mouths to cling to rocks, and their ventral muscles to pull their bodies upstream against the current.

As did the specialists in fishes and dung beetles, herpetologists found few species but many endemics. Nutrient-poor forests are generally unfavorable habitats for amphibians and reptiles, and on the upper platform the team found only 16 species: 8 anurans, 3 lizards, and 3 snakes. Nearly half, however, are species potentially new to science—3 lizards (*Euspondylus*, *Neusticurus*, *Proctoporus*) and 3 frogs (*Centrolene*, *Eleutherodactylus*, *Syncope*)—suggesting that these isolated tablelands could drive evolution in fishes, frogs, lizards, and dung beetles in similar ways.

Plant diversity—concentrated in trees and shrubs in Kapiromashi and on the lower platform of Katarompanaki—shifted to smaller lifeforms on the upper platform at Katarompanaki. Here, the highest richness was concentrated in epiphytes and trunk climbers, particularly orchids and ferns. Of the 275 fertile specimens on the tablelands, a quarter were orchids, including about 15 species new to science.

In other areas of Peru (e.g., Cordillera del Cóndor, Cordillera Azul), stunted forests support a suite of specialized bird species, but we did not encounter these elfin-forest specialists at Katarompanaki. Ornithologists documented only moderate numbers of bird species at this site, although the densities of game birds, particularly the typically rare Black Tinamou, were extraordinarily high.

We found numerous signs of spectacled bear (*Tremarctos ornatus*) in the stunted forest, including trails, dens, and discarded and half-eaten palm stems. Our Machiguenga guides estimated that bears were in the area three months prior to our visit, confirming other research that suggests these animals travel widely

through large territories, tracking seasonal fluctuations in food abundance.

On the lower platform, species richness in all groups was much higher, although researchers spent less time investigating this area. Most notable were the abundance of fruiting trees and the extraordinary densities of woolly monkeys (*Lagothrix lagothricha*) feeding on them, including an enormous group of 28 individuals.

We believe humans have never visited this site before. Reaching the tablelands without a helicopter appears nearly impossible.

Mid-elevation slopes (Tinkanari, 2,100-2,400 m)

Our third inventory site was in the western corner of the Zona Reservada, close to its junction with Parque Nacional Manu (Figure 3B). The headwaters of the Río Timpía and the Río Manu originate several hundred meters above this site, and our trails crossed dozens of small creeks with moss-covered rocks (Figure 3K). This site was atypically flat, however, with water pooling in several places in the forest and forming boggy areas.

As at Katarompanaki camp, we distinguished two forest types at this site. A tall forest on richer soils dominates 90% of the area and surrounds a neatly delimited area (~0.5 km²) of stunted shrub forest growing on a much harder acidic rock. The stunted shrub forest was obvious from the air and was similar to other outcrops on acidic rock seen during the overflights of the Zona Reservada.

Signs of spectacled bear were common and widespread in the stunted forest and ranged from trails and dens to recent food remains and fresh scat. Spectacled bears were one of the most abundant mammals we recorded in Megantoni, second only to woolly monkeys. Moreover, our Megantoni surveys recorded the highest relative density of spectacled bear reported in any Peruvian inventory.

Again, game birds were abundant and tame, including Sickle-winged Guan (*Chamaepetes goudotii*), Wattled Guan (*Aburria aburri*), and Andean Guan (*Penelope montagnii*). At this site, ornithologists photographed Scimitar-winged Piha (see Range

Extensions, above) and tape-recorded calls and a flight display. We believe this flight display has never been witnessed before.

We found several new species and range extensions for plants at this site. Ferns dominated these forests (Figure 5) with high richness (~30 species/100 m²) and high densities, especially of tree ferns (~2,000 individuals/ha). As in the Katarompanaki tablelands, species richness was concentrated in epiphytes rather than trees and shrubs.

Amphibians and reptiles showed patterns of diversity parallel to those of fishes, as they did at Katarompanaki. Species richness was limited overall, but several novelties and endemics dominated the community. Ichthyologists found high fish densities in all streams sampled, registering 5 species of fishes, including 2 *Astroblepus* not found at Katarompanaki. Herpetologists recorded 10 species of anurans, 2 lizards, and 4 snakes. One of the most notable records, *Atelopus erythropus*, previously was known only from the holotype and populations in the Kosñipata valley. The largest of all frogs found at this site was an arboreal marsupial frog, *Gastrotheca* sp. (Figure 9F), similar to *G. testudinea* (W. Duellman, pers. comm.). *Gastrotheca* sp. was nearly ubiquitous—males sang from the canopies in almost every habitat—and this species is almost certainly new to science.

HUMAN COMMUNITIES

In contrast to the biological communities, the social landscape was well known before our inventory. For more than two decades, CEDIA and other organizations have engaged in participatory work with many communities in the region, and their efforts, in conjunction with the long-term vision of many of the native inhabitants, inspired the proposal for a protected area in Megantoni.

To date, CEDIA's efforts have focused largely on the traditional inhabitants of the region—the Machiguenga, Ashaninka, Yine Yami, and Nanti.

However, two distinct cultural groups live in the area surrounding Zona Reservada Megantoni: native populations living in communities and colonists living in rural settlements (see Figure 1). These groups are coarsely separated within the landscape. The bulk of the native peoples live north rather than south of Megantoni (12,000 vs. 4,000 people) and inversely, most colonists live south rather than north of ZRM (150,000 vs. 800 people). Native peoples practice subsistence agriculture and have lived in these forests for millennia, while colonists are more recent arrivals, and typically practice larger-scale commercial agriculture. A large part of the long-term success of a protected area in Megantoni will rely on stabilizing the agricultural frontier, particularly in the south, and engaging both native inhabitants and colonists in the protection and management of the region.

CONSERVATION RISKS AND OPPORTUNITIES

The conservation landscape we propose for Megantoni will provide long-term, strong protection for a biologically and culturally rich region, and is an unparalleled opportunity to

- 01 **Protect unique flora and fauna**, including the 60-80 species new to science found in Megantoni,
- 02 **Link two large protected areas**, ascending from the Amazonian plain in Parque Nacional Manu to the Andean slopes in the Cordillera Vilcabamba,
- 03 **Preserve a landscape sheltering uncontacted indigenous communities**, living in the extreme northeastern corner of Megantoni, and
- 04 **Work with neighboring communities in designing ecologically compatible activities** (including well-managed ecotourism) that will reinforce the protection of Megantoni.

ASSETS

The isolation and ruggedness of Megantoni, the collective knowledge of its inhabitants, and the biological and cultural riches within its borders are enormous assets for conservation in the region. Here we detail several of the most striking and general conservation assets within ZRM, although undoubtedly many more exist.

Intact habitats

Several particularly well-preserved and unique habitats exist within ZRM. Elsewhere in the Peruvian Andes, high-altitude grasslands (puna) experience intensive land use, overgrazing, and overburning, and upland streams are populated with invasive, exotic rainbow trout that have decimated native fishes. Megantoni provides an opportunity to preserve the full richness of this intact mountain flora and fauna and could provide a living reference for restoration efforts in degraded grasslands and aquatic habitats in nearby areas.

Traditional knowledge/cultural richness

These forests are intimately familiar to the Machiguenga, Nanti, Ashaninka, and Yine Yami. Collectively, these groups safeguard a wealth of traditional knowledge—an understanding of animal movements and behaviors, seasonal fluctuations in weather and resources, favorable planting times and ecologically sensitive cultivation methods—providing the closest approximation to a communal almanac for the region.

Pongo de Maenique

The rough waters and life-threatening whirlpools and rapids of the Pongo de Maenique are a spiritual center for the traditional inhabitants of the region, and separate the Alto Urubamba from the Bajo Urubamba. Although now navigable, for centuries the Pongo shielded the Bajo Urubamba from development or colonization. Today the Pongo remains an asset, continuing to play a deep spiritual role in the lives of traditional inhabitants of the region, and providing spectacular ecotourism opportunities for native communities.

Remoteness

The forested ridges and valleys of Zona Reservada Megantoni are difficult to reach—they require three full days of travel from Cusco, via planes, boats, and trails—and their isolation has spared Megantoni the deforestation common in many parts of the Andes.

THREATS

Among the major threats to Zona Reservada Megantoni are the following:

Rampant, ill-planned colonization

Colonists have settled on steep, landslide-prone slopes. Conservation-compatible cultivation is impossible in these areas. Typically, colonists move from one unsuitable area to the next, barely eking out an existence, and deforesting vast areas in the process.

Natural gas pipeline development

The extraction of hydrocarbons is perhaps the largest threat to ZRM, as the Camisea gas operation lies just ~40 km north of the Zona Reservada. Natural gas extraction in the area has already forced native communities to leave their traditional lands, and the next few years may see increased exploration for gas deposits along the Bajo Urubamba.

Illegal logging

Enforcing forestry laws is nearly impossible in such a remote area, and illegal loggers have extracted timber from areas to the north of ZRM (e.g., Reserva del Estado a Favor de los Grupos Étnicos Kugapakori-Nahua).

CONSERVATION TARGETS

The following species, forest types, communities, and ecosystems are of particular conservation concern in Megantoni because they are (i) especially diverse or unique to this area; (ii) rare, threatened, vulnerable, or declining here and/or elsewhere in Peru or the Andes; (iii) key to ecosystem function; or (iv) important to the local economy. Some of these conservation targets meet more than one of the criteria above.

ORGANISM GROUP	CONSERVATION TARGETS
Biological Communities	<p>Headwater streams of the Río Ticumpinía and Río Timpía (Figure 3K), which harbor a unique ichthyofauna</p> <p>Pristine aquatic habitats in the Peruvian Andes that support healthy populations of native species</p> <p>Stunted shrub forests on acidic rock outcrops</p> <p>Pristine expanses of high-altitude grasslands</p> <p>Large tracts of bamboo-dominated forest (Figure 3E)</p> <p>Continuous forest from lowland flood plains to highland grasslands</p>
Vascular Plants	<p>Hyperdiverse Andean plant families, especially orchids (Figure 6) and ferns (Figure 5)</p> <p>Populations of timber trees at lower elevations, including <i>Cedrela fissilis</i> (cedro), <i>Cedrelinga cateniformis</i> (tornillo)</p> <p>More than 25 plant species that only occur in Megantoni</p>
Dung Beetles	<p>Large dung beetle species (especially <i>Deltochilum</i>, <i>Dichotomius</i>, <i>Coprophanaeus</i>, <i>Phanaeus</i>, and <i>Oxysternon</i>), susceptible to local extinctions and functionally important for dispersing seeds, controlling mammalian parasites, and recycling nutrients</p> <p>Rare and restricted-range species (including at least ten species new to science)</p>
Fish	<p>Fish communities in streams and other aquatic habitats that drain the intact forests between 700 and 2,200 m asl</p> <p>Endemic Andean species such as <i>Astroblepus</i> (Figures 8B, 8D), <i>Trichomycterus</i> (Figures 8E, 8F), <i>Chaetostoma</i> (Figure 8A)</p> <p>Species highly specialized on fast-flowing waters and restricted to elevations above 1,000 m</p>

CONSERVATION TARGETS

Reptiles and Amphibians

Communities of anurans, lizards, and snakes typical of middle-elevation slopes in southeastern Peru (1,000-2,400 m asl)

Amphibian communities in streams

Populations of rare species and species with restricted distributions, including *Atelopus erythropus* and *Oxyrhopus marcapatae* (Figure 9B)

New amphibian species including an *Osteocephalus* (650-1,300 m asl, Figure 9E), a *Phrynopus* (1,800-2,600 m asl), an *Eleutherodactylus* (1,350-2,300 m asl), a *Centrolene* (1,700 m asl, Figure 9H), a *Colostethus* (2,200 m asl), and a *Gastrotheca* (2,200 m asl, Figure 9F)

New reptile species including a snake (*Taeniophallus*, 2,300 m; Figure 9D); and four lizards: an *Euspondylus* (1,900 m asl, Figure 9A), an *Alopoglossus* (Figure 9C), a *Neusticurus*, and a *Proctoporus*, living on the isolated tablelands in Megantoni

Lower elevation (< 700 m) populations of yellow-footed tortoises (*Geochelone denticulata*) hunted for food.

Birds

Healthy populations of game birds (Tinamidae and Cracidae), often overhunted in more populated sites

Black Tinamou (*Tinamus osgoodi*, Figure 10C), Scimitar-winged Piha (*Lipaugus uropygialis*, Figure 10D), and Selva Cacique (*Cacicus koepckeae*), Vulnerable species (IUCN), each known from few sites worldwide

Healthy populations of Military Macaw (*Ara militaris*, Figure 10A), a Vulnerable species (IUCN), and Blue-headed Macaw (*Propyrrhura couloni*), a rare and local macaw in Peru

Healthy avifaunas of upper tropical forest, montane forest, and puna

CONSERVATION TARGETS

Mammals

Carnivores with large home ranges, e.g., jaguar (*Panthera onca*, Figure 11A), puma (*Puma concolor*, Figure 11D), and spectacled bear (*Tremarctos ornatus*, Figure 11B)

South American tapir (*Tapirus terrestris*, Figure 11F), whose low reproductive rate makes it particularly vulnerable to overhunting

Populations of the South American river otter (*Lontra longicaudis*, Figure 11E) that are threatened elsewhere by contaminated rivers

Primates that are subjected to serious hunting pressure in certain portions of their geographic distribution: e.g., red howler monkey (*Alouatta seniculus*), white-fronted capuchin (*Cebus albifrons*), brown capuchin (*Cebus apella*), common woolly monkey (*Lagothrix lagothricha*, Figure 11C), saddlebacked tamarin (*Saguinus fuscicollis*)

Vulnerable species such as pacarana (*Dinomys branickii*), ocelot (*Leopardus pardalis*), giant anteater (*Myrmecophaga tridactyla*), and giant armadillo (*Priodontes maximus*)

Healthy populations of medium-sized and large mammals, especially monkeys, that provide essential dung resources for beetles and other invertebrates

RECOMMENDATIONS

Our long-term vision for the Megantoni landscape integrates two complementary goals: to conserve the area's incredible biological diversity, and to preserve the cultural patrimony of the traditional inhabitants of the region—including the voluntarily isolated Nanti people living within Megantoni. In this section, we offer some preliminary recommendations to achieve this vision for Zona Reservada Megantoni, including specific notes on protection and management, further inventory, research, monitoring, and surveillance.

Protection and management

- 01 **Establish the Santuario Nacional Megantoni inside the boundaries outlined in Figures 1, 2.** Rapid protection of Megantoni is critical, as ill-planned colonization continues to deforest wilderness areas north and south of the reserve boundaries. Zona Reservada Megantoni should be granted the strongest protection status possible to conserve its valuable cultural and biological resources—including species potentially endemic to Megantoni's mountains—and to maintain the extremely important corridor between Parque Nacional Manu and Cordillera Vilcabamba. **Update:** On 11 August 2004, Supreme Decree 030-2004-AG established the Santuario Nacional Megantoni (216,005 hectares). Together with Parque Nacional (a category typically given to larger areas), Santuario Nacional represents the strongest protection possible within the Peruvian parks system (SINANPE).
- 02 **Relocate settlements currently established inside the Zona Reservada.** Two adjacent communities of colonists, Kirajateni and La Libertad (Figure 1), are established within the southern limit of the Zona Reservada. These communities include 10-30 landowners, are less than two years old, and are situated on steep slopes with unproductive soils, unsuitable for agriculture. These settlements should be relocated to more favorable lands.
- 03 **Promote the completion of legal land titling in the areas next to the Zona Reservada Megantoni and stabilize the agricultural frontier.** In the past, there has been promotion of areas unsuitable for agriculture (steep, landslide-prone slopes) as settlement opportunities for colonists. These settlements invariably lead to perpetuation of poverty, severe degradation of the biological communities, and frustration of farmers. A sound planning effort, based on accurate assessments of viable land-use options, should manage the dual aims of providing land for people in the region and protecting its biological communities.

RECOMMENDATIONS

Protection and
management
(continued)

- 04 **Map, mark, and publicize the boundaries of the Megantoni protected area.**
As part of their initiative formally to protect the area, CEDIA has led efforts to mark several segments of the Megantoni boundaries. Building on these earlier efforts, a more comprehensive campaign should start with areas most vulnerable to illegal incursions, especially along the southern border in the Alto Urubamba. Signs should include information on the legal status of Megantoni, and the regulations governing activities within its borders.
- 05 **Minimize illegal incursions into the area** by establishing guard posts at critical access points along Megantoni's boundaries.
- 06 **Involve local communities and local authorities in protection and management of the Megantoni protected area**, promoting local participation in protection efforts including:
 - A. **Involving members of local communities as park guards, managers, and educators.**
 - B. **Encouraging local ecotourism efforts and promoting regulated development of other tourism opportunities.** The native community of Timpía (Figure 1, A13) has established an ecotourism operation along the Urubamba (Machiguenga Center for Tropical Studies), and leads tours of the clay licks and wildlife within the spectacular Pongo de Maenique. Responsible development of low-impact tourism should be encouraged as an activity to involve local communities directly in activities compatible with the long-term protection of the area.
 - C. **Managing harvest of game birds, mammals, and fishes by members of native communities.** We found evidence of previous hunting activity (old trails, small plantain patch) at our Kapiromashi campsite along the Río Ticumpinía. We recommend research (see below) on the use of the landscape by native communities and their traditional management of game harvests and subsequent management as necessary.
- 07 **Minimize impacts to headwaters within the region.** Four major rivers originate within the area: Timpía, Ticumpinía, Yoyato (Urubamba drainage), and Manu (Madre de Dios drainage). The Río Timpía and the Río Manu originate on the slopes of the mountains in the northeastern corner of Megantoni (near Tinkanari campsite); the Río Ticumpinía originates in the heart of the reserve; and the Yoyato headwaters lie within the “bulge” along the southern border of Megantoni (Figures 2, 3). Extreme care should be taken to protect these headwater areas, as they provide water for two of the most important drainages in southeastern Peru.

RECOMMENDATIONS

Protection and management
(continued)

- 08 Protect all natural communities from illegal harvesting, in particular orchids.** Orchids are protected under CITES regulations in Peru, and formal protection of Megantoni is an important step towards impeding unauthorized orchid collecting. However, park guards should be on the alert for illegal orchid collectors, as the beauty of these plants inspire collectors to go to great lengths to obtain samples.

Zoning
(see map p. 50)

- 01 Protect the area where indigenous people live in voluntary isolation, for their exclusive use (Uso Exclusivo).** Uncontacted Nanti peoples live along the Timpía river in the northeastern corner of Megantoni.
- 02 Create a special use (Uso Especial) area for the indigenous people living in the Comunidad Nativa Sababantiari that allows them to continue their traditional use of the forest.** In this area, we also recommend implementing a participatory community program to monitor the impact of hunting.
- 03 Protect pristine puna grasslands in Megantoni.**
- A. Strictly protect the isolated puna habitat in the southeastern corner of Megantoni.** Because it is isolated from the more extensive and interconnected puna habitat in other parts of Megantoni and PN Manu, this puna patch could harbor endemic and rare species.
- B. Zone the intact puna habitats along the Zona Reservada's southern border as Area Silvestre** to promote research studies that could eventually help to restore and manage degraded puna in nearby areas.

Further inventory

- 01 Continue basic plant and animal inventories, focusing on other sites and other seasons, especially October-February.**
- A. Unsampled aquatic habitats** include (1) the lower part of ZRM, from 500 to 700 m asl; (2) the Río Yoyato drainage; (3) the upper Río Timpía; (4) the aquatic habitats of the mountains between the Río Ticumpinía and the Pongo de Maenique; (5) habitats between 900 and 1,500 m asl; (6) the Río Urubamba where it passes through the Pongo de Maenique; (7) the blackwater lagoons of the upper Río Timpía; (8) the ponds of the high-altitude grasslands (puna); and (9) the aquatic ecosystems inside ZRM west of the Pongo, including part of the Río Saringabeni.

RECOMMENDATIONS

Further inventory
(continued)

B. Unsampld terrestrial habitats include (1) areas west of the Pongo de Maenique; (2) the cliff faces around the Pongo; (3) forests growing at elevations from 500 to 700 m asl and 2,300 to 4,000+ m asl; (4) the high-altitude grasslands; (5) the stretch of triangular slabs (Vivians) along the northern edge of the reserve; (6) outcrops of acidic rocks scattered throughout the reserve; and (7) uncharacteristically high-elevation patches of lowland *Guadua* bamboo (1,200-1,500 m asl).

02 Map the geological formations within Megantoni, and conduct finer-scale geological inventories throughout the region, beginning with the most prominent landscape features (e.g., tablelands, Vivians, Pongo de Maenique). In parallel, the Geographic Information System (GIS) developed by CEDIA for the region should be elaborated to include more detailed geological information and to integrate existing data on biological communities.

03 Search for two undescribed species of birds, both recently discovered to the east of Megantoni (D. Lane, unpub. data). Both undescribed species are probably *Guadua* specialists, a tyrant flycatcher (*Cnipodectes*, Tyrannidae) known along the Río Manu, and along the lower Río Urubamba at elevations below 400 m (Lane et al., unpubl. ms.); and a tanager (Thraupidae), observed along the Kosñipata road at San Pedro, at ~1,300 m elevation (Lane, pers. obs.). Both species are likely to occur within the Zona Reservada.

Research

01 Examine the use of the Megantoni corridor by wide-ranging species (large carnivores and ungulates, raptors, migrating birds, and mammals). Very few pristine areas like Zona Reservada Megantoni connect puna to lowland tropical forest. Continuous corridors can be extremely important for fauna, especially for species with large seasonal migrations, or large home ranges. Understanding movement patterns and resource use in these wide-ranging species will be critical in designing long-term management strategies for their populations.

02 Evaluate the impact of the protected area on deforestation rates in the region, particularly on deforestation near (and within) park boundaries.

03 Evaluate the ecological impact of subsistence hunting by human communities on local fauna. We recommend focusing this research in the zones used by the Comunidad Nativa Sababantiari and other communities living next to the Zona Reservada—for example, Timpía, Saringabeni, Matoriato, and Estrella. This research should be directed toward preserving wild mammal populations while preserving the quality of life of subsistence hunters and their families.

RECOMMENDATIONS

Research (continued)

- 04 **Measure the efficacy of signs marking reserve boundaries in reducing illegal incursions into the area.**
- 05 **Investigate the natural dynamics of pristine aquatic environments in ZRM.** In the Alto Urubamba watershed, rainbow trout (*Oncorhynchus mykiss*) are widespread in natural environments and are cultivated throughout the watershed. This invasive species is not yet present in ZRM. Megantoni offers the unparalleled opportunity to conserve and study aquatic habitats that are still free of non-native invasive species.
- 06 **Evaluate the effects of fishing toxins (traditional fishing method, known locally as *barbasco* or *huaca*) on aquatic communities.** Casual observations suggest these natural toxins harm fish communities and other aquatic biota, including river otters (*Lontra longicaudis*), but few scientific studies in Peru quantify this damage, especially at a population level evaluating cumulative effects. We recommend investigating the effects of fishing toxins on aquatic communities, and, if necessary, complementing these studies with workshops or environmental education programs or both, to reduce toxin use in local communities.
- 07 **Investigate the role of climate change in species distributions.** Species with narrow elevational ranges, including many of the plants, dung beetles, amphibians, reptiles, and fishes found in Megantoni, may be the most sensitive to global warming and to local changes in climate associated with deforestation. The Andean Biodiversity Consortium (www.andesbiodiversity.org) is currently researching long-term climatic trends and vegetation patterns in mountain ranges near Megantoni, and studies on non-plant taxa could piggyback on their efforts.
- 08 **Determine the carrying capacity of local tourism efforts,** via research directed at estimating tourist visits and impacts on biological communities.

Monitoring

- 01 **Create a comprehensive ecological monitoring program that measures progress toward conservation goals established in a site-specific management plan** (see Protection and Management recommendation 03, above). Use results of research to establish the links between monitoring indicators and potential sources of change. Use results of inventory to establish a baseline for monitoring projects.
- 02 **Track illegal incursions into the area.** Use the results of Research recommendation 04, above, to establish goals for reducing incursions. Modify strategies to target the most-vulnerable entry points.

RECOMMENDATIONS

Monitoring
(continued)

- 03 **Monitor the rate and distribution of deforestation in the region, in relation to protected-area boundaries.** Use the results of Research recommendation 02, above, to establish goals for reducing deforestation. Modify management strategies, including zoning or protected-area boundaries, to respond to monitoring results.

Surveillance

- 01 **Establish meteorological stations in the area.** None currently exists near Megantoni, and meteorological data will complement much of the proposed research in the area (e.g., species responses to climate change, seasonal migrations along the corridor).
- 02 **Track movements of native settlements.** Native communities often move seasonally in response to natural variation in resource availability, and their movements may influence flora and fauna abundances differentially across the landscape.
- 03 **Sample regularly for chytrid fungus in upland aquatic habitats.** At middle and high elevations, the rapid diffusion of a chytrid fungus from Central America toward the Andes has in recent years precipitated dramatic declines and extinctions of amphibian populations in Ecuador, Venezuela, and northern Peru. We found no evidence of chytrid fungus in Megantoni, but regular sampling of species living in highland brooks and streams, such as *Atelopus* toads and glass frogs (Centrolenidae, Figure 9H), will be important for early detection of the fungus.

If chytrid fungus is found in Megantoni, it should be reported immediately to the Declining Amphibian Populations Task Force (<http://www.open.ac.uk/daptf/index.htm>), an organization that serves as a clearing house for information about amphibian declines and the means by which declines can be slowed, halted, or reversed.

- 04 **Survey fish populations.** The next few years may see increased exploration for natural gas deposits along the Bajo Urubamba. Additional gas exploration risks polluting the Bajo Urubamba, and potentially altering migration patterns of fishes reproducing closer to the headwaters (up to ~500 m asl). These changes would alter local fish distribution and possibly reduce game fish species. Tracking the composition of fish communities, in addition to recording resource use by local fishermen, will be critical to protecting the Bajo Urubamba drainage, and to altering management to preserve fish communities within its waters.

Technical Report

OVERVIEW OF INVENTORY SITES

Zona Reservada Megantoni is an intact wilderness corridor of 216,005 ha on the eastern slopes of the Peruvian Andes, widest at the eastern end along its broad border with Parque Nacional Manu, and tapering to a narrow wedge at its western limit where it joins with the Vilcabamba conservation complex (Reservas Comunales Machiguenga and Ashaninka, and Parque Nacional Otishi, see Figure 1). Elevation decreases along a similar westward trajectory. From higher-altitude grasslands (up to 4,000 m) restricted to the southeastern end of the area, the landscape descends in a spectacular series of sharp ridges and rugged slopes until it reaches the river valley bottoms (500+ m) of the lowlands in the west.

In the southwestern corner, the Río Urubamba bisects a large ridge, creating the mythical Pongo de Maenique canyon and exposing clay licks used by Military Macaws (*Ara militaris*) and spider monkeys (*Ateles* sp.). Three of the Urubamba's tributaries—the Río Timpía and the Río Ticumpinía in the north, and the Río Yoyato along the southern boundary—originate within the Zona Reservada, as do the headwaters of the Río Manu (see Figures 1, 2).

Much of Zona Reservada Megantoni is covered in patches of live and dead bamboo: *Guadua* species (Figure 3E) at lower elevations and *Chusquea* species and their allies at higher elevations. In some places the bamboo creates a nearly impenetrable, monodominant stand, whereas in others the bamboo species is draped on and around several tree species, usually only a small subset of the diversity in the surrounding forest.

Pronounced patchiness characterizes the entire Zona Reservada Megantoni. Over short distances—as small as several hundred meters—habitats can change from stunted shrub forests growing on exposed acidic rocks, to forests growing on richer soils with a canopy taller by nearly tenfold, with little or no overlap in species composition between the two areas.

Since the Zona Reservada contains extraordinarily high habitat heterogeneity, both horizontally, at small spatial scales, and vertically, along an altitudinal gradient, our goal in selecting biological inventory sites was to sample the habitat diversity to the greatest extent possible.

SITES VISITED BY THE BIOLOGICAL TEAM

We combined our observations from the November 2003 overflight and our interpretations of Landsat TM+ images (bands 4, 5, 3, and 8 panchromatic) to select inventory sites at different elevations, trying to include access to a range of altitudes and habitats at a single site (see Figures 2, 3). Because of the rugged terrain, access to highland sites in Megantoni is challenging, and in many cases impossible. For our two higher-elevation inventory sites, the advance team—who cut trails and prepared camp before the inventory—gained access to the sites by descending a cable from a hovering helicopter.

During the rapid biological inventory of Zona Reservada Megantoni from 25 April to 13 May 2004, the inventory team surveyed three sites spanning a 1,700-m altitudinal gradient, starting from 650 m above sea level (asl) and reaching 2,350 m. Below we describe these three sites in more detail and include information on a fourth site that was visited only by the advance trail-cutting team. Each site name, in Machiguenga and chosen by the Machiguenga guides accompanying us on the inventory, represents an obvious and dominant feature of the vegetation.

Kapiromashi (12°09'43.8"S 72°34'27.8"W, ~760-1,200 m asl, 25-29 April 2004)

This was the first site we visited, and the only one in a large river valley (Figures 3A, 3C). Our camp was situated in a regenerating landslide, along a small (5-m-wide) transient stream about 200 m from its junction with the Río Ticumpinía. Although the Río Ticumpinía measured ~40 m across during our stay, it is one of the largest rivers in Zona Reservada Megantoni and can span 150 m or more when it is fully charged with water.

Our Machiguenga guides from Timpía, a community 28 km to the northwest at the junction of the Río Timpía and the Río Urubamba, had never visited this site. However, we encountered a small patch of 8-9 plantains and old hunting trails on the southern slope of the valley, indicating that the inhabitants of

Sababantiari, a community one day of travel downriver, likely hunt in this area.

Over four days we explored more than 12 km of trail on either side of the Río Ticumpinía valley, often walking for more than 0.5 km along the rock-strewn, sandy beaches to reach one of the few places where we could cross the river. One additional trail traversed a large island formed where the river diverges and rejoins itself 1.5 km downriver.

Our trail system reached the crest of the southern ridge around 1,100 m asl. Although the ridge on the opposite side of the river appeared to extend to at least 1,500 m asl, we could not reach areas above 1,200 m asl on this higher ridge. Clouds typically moved from the south over the lower ridge and settled against the northern slope, forming a cloud bank around 1,100 m asl. In general, the area contains exceptionally humid forest. Nonetheless, while we were in the field no large downpours occurred, several streams dried up and drought stress was evident in orchids on the northern slope.

Kapiromashi means “much bamboo” in Machiguenga and is the word our local guides used to describe the impressive patches of *Guadua* bamboo (Figure 3E) that dot slopes on both sides of the river, as well as the river island. All trails contained at least one patch of *Guadua* bamboo, and several traversed upwards of 80% bamboo-dominated forest (*pacal*). We found evidence of natural disturbance on most of the trails, often walking through a time series of forest in different stages of recovery from old and new landslides, with more mature forest marked by larger-sized tree stems and their greater epiphyte loads. Underlying this matrix of disturbance is a mosaic of limestone-derived and more acidic soils sometimes separated only by tens of meters. Several plant species are restricted to only one of these soil types.

Judging from our overflight of the area and the satellite images, this area is likely representative of the habitat along the Río Timpía inhabited by the voluntarily isolated Nanti people (Figure 12E).

**Katarompanaki (12°11'13.8"S 72°28'13.9"W,
~1,300-2,000 m asl, 2-7 May 2004)**

At the heart of Zona Reservada Megantoni, several massive tablelands rise between two tributaries of the Río Ticumpinía (Figure 3A). These tablelands are obvious on satellite images and do not appear to occur in either Parque Nacional Manu or the Vilcabamba conservation complex. Our second campsite was on the highest of these tablelands, and we explored both this higher tier and another platform 400 m below it. This campsite was christened Katarompanaki for the *Clusia* tree species (Figure 3G) that dominates the canopy on the top tier of the tablelands.

Although from the air the area appears to be a flat, slowly ascending surface, on the ground the surface is uneven and crisscrossed by a network of small streams that carve deeply into areas of softer substrate. At each stream crossing, the trails descended and rose sharply. The two largest streams (10-20 m wide), one on each tier, consisted of enormous, entire slabs of rock, and were composed of such a hard substrate that scratching the surface, even with plant clippers, was nearly impossible.

Radically different vegetation grows on each tier. On the higher platform short-statured, low-diversity vegetation grows on hard acidic rock. The lower tier supports taller, higher-diversity forest on much richer soils. Because of the slow rates of decomposition, the forest floor on the upper tier is a treacherous tangle of roots and fallen trees, distinctly spongy, and sprinkled with large holes more than 1 m deep. We found little evidence of mineral soil, although a humic layer is present. On the lower tier, the forest is more productive and the richer clay soils support several fruiting species and a substantial mammal fauna.

Traveling between the two tiers was difficult, with a frighteningly vertical descent in some spots. Once on the second tier, the trail passed below a spectacular waterfall pouring over the lip of the first tier, the water cascading past 40 m of vertical rock to crash directly onto the second tier below.

On the few cloud-free days, the southern edge of the top platform granted researchers spectacular views of

a string of triangular slabs known as Vivian formations to the west (Figure 3F), a jumble of steep ridges to the south, several jagged peaks to the east and, across the expanse of short-statured forest of the platform to the north, a sheer rock wall rising from the other side of the river valley. The river island of Kapiromashi camp—a mere 12 km to the west—was distinctly visible from the southwestern corner of the higher platform.

During our six days at this site, we experienced several localized downpours, with intense steady rain in one spot, and blue skies 1.5 km away.

We found no evidence that humans had ever visited this site and the density of woolly monkeys (*Lagothrix lagothricha*, Figure 11C) in the lower-tier forest was noticeably high.

**Tinkanari (12°15'30.4"S 72°05'41.2"W, ~2,100-
2,350 m asl, 9-13 May 2004)**

Our third inventory site was in the western corner of the Zona Reservada, close to its junction with Parque Nacional Manu (Figure 3B). Throughout the Andes and in parts of the Zona Reservada, this elevation contains some of the steepest slopes. This site was atypically flat, however, with water pooling in several places in the forest, and even forming a small (20-m-diameter) blackwater pond that was not visible on the satellite image.

The headwaters of the Río Timpía and the Río Manu originate several hundred meters above this site, and our trails crossed dozens of small creeks with moss-covered rocks (Figure 3K). A creek formed by a recent landslide (*huayco*), the largest waterway at this site, provided us with a window on the complicated geology of the area. Walking upward along the landslide, on rocks that were still free of moss, we observed different strata within the exposed rocks, alternating hard sandstone with other layers of substrate, including shale, and even carbon.

The streams in the area often descended stepwise, with a flat stretch and a steep descent followed by another flat stretch. Our working hypothesis is that the flat stretches reflect softer substrates that erode quickly, or alluvium, followed by harder sandstone, and then the next layer of softer substrate.

As at Katarompanaki camp, we distinguished two forest types at this site. A tall forest on richer soils dominates 90% of the area and surrounds a neatly delimited area (~0.5 km²) of stunted shrub forest growing on a much harder acidic rock. One forest type abutted the other, with no transition.

The stunted shrub forest was obvious from the air and was similar to other outcrops on acidic rock seen during the overflights of the Zona Reservada. The lower portion of the shrub forest was even shorter, dominated by terrestrial orchids and a thin-stemmed *Clusia* sp. In addition to our cut trails, a grid of spectacled bear trails traversed the stunted forest.

More than ten species of tree ferns, or *tinkanari* (Figure 5A), dominated the higher forest, in addition to several species and relatives of *Chusquea* bamboo.

Shakariveni (12°13'08.9"S 72°27'09.1"W, ~960 m asl, 13-19 April 2004)

About 13 km east of Kapiromashi camp, and directly below the large tablelands of Katarompanaki camp, the advance team established a campsite at the junction of the Río Shakariveni and a small tributary. From here, they spent six days exploring the region, hoping to reach the tablelands above. During their unsuccessful efforts to reach higher ground the team observed several vertebrates that are included in the appendices. Close to their campsite, the team encountered an abandoned farm plot (*chacra*), potentially cleared by colonists entering the Zona Reservada from the south. This area closely resembles Kapiromashi camp in its matrix of forest containing large areas dominated by *Guadua* bamboo patches, as well as in the successional flora along the rocky riverbed.

OVERFLIGHT OF ZONA RESERVADA MEGANTONI

Authors: Corine Vriesendorp and Robin Foster

ZONA RESERVADA MEGANTONI

Situated on the eastern slopes of the Andes, the rugged, spectacular terrain of Zona Reservada Megantoni ranges

from deep, humid canyons to moist, high-altitude puna grasslands. Formed during the geological turmoil associated with the uplift of the Andes, the forests within Megantoni grow on a heterogeneous mix of uplifted rocks, steep slopes, jagged mountain ridges, and flat tablelands ranging in elevation from 500 to 4,000+ m.

Two steep ridges traverse stretches of the Zona Reservada, descending from east to west. The Río Urubamba bisects one of these ridges in the southwestern corner, creating the Pongo de Maenique river gorge (see Figures 2, 13). The Urubamba's tributaries (principally the Río Timpía, the Río Ticumpinía, and the Río Yoyato) run haphazardly through the deep valleys in the Zona Reservada, carving a path between the towering ridges above them.

Along both sides of the lower Urubamba, deforestation is substantial, with larger slash-and-burn plots obvious on the satellite image, and evidence of colonization disappearing only at the boundary of the reserve (Figure 1). Upriver from the Pongo de Maenique, and along the Río Yoyato on the southern side of the Zona Reservada, the colonization threat from higher in the Andes seems even greater. The river gorge appears to provide at least a partial barrier to deforestation.

HELICOPTER OVERFLIGHT

On 3 November 2003, a team of scientists from CEDIA, INRENA, CIMA, PETT and The Field Museum flew by helicopter over the rugged terrain of Zona Reservada Megantoni. The flight route traversed an impressive altitudinal gradient, starting from the lowlands (300+ m asl) in the northwestern corner of the ZRM, crossing over expansive table mountains and isolated ridges (1,000-2,000 m asl) near the center, and reaching the highlands (4,000+ m asl) in the southeastern edge. Below we complement the satellite images with our observations from the overflight, focusing specifically on obvious changes in vegetation and habitat within the area.

From the Pluspetrol base in Malvinas, we followed the meandering Río Urubamba upriver to a narrow tongue of steep ridges extending in a long line

on either side of the Pongo de Maenique. A striking contrast exists between the northern and southern faces of these ridges. The northern faces usually are covered in immense, scrambling patches of bamboo (*Guadua* spp.) and the southern faces in vegetation of much higher diversity. The nearly complete cover of bamboo on the northern faces of these ridges suggests that a catastrophic disturbance, such as a massive fire or an earthquake, might have cleared competing vegetation and promoted bamboo colonization in the past.

On some of the northern faces, open patches suggest that tall forests have collapsed under the weight of the *Guadua* bamboo, creating a mixture of *Iriartea deltoidea* (Arecaceae), *Triplaris americana* (Polygonaceae), and *Cecropia* sp. (Cecropiaceae) crowns amidst the bamboo tangles. Even where tall forest is present, the understory appears to be dominated by bamboo. At higher elevations, the *Guadua* bamboo is confined to small, disturbed areas and is eventually replaced by *Chusquea* and other small bamboo species.

In contrast, a much more diverse vegetation grows on the southern faces of the ridge, sporadically interrupted by stunted forest on quartzite outcrops, and by vast landslides colonized by a suite of fast-growing species. The ridgetops separating the two faces often support monodominant patches of forest, likely reflecting the poor growing conditions on these exposed, older soils.

Farther eastward, the ridge is interrupted by a string of triangular slabs known as Vivian formations (Figure 3F), with slopes gently rising toward their apex on one side and abruptly falling along a sheer rock face on the other. On their slopes, Vivians support a variety of stunted vegetation, and sometimes are covered in bamboo. After nearly 30 km the Vivians disappear and are replaced by a series of expansive tablelands.

From the flat tops of the tablelands, dramatic waterfalls pour over sandstone cliffs into the river gorge below. Vegetation on the tablelands is variable, usually dominated by atypically short *Dictyocaryum lamarckianum* palms mixed with other stunted trees. At least one shelf of the tablelands is dominated by monocarpic *Tachigali* (Fabaceae) trees, both alive and

recently dead. Steep slopes on the higher mesas at 1,500-2,000 m asl are dotted with *Alzatea* (Alzateaceae) trees often mixed with tall treeferns (an ideal habitat for Andean Cock-of-the-Rock, *Rupicola peruviana*).

From the mesas we descended to the river confluence of two tributaries of the Río Timpía, passing through narrower and deeper valleys with steep slopes. Along the isolated but broad valley of the largest tributary of the Timpía we observed 10-15 small plots with plantains and thatched-roof shelters, confirming the previously suspected presence of voluntarily isolated groups of Nanti in this area.

Cliffs and steep slopes with landslides continue up to the highest point in the southeastern corner of the reserve, where the ridgetops are more gently sloping. The trees are shorter, twisted, and covered with lichens, giving way to the high-altitude puna grasslands intermixed with patches of shrubby forest composed principally of *Polylepis* (Rosaceae) and *Gynoxys* (Asteraceae). The puna is dotted with scattered tarns and has a mix of giant *Puya* bromeliads and other herbaceous flora, along with the grass cover.

Although we heard reports of this area being used for grazing, we did not see cattle paths from the air. We did see evidence of recent fires, with blackened stems dotting several ridge tops, but we believe the fires to be natural. Cove forests along small highland streams appear to act as natural firebreaks.

From here, we descended along the southern edge of the ZRM, flying over successively lower crests on our return to Malvinas.

FLORA AND VEGETATION

Participants/Authors: Corine Vriesendorp, Hamilton Beltrán, Robin Foster, Norma Salinas

Conservation targets: Hyperdiverse Andean plant families, especially orchids and ferns, along an altitudinal gradient from lowland forest to puna; small populations of timber trees at lower elevations (*Cedrela fissilis* [cedro]; *Cedrelinga cateniformis* [tornillo]); large tracts of bamboo-dominated forest; pristine expanses of high-altitude grasslands; stunted shrub forests on acidic rock outcrops; and the more than 25 plant species endemic to Zona Reservada Megantoni

INTRODUCTION

Before setting foot in the forests of Zona Reservada Megantoni (ZRM), we knew that our rapid inventory would focus on some of the most diverse plant communities on the planet. Considered “the global epicenter of biodiversity” (Myers et al. 2000), the tropical Andes shelter nearly 15% of the world’s plant diversity within their slopes, peaks, and isolated valleys. Moreover, close to half of the Andean flora is likely endemic, i.e., occurs nowhere else in the world.

Andean forests are still poorly understood from a floristic standpoint, and our botanical knowledge of the distribution, composition, and dynamics of these dauntingly diverse forests remains rudimentary. During this inventory, our closest points of comparison were the protected areas adjacent to Megantoni, Parque Nacional Manu to the east, and the Cordillera Vilcabamba (Parque Nacional Otishi, Reserva Comunal Machiguenga, Reserva Comunal Ashaninka) to the west.

Although Manu is one of the best-studied sites in South America (Wilson and Sandoval 1996), most research has focused on elevations lower than those at any site within Zona Reservada Megantoni (500-4,000 m asl). Botanists have collected in the Kosñipata valley in Manu from 2,600 to 3,600 m asl and have generated a preliminary list of the flora (Cano et al. 1995). Recently, Miles Silman, N. Salinas, and colleagues have established several 1-ha tree inventories from lowlands to treeline within the Kosñipata valley of Manu (700-3,400 m asl). These plots are more comparable to our

inventory sites than are floristic studies from Cocha Cashu in Manu (Foster 1990). To the west of ZRM, there is some sampling overlap between our inventory sites (650 m, 1,700 m, 2,200 m asl) and the rapid inventory in the Cordillera Vilcabamba (1,000 m, 2,050 m, 3,350 m asl; Boyle 2001).

Finally, to the north of ZRM, scientists working with the Smithsonian Institution documented an intact, highly diverse forest mixed with bamboo as part of the biodiversity surveys and environmental impact assessments for the Camisea natural gas extraction project (Holst 2001, Dallmeier and Alonso 1997). These forests in the lower Urubamba valley are on hills lower and drier than those in Megantoni, and forests similar to these are protected in Reserva Kugapakori-Nahua, which abuts ZRM on its northeastern border.

METHODS

To characterize plant communities at each inventory site, the botanical team explored as many habitats as possible. We used a combination of general collections, quantitative sampling in transects, and field observations to generate a preliminary list of the flora (Appendix 1).

During our three weeks in the field, we collected 838 fertile specimens now deposited in the Herbario Vargas in Cusco (CUZ), the Museum of Natural History in Lima (USM), and The Field Museum (F). R. Foster and N. Salinas took approximately 2,500 photographic vouchers of plants.

C. Vriesendorp inventoried understory plants (1-10 cm dbh) in ten transects: three in Kapiromashi, four in Katarompanaki, and three in Tinkanari, for a total of 1,000 stems. Understory transects varied in area but were standardized by the number of stems, following the method of Foster et al. (<http://www.fieldmuseum.org/rbi>). All members of the botanical team catalogued plants of all life forms, from canopy emergents and shrubs to herbs and epiphytes. In addition to making general collections, N. Salinas (Orchidaceae) and H. Beltrán (Asteraceae and Gesneriaceae) focused on their families of expertise at each site.

FLORISTIC RICHNESS AND COMPOSITION

Conservative estimates of vascular plant diversity for the eastern Andean slopes of Peru range from 7,000-10,000 species, suggesting that forests in these areas may contain half or more of the plant species in Peru (Young 1991). Based on our field observations and collections at the three inventory sites, we generated a preliminary species list of ~1,400 species for Zona Reservada Megantoni (Appendix 1). Using preliminary lists from similar elevations in the Cordillera Vilcabamba to the west (Alonso et al. 2001) and Parque Nacional Manu to the east (Cano et al. 1995, Foster 1990), we estimate a total flora of 3,000-4,000 species for the 215,006 ha of Megantoni. This is necessarily a broad approximation as our quick survey covered only a subset (650-2,350 m) of the full elevational range (500-4,000+ m) within the Zona Reservada.

As in other forests on the slopes of the eastern Andes, floristic richness within Megantoni is extremely high. In ZRM, we documented an astonishing diversity of orchids and ferns, particularly at the two higher-elevations sites of Katarompanaki and Tinkanari. These two plant groups dominated the flora and contained at least a quarter of the species we observed in the field (Pteridophyta, 190 species; Orchidaceae, ~210 species; Appendix 1). Ferns are commonly encountered in montane habitats; however, the diversity and abundance of ferns in Megantoni were particularly high. Of the 118 genera reported for Peru (Tryon and Stolze 1994), we found representatives of nearly half (~ 55) in Megantoni.

Of the 116 fertile orchid collections, we suspect that 20 represent species new to science (see Figure 6). The number of new orchid species still awaiting discovery may be even higher, given that the majority of the orchids we observed in the field were sterile or in fruit (and therefore effectively sterile for orchid taxonomists). Moreover, we were unable to take comprehensive samples of tree canopies where orchid abundance and diversity are usually highest. For that reason, the number of new orchid species we observed was even more remarkable.

Compared to the floras of other lower- and middle-elevation sites on the Andean slopes, certain

families and genera were notably rich in species.

We observed high numbers of Rubiaceae (92), Melastomataceae (64), Asteraceae (53), Araceae (52), Fabaceae (*sensu lato*, 52), and Piperaceae (49) across all three sites. At the generic level, we encountered 33 species each of *Psychotria* (Rubiaceae) and *Miconia* (Melastomataceae), 25 species of *Peperomia* (at least 10 species at each site), 24 species of *Piper* (Piperaceae), and at least 15 species each for *Pleurothallis* and *Maxillaria* (Orchidaceae, Figures 6C, 6E, 6F, 6G, 6I, 6S, 6T, 6X, 6Y, 6Z, 6AA, 6HH, 6JJ, 6KK, 6LL, 6NN). We found high species richness in *Anthurium* (24) and *Philodendron* (18), both genera in the Araceae, a principally epiphytic and typically species-rich family at higher elevations. Species richness of *Elaphoglossum* ferns (more than 15, Figure 5H) was astonishing at Tinkanari (2,100-2,350 m); this campsite may be one of the global centers of diversity for the genus. At this same elevation, we recorded sympatric populations of at least 10 species of tree ferns (mostly in the genus *Cyathea*, Figures 5A, 5B, 5K), as well as 8 species of bamboo (*Chusquea* and close relatives).

We encountered fewer species and individuals of palms (Arecaceae; 23 species) than we expected, but lower-elevation sites in Megantoni probably support larger populations and more species. For Bromeliaceae, a principally epiphytic family, the area supports several abundant species, but with the exception of *Guzmania* (15 species) it does not seem especially species rich.

VEGETATION TYPES AND HABITAT DIVERSITY

In contrast to nearby Amazonian forests, where broad floristic similarity can be found over thousands of kilometers (Pitman et al. 2001), Andean forests are floristically heterogeneous at almost any spatial scale—from satellite images, to helicopter overflights, to short hikes on the ground. Even forests at similar elevations typically exhibit differences in composition and structure. Much of this heterogeneity derives from the rugged and varied topography, microclimatic changes along elevational gradients, disturbance from landslides, and dramatic, small-scale variation in substrate.

However, our understanding of how these factors interact to determine plant community composition remains limited.

Our inventory sites spanned 650-2,350 m in elevation. We were not able to sample sites at either the lowest (500-650 m) or the highest (2,350-4,000 m) elevations that make up some 20% of the Zona Reservada, but we believe that the sites we visited are representative of plant communities across a large proportion of the Zona Reservada.

Lower mountain slopes

(Kapiromashi, 650-1,200 m, 26-30 April 2004)

Our first campsite was situated adjacent to the Río Ticumpinía. We explored the forests dominated by patches of bamboo on the steeply ascending slopes on either side of the river valley. Overflights of the region suggest that similar plant communities grow along the Río Timpía on the eastern side of the Zona Reservada.

One of the largest rivers in the region, the Ticumpinía is fast-flowing and dynamic, changing course rapidly enough that our 2001 satellite image was already outdated. During our visit in the late rainy season, the river levels were unexpectedly low, exposing a broad floodplain (Figure 3C). We suspect that these forests receive 5-6 m of rain per year, with no significant dry periods. The high humidity, further exaggerated by the narrowness of the valley, may explain why we found several species typical of higher elevations at this site.

Guadua-dominated forest

A key feature of vegetation here and elsewhere at lower elevations in the Zona Reservada is scattered stands of stout *Guadua* bamboo (Figure 3E). Although the factors influencing the distribution of bamboo patches across the landscape are poorly understood, these stands are a continuation of the *Guadua* patches that dominate vast stretches of southwestern Amazonia. All trails at this site crossed *Guadua* patches, ranging from isolated clumps of bamboo to tangles covering several kilometers. Within larger patches of bamboo, species richness of plants was markedly reduced, and in some places downright depauperate. Transect data reveal that the understory

plant community growing in areas with bamboo is approximately half as rich as that growing nearby, outside *Guadua*-dominated forest (29 vs. 57 species).

Typically, bamboo stems were interspersed with a mixture of palms (*Socratea exorrhiza*, *Iriartea deltoidea*; Arecaceae) and secondary forest species (*Cestrum* sp., Solanaceae; *Neea* sp., Nyctaginaceae; *Triplaris* sp., Polygonaceae; *Perebea guianensis*, Moraceae; and spiny lianas of *Uncaria tomentosa*, Rubiaceae, the medicinal plant *uña de gato*, or cat's claw). Thin-stemmed shrubs and suffrutescent herbs dominated the understory, including *Begonia parviflora* (Begoniaceae), a *Sanchezia* sp. (Acanthaceae) with bright red bracts, and *Psychotria viridis* (Rubiaceae), an ingredient of the hallucinogen ayahuasca. Less frequently, we encountered species more typical of mature forest, including *Guarea* spp. (Meliaceae) and at least three species of Lauraceae.

Non-Guadua forest

Farther upslope in this area (above 800 m asl), we explored areas without *Guadua* bamboo and encountered more exciting plant assemblages, with a higher diversity of trees and shrubs. The plant community here was a mix of species typical of higher elevations, species typical of the lowlands, and secondary-forest species colonizing local disturbances. Because of the high frequency of landslides and treefall gaps, we found few undisturbed sites and few true dominants in the plant community.

Within the more humid valleys, several species grow below their known altitudinal ranges. Below 1,000 m we encountered *Bocconia frutescens* (Papaveraceae), which grows elsewhere above 1,700 m, and *Maxillaria alpestris* (Orchidaceae), an orchid known from 1,800-2,700 m at Machu Picchu.

Canopy trees here were larger than those growing within the *Guadua* stands, and more likely to be covered in trunk climbers. Several large tree species (dbh > 30 cm) typical of lower-elevation sites occurred here, including natural rubber, *Hevea guianensis* (Euphorbiaceae); two important but infrequent tropical timber trees, *Cedrela fissilis* (Meliaceae) and

Cedrelinga cateniformis (Fabaceae s.l.); *Poulsenia armata* (Moraceae); *Dussia* sp. and *Enterolobium* sp. (Fabaceae s.l.); and several species of *Ficus* (Moraceae). We observed few palm species. At surprisingly low densities, we encountered *Socratea exorrhiza*, *Iriartea deltoidea*, *Oenocarpus bataua*, *Wettinia maynensis*, and a few species of *Geonoma*, but we did not observe any species of the *Bactris* or *Euterpe* palms that typically co-occur with these species in lowland sites.

Like those of the overstory, understory communities contained a mix of secondary-forest species and species more typical of mature forest. We encountered 57 species in a 100-stem understory transect, and the most “common” species, *Henriettella* sp. (Melastomataceae), made up only 6% of the stems. Other common understory species included *Perebea guianensis* (Moraceae, 5%), *Miconia bubalina* (Melastomataceae, 5%), and *Tapirira guianensis* (Anacardiaceae, 4%). In the same transect, we registered 20 different families. Four families harbored the bulk of the species diversity: Lauraceae (7 species), Fabaceae *sensu lato* and Rubiaceae (6 species each), and Melastomataceae (5 species). In some areas, the shrubs *Psychotria caerulea* and *Psychotria ramiflora* (Rubiaceae) were locally dominant. In species richness this non-*Guadua* forest seems similar to other areas of wet Andean foothills in southern Peru and Bolivia, higher than much of the central Amazon, but not as rich as the flora of northern Peru and Ecuador.

River floodplain and islands

An obvious successional flora grows along the edge of the Río Ticumpinía and on the river island near our campsite, similar to riverside plant communities throughout lowland southeastern Peru (e.g., Madre de Dios). Clumps of *Tessaria integrifolia* (Asteraceae), *Gynerium sagittatum* (Poaceae), and *Calliandra angustifolia* (Fabaceae s.l.) grew closest to the river, followed by an overstory of *Ochroma pyramidale* (Bombacaceae), *Cecropia multiflora* (Cecropiaceae), and *Triplaris americana* (Polygonaceae). Behind these taxa, or sometimes interspersed with them, we frequently

encountered trees of *Guettarda crispiflora* (Rubiaceae) and *Inga adenophylla* (Fabaceae s.l.). At the center of the river island, a slightly depressed, wetter area supported an herb layer including species of *Mikania* (Asteraceae), *Costus* (Costaceae), and *Renalmia* (Zingiberaceae).

Streamside forest

In the beds of the larger streams thrives a low-diversity assemblage of colonizing species, including *Tovaria pendula* (Tovariaceae), three species of *Urera* (*U. caracasana*, *U. baccifera*, *U. laciniata*; Urticaceae), *Acalypha diversifolia* (Euphorbiaceae), scrambling *Phytolacca rivinoides* (Phytolaccaceae) and *Mikania micrantha* (Asteraceae), a spiny *Wercklea ferox* shrub (Malvaceae), and dense patches of *Banara guianensis* treelets (Flacourtiaceae). In the second-growth overstory alongside the stream, we found several abundant species important for vertebrate frugivores. They included *Inga adenophylla* (Fabaceae), an *Allophylus* sp. (Sapindaceae), four species of *Piper* (Piperaceae), and a large-leaved *Guarea* (Meliaceae).

Large *Ladenbergia* (Rubiaceae) trees—a species obvious from afar with its broadly ovate leaves and panicles of dried, dehisced capsules—and *Triplaris* (Polygonaceae) trees, protected by fierce *Pseudomyrmex* ants, dominate the less frequently disturbed forest along the streams. Below their canopy, we commonly encountered an understory flora of *Sanchezia* sp. (Acanthaceae), *Psychotria caerulea* (Rubiaceae), *Macrocnemum roseum* (Rubiaceae), and *Hoffmannia* spp. (Rubiaceae). Also, we observed extensive understory populations of *Heliconia robusta* (Heliconiaceae), a rarely collected species, known in Peru from only a handful of collections.

Middle-elevation tablelands

(Katarompanaki, 1,350-2,000 m, 2-7 May 2004)

From the Río Ticumpinía valley we flew via helicopter to an isolated, two-tiered tableland near the center of ZRM. From the air we saw stunted vegetation on the top tier, and much taller, closed-canopy forest on the lower tier. On the ground we found that extremely hard

rock underlay the vegetation growing on the top tier, and the stunted size of the free-standing plants likely reflects the limited nutrient availability and poor growing conditions of this substrate. Our camp was centered in the stunted vegetation on the top tier, and we spent most of our time sampling these plant communities. Our last two days were dedicated to exploring the lower tier.

Stunted forests on rock outcrops are common in Megantoni. Although these communities have a consistent appearance and forest structure when seen from the air, floristic composition appears to vary substantially from one to the other, with different species dominating each hard-rock surface. This variation may reflect biogeographic barriers to dispersal among sites with similar geology, random assembly of communities, different geochemistry, or even microendemism caused by recent speciation on isolated substrates.

A wall of clouds forms an almost permanent bank on the southern edge of the top tier of the platform, and both the density and the diversity of epiphytic climbers are higher at this site than at the first campsite. Whereas on the lower mountain slopes plant diversity is concentrated in trees and shrubs, at this higher site the bulk of the diversity shifts to epiphytic and herbaceous plants, especially on the top tier of the tablelands.

Orchids illustrate this shift dramatically. The ~120 species of Orchidaceae recorded across both tiers account for nearly a quarter of the plant diversity at this site. Moreover, of the 66 species we found in bloom, at least 17 do not resemble any known species and are likely new to science (Figure 6).

Below we focus on the floristic differences and similarities between the two tiers, characterizing the vegetation on each, and comparing the vegetation on these two tiers of the middle-elevation tablelands to our inventory sites on the lower slopes (Kapiromashi) and somewhat higher middle-elevation slopes (Tinkanari).

Upper tier (1,760-2,000 m)

The top tier of the tableland resembles a tilted platform, which slopes upward toward the southeast and rises

over 200 m in elevation from its lowest to its highest point. As the elevation on the upper platform increases, the plant community decreases in stature and in diversity. This change is perhaps best exemplified by the distribution of *Dictyocaryum lamarckianum* (Arecaceae) palms. At lower elevations on the upper tier, *D. lamarckianum* is one of the dominant trees. But as elevation increases, the population thins out and individuals are shorter. At upper elevations on the platform, the low-diversity assemblage does not include any *D. lamarckianum* palms.

Our 100-stem understory transect at lower elevations on the upper tier (~1,760 m) contained 28 species, compared to only 13 species at the upper end of the platform (~2,000 m). However, diversity in both transects was lower than would be expected for either of these elevations, presumably because the extremely hard (and likely acidic) rock substrates limit the number of species able to colonize this site. As a point of comparison, an understory transect at the higher Tinkanari campsite (~2,200 m) registered 32 species.

On the lower reaches of the platform, the canopy was ~15-20 m tall, and three tree species dominated the overstory and understory: *Alzatea verticillata* (Alzateaceae) and a large-leaved *Clusia* sp. (Clusiaceae, Figure 3G) growing alongside *D. lamarckianum* palms. Filling in the gaps among individuals of these three species was a mix of short-statured trees in the families Melastomataceae, Rubiaceae, and Euphorbiaceae (four species each); at least three species of tree ferns; and an occasional small palm (*Euterpe precatoria*, *Geonoma* spp.; Arecaceae).

On the upper reaches of the platform, where lightning strikes probably cull out tall trees, vegetation was much shorter: the canopy was ~2 m high, with a few “emergents” reaching 4 m. Three species were overwhelmingly abundant here, including *Weinmannia* sp. (Cunoniaceae), *Cybianthus* sp. (Myrsinaceae), and a small-leaved *Clusia* sp. A few species of *Chusquea*-like bamboos with thin, floppy stems occurred infrequently at this elevation, often supported by other stems. Silvery *Ceroxylon parvifrons* palms, a preferred food of

spectacled bears (*Tremarctos ornatus*, Figure 11B), were scattered throughout. Many of these short palms had obvious chew marks on their stems. The uprooted stems of others were discarded, with the soft interior nearly entirely consumed.

Lower tier (1,350-1,600)

To gain access to the lower tier, we followed a trail 5 km northeast of camp, crossing half a dozen streams and ending in a spectacularly steep descent of nearly 250 m. On the lower tier, patches of closed-canopy forest grew interspersed with patches of secondary growth. Here the canopy was 30-40 m tall, with several emergent trees extending another 10 m above it.

Our only trail on the lower tier skirted the steep rock face below the upper tier, passing one large waterfall and crisscrossing a large stream. We examined the plant communities along both sides of the stream and studied the flora along the banks from within the stream itself, walking as far up- and downstream as possible.

Alongside the stream, we encountered a flora principally composed of species from lower elevations; every once in a while we were surprised to find a species typically occurring at much higher elevations. Many of the species had been recorded at the Kapiromashi campsite, nearly 500 m lower than this site, including species such as *Guettarda crispiflora* (Rubiaceae) and *Banara guianensis* (Flacourtiaceae). Within the canopies of streamside trees, we spotted the large red flowers of *Mucuna rostrata* (Fabaceae), a species known from lowland floodplains in Peru. This elevation may be the highest recorded for this species. Also growing alongside the stream were species more typical of higher elevations, such as an abundant flowering *Turpinia* tree (Staphyleaceae).

Fruiting plants were remarkably abundant on the forested terraces on either side of the stream, and species with large fruits important for frugivores were especially well represented (see Mammals). Walking around the 1.5-km loop, we encountered fruits of *Caryocar amygdaliforme* (Caryocaraceae), three species of *Ficus* (Moraceae), two species of Myrtaceae (probably *Eugenia*), *Tabernaemontana sananho*

(Apocynaceae), two *Psychotria* spp. and one *Faramea* sp. (Rubiaceae), at least four species of Melastomataceae, a softball-sized Cucurbitaceae, and an *Anomospermum* sp. (Menispermaceae).

On these forested terraces, we encountered several trees more than 1 m in diameter, including 2 legumes (*Parkia* sp., *Dussia* sp.; Fabaceae), 3 species of *Ficus* (Moraceae), and at least 1 species of *Pouteria* (Sapotaceae). For our two 100-stem understory transects on either side of the stream, we recorded ~70% species overlap and nearly equivalent species richness (50 and 46 species). One transect was dominated by *Iriartea deltoidea* (Arecaceae, 9%), a palm species that is often the most common tree in Amazonian tree plots (Pitman et al. 2001), and the other by a *Croton* sp. (Euphorbiaceae, 8%) with a single gland on the petiole. In addition to these 2 species, both transects contained nearly equivalent numbers of *Protium* (Burseraceae), *Coussarea* (Rubiaceae), *Mollinedia* (Monimiaceae), and *Chrysochlamys* (Clusiaceae). Several dominants in the understory at this site, including *Urera baccifera* (Urticaceae) and *Pourouma guianensis* (Cecropiaceae), were present in similar abundances in the Kapiromashi understory transects. More than half of the species belonged to five families: Lauraceae (8 species), Rubiaceae (7 species), Melastomataceae (6 species), Myrtaceae (3 species), and Chloranthaceae (2 species).

Middle-elevation slopes

(Tinkanari, 2,100-2,400 m, 9-14 May 2004)

From the middle-elevation tablelands, we flew across 41 km of ridges and valleys to reach the eastern edge of the Zona Reservada, adjacent to Parque Nacional Manu. The headwaters of the Río Timpía and the Río Manu originate on these slopes, and most of the streams contained fast-flowing, oxygenated water.

Slopes at this elevation are usually precipitous, and views across the valley revealed several sheer cliffs and sharp inclines on most of the facing slopes. However, this site was uncharacteristically flat. In one depressed area, a small, stagnant, blackwater pond had formed, and all of the forest we explored had only a gentle slope.

As at the middle-elevation tablelands, two main forest types occur at this site. A tall, closed-canopy forest is the principal vegetation in the area and surrounds small, isolated patches of stunted shrub forest growing on shallow soils over hard rock near the edge of the escarpment that drops to the valley below. These two forest types share only 10% of their species, despite abutting each other.

Tall forest

Tall forest dominates the vegetation at this site. The canopy ranges from 30 to 40 m tall, with some emergent trees surpassing 50 m. The tree community is not diverse and is dominated by a few species. Along most trails, *Calatola costaricensis* (Icacinaceae) accounts for a quarter of the trees in the subcanopy and its large, hard seeds litter the ground. Growing in the understory alongside *Calatola* was a mix of two species of *Hedyosmum* (Chloranthaceae) and tree ferns or bamboo (*Chusquea*). The high canopy is dominated by trees of *Hyeronima* sp. (Euphorbiaceae), *Heliocarpus* cf. *americanus* (Tiliaceae), *Weinmannia* sp. (Cunoniaceae), *Elaeagia* sp. (Rubiaceae), *Ficus* spp. (Moraceae), and many huge, broad-crowned *Sapium* (Euphorbiaceae) of a species none of us had seen before (and which we were unable to collect). We found few large (> 80 cm diameter) individuals of *Podocarpus oleifolius* (Podocarpaceae), *Juglans neotropica* (Juglandaceae), and *Cedrela montana* (Meliaceae). *Alnus acuminata* (Betulaceae) and *Morus insignis* (Moraceae), genera typical of northern temperate forests, are frequent colonizers of landslide disturbances.

The dominant shrubs are *Mollinedia* sp. (Monimiaceae) and an *Oreopanax* sp. (Araliaceae), while *Pilea* spp. (Urticaceae) are the most conspicuous terrestrial herbs. We found abundant root parasites *Corynaea crassa* (Balanophoraceae) growing on *Hedyosmum* roots, but not exclusively.

Ferns are an important and conspicuous element of these forests (Figure 5). In a 5 x 25 m transect we counted 30 species of ferns and their allies (Pteridophyta). Pteridophyta also dominated the epiphyte community, and trees supported an average of

10 epiphytic fern species per trunk. Tree ferns (mostly *Cyathea*; Figures 5A, 5B, 5K) are superabundant and diverse in the understory at this site. Extrapolating from a 150 x 1 m transect, tree fern densities at this site could reach 2,000 individuals per ha. We commonly encountered 5 to 6 species of tree ferns; 3 or 4 others specialize on particular habitats and occur infrequently.

Tree ferns were most common in intact forest with a high canopy, even if the understory received substantial amounts of light. In contrast, the common large *Chusquea* bamboo (with stems ~10 cm diameter) formed extensive solid stands principally in areas with few high canopy trees. Tree fern and bamboo populations rarely co-occur, suggesting that bamboo may invade areas where the canopy has been disturbed (e.g., after a violent windstorm), but as trees recover and begin to shade the bamboo, tree ferns can gradually recolonize the area and ultimately replace the bamboo.

Stunted shrub forest

Shrub forest covers a 0.5-km² area on the exposed southwestern face of these middle-elevation slopes and is distinctly visible from the air. On the upslope portions of the shrub forest, the tallest stems nearly reach 6 m. The plant community decreases in stature and changes in composition as the slope descends. On the upslope portions, the forest appears orange from afar, thanks to orange-leaved species in the genera *Graffenrieda* (Melastomataceae), *Clethra* (Clethraceae), *Clusia*, *Weinmannia* (Cunoniaceae), *Styrax* (Styracaceae), and *Cybianthus* (Myrsinaceae). Several small species of *Chusquea* bamboo grow haphazardly on this upper portion. Although many genera are shared with the stunted forest growing on the Katarompanaki tablelands, most species are distinct.

Further downslope, the *Graffenrieda* is still present, albeit shorter in stature, but most of the other upslope dominants disappear. The plant community here is much shorter, averaging 1.5 m. Several terrestrial orchids are common this area, including *Gomphichis plantaginifolia* and *Erythrodes* sp., mixed with *Blechnum* ferns and a small-leaved clonal *Clusia* that dominates the vegetation, along with three species of

less common *Ilex* (Aquifoliaceae) and a stiff-leaved *Miconia* (Melastomataceae), among others. The small wax palm present at Katarompanaki, *Ceroxylon parvifrons*, occurs here as well, where spectacled bears also consume it.

ORCHIDS (Norma Salinas)

The Orchidaceae is one of the most diverse flowering plant families in the world, with 25,000 to 35,000 species. Individuals vary broadly in size, ranging from almost tiny epiphytes to shrubs.

The eastern slopes of the Andes—from Colombia to Bolivia—support a high diversity of orchids, with many endemic species. During the last 30 years in Peru, few plant collectors have focused on orchids, and there are probably many orchids species still awaiting discovery. In a rapid inventory of Cordillera del Cóndor, 26 of the 40 orchid species were new to science (Foster and Beltrán 1997). More recent studies have resulted in hundreds of new records for Peru, and have shifted the known centers of diversity for many genera, including *Lycaste*, *Kefersteinia* and *Stenia*, from Ecuador and Colombia to Peru.

Not surprisingly, we encountered a rich orchid community in Megantoni during our inventory, in almost every sampled habitat (Figure 6). In a little over two weeks, we found 116 species of fertile orchids, and ~80 sterile species. Our estimates for sterile species are conservative, as many species of the subtribe Pleurothallidinae are easily confused without flowers. Nor do these estimates include the subtribe Oncidiinae, a family that flowers during a different season, as do several other subtribes.

We suspect 20 of the 116 fertile species may be new to science. Additionally, various species are new records for Peru, including *Elleanthus hirtzii*, previously known only from Ecuador. The Zona Reservada is pristine, and we found healthy and large orchid populations. Of the flowering species, 90% were epiphytic, and 10% terrestrial. A few species were lithophytes, growing on rocks or cliff faces.

Species in the genera *Maxillaria*, *Epidendrum*, *Lepanthes*, *Platystele*, *Pleurothallis* and *Stelis* represented the majority of the fertile orchids observed during the inventory. We registered several species in rare genera, including *Baskervilla*, a genus with fewer than ten species, and distributed from Nicaragua to Peru and Brazil. Additionally, we found a species of *Brachionidium*, a genus that is poorly represented in Peru even though it ranges from Costa Rica to Bolivia.

All sites visited during the inventory (from 760 to 2,350 m asl) displayed high orchid species richness. Of all the flowering plants at each site, in Kapiromashi (~760-1,200m) 7% were orchids, in Katarompanaki (~1,300-2,000 m) 24% were orchids, and in Tinkanari (~2,100-2,350 m) 11% were orchids.

In several genera we observed hints of incipient speciation. For example, we found two species of *Sobralia* that closely resembled *S. virginalis* and *S. dichotoma*. However, upon closer inspection, morphological differences on the lip of both species are large enough to suggest that the specimens from Megantoni are either in the later stages of speciation, or already distinct species. Similarly, we observed variability in form and color of many species of *Maxillaria*, along with high species richness in this genus.

Of the fertile orchid species, few are shared with other orchid-rich areas in Peru (e.g., Machu Picchu, Manu, Vilcabamba). A few species are restricted to small areas, or threatened in other areas of Peru, but present large healthy populations in the ZRM. For example, both *Masdevallia picturata* (Figures 6A, 6H) and *Maxillaria striata* (Figure 6TT) are considered threatened in Parque Nacional Manu, yet appear abundant in Megantoni. Also, an *Otoglossum* sp. found abundantly at the Tinkanari campsite was found only occasionally in PN Manu at 2,500-2,600 m asl. A species recently described from Machu Picchu, *Prosthechea farfanii*, also has large populations in Megantoni. These data suggest that other sites in ZRM may harbor populations of orchids that are suffering declines in other areas of the Andes, including perhaps *Masdevallia davisii*, a species with critically low numbers of individuals.

NEW SPECIES, RARITIES, AND RANGE EXTENSIONS

Although most of the plant species we collected during the inventory are still unidentified, some already have been confirmed as new species, or substantial range extensions for described species. As more species are identified, or additional new species are confirmed, we will update our plant list at <http://www.fieldmuseum.org/rbi/>.

We include collection numbers for each potential new species or range extension, as a reference to collections housed at the Vargas Herbarium in Cusco (NS, Norma Salinas) or the Museum of Natural History in Lima (HB, Hamilton Beltrán).

The bulk of potentially new species are orchids; most come from the higher-elevation campsites. Preliminary revisions in the Vargas Herbarium in Cusco of collections from Peru, Bolivia, and Ecuador suggest that perhaps 20 of the 116 fertile orchid collections may be new to science (see Orchids, Figure 6), a remarkable number for a three-week inventory. Based on digital photographs we took in the field, specialists have tentatively identified 9 additional plant species as new to science. All are from our two higher-elevation campsites.

On the upper tier of the middle-elevation tablelands at Katarompanaki campsite (1,300-2,000 m), we encountered potential new species in the following genera: *Psammisia* (Ericaceae, NS6931; Figure 4A), *Schwartzia* (Marcgraviaceae, NS6880; Figure 4F), *Trichilia* (Meliaceae, NS6788), and *Macrocarpaea* (Gentianaceae, NS6869). At Tinkanari, our highest-elevation site on the middle-elevation slopes, we found several potential new species, including an Acanthaceae with lilac-colored flowers (NS7198), a *Sphaeradenia* (Cyclanthaceae, NS7184), a Gesneriaceae with a big, pedunculate fruit (HB5950, Figure 4C), a *Hillieria* cf. sp. with bright orange flowers (Phytolaccaceae, NS7237; Figure 4E), and a *Tropaeolum* sp. (Tropaeolaceae, NS7235).

Several collections in Megantoni extend the known ranges of species hundreds of kilometers farther south. One is from our low-elevation campsite,

Kapiromashi, where we registered *Wercklea ferox* (Malvaceae, NS6735) for the first time in southern Peru. At Katarompanaki, we found *Ceroxylon parvifrons* (Arecaceae, NS7037), *Tapinostemon zamoranum* (Gentianaceae, NS6857; Figure 4B), *Sarcopera anomala* (Marcgraviaceae, NS6881) and *Macleania floribunda* (Ericaceae, NS6939). At Tinkanari, we encountered *Miconia condylata* (Melastomataceae, NS7211) and *Peltastes peruvianus* (Apocynaceae, NS7273; Figure 4D), both previously known only from northern Peru.

Our collection of *Heliconia robusta* (Heliconiaceae, NS6600) fills a large gap in its distribution. This *Heliconia*, with triangular green and red bracts and yellow flowers, dominated parts of the naturally disturbed forest around our low-elevation campsite, Kapiromashi. Known mostly from Bolivia, it has been collected only a handful of times in Peru and was overlooked in the *Catalogue of the Flowering Plants and Gymnosperms of Peru* (Brako and Zarucchi 1993).

Two species encountered at the higher-elevation sites are first collections for Peruvian forests. Although seen and reported in Huanuco and Puno, our Tinkanari collection of *Spirotheca rosea* (Bombacaceae, NS7128; Figure 4G) is the first specimen for any Peruvian herbarium. Another first specimen for Peru, *Guzmania globosa* (Bromeliaceae, NS6808; Figure 4H) grew in small patches on the upper tier of the Katarompanaki tablelands. This species was previously known from Ecuador and photographed, but not collected, in the rapid biological inventory of Cordillera Azul (Alverson et al. 2001).

THREATS, OPPORTUNITIES, AND RECOMMENDATIONS

Zona Reservada Megantoni connects two important conservation areas: Parque Nacional Manu and the Vilcabamba conservation complex (Parque Nacional Otishi and Reservas Comunes Ashaninka and Machiguenga, see Figure 1). We recommend the highest level of protection for the valleys, slopes, mesas, ridges, and high-altitude grasslands that span the elevational gradient of more than 3,500 m within ZRM. Intact

elevational transects are rare in the tropical Andes, and protecting ZRM is urgent. Natural gas is being extracted to the north, and colonization threatens from the south. If ZRM is not protected, a rare opportunity to link two large protected areas and to protect more than 2.6 million ha will be lost.

Judging from our observations from the overflight, the inventory, and satellite images, we recognize several particularly well-preserved and unique habitats within ZRM. Wet high-altitude grasslands (puna) experience intense land use, overgrazing, and overburning in other areas of Peru. Compared to Parque Nacional Manu and other areas of the eastern Andean slopes, from the air Megantoni appears to contain possibly the least disturbed extensions of high-altitude grassland in Peru. Protecting ZRM provides an opportunity to preserve the full richness of this intact mountain flora and could provide a living reference for restoration efforts in degraded grasslands nearby.

The expansive mid-elevation tablelands, including Katarompanaki camp where we found more than 15 orchid species new to science, are a geological formation that appears to occur only in Megantoni, and not in the neighboring Cordillera Vilcabamba conservation complex or Parque Nacional Manu. Protecting Megantoni will safeguard these unique landscape features and will protect a site important for orchid populations. Orchids are protected under CITES regulations in Peru, and formal protection of Megantoni will impede unauthorized orchid collecting.

The importance of Megantoni as a conservation area does not rest solely on its role as a pristine biological corridor, but also reflects the endemic species that occur within its boundaries. We estimate a flora of ~3,000-4,500 species for ZRM. We know some of these plant species are shared with neighboring Manu and Vilcabamba. However, our knowledge of plant communities at all three of these sites is too limited to calculate exact numbers of species unique to each area. As a preliminary indication, the 25-35 species potentially new to science imply high levels of plant endemism within ZRM (see Figures 4, 6). These

potential new species, discovered during 15 days of plant surveys, suggest that 1-2% of all the plant species projected to occur in Zona Reservada Megantoni are not currently known from adjacent protected areas or any other site in the world. Additional surveys may uncover some of these undescribed species in neighboring Manu or Vilcabamba. However, given the number of floristic novelties found during the rapid inventory, future inventories in Megantoni are likely to uncover additional endemic species in ZRM.

DUNG BEETLES

(Coleoptera: Scarabaeidae: Scarabaeinae)

Participant/Author: Trond Larsen

Conservation targets: Large dung beetle species, susceptible to local extinctions and functionally important for dispersing seeds, controlling mammalian parasites, and recycling nutrients (especially *Deltochilum*, *Dichotomius*, *Coprophanaeus*, *Phanaeus*, and *Oxysternon*); several rare and restricted-range species (including at least ten species new to science); healthy populations of medium-sized and large mammals, especially monkeys, that provide essential dung resources; intact habitats that support distinct dung beetle communities sensitive to habitat degradation

INTRODUCTION

Dung beetles (subfamily Scarabaeinae) are diverse and abundant, and their diversity often mirrors broader patterns within the community (Spector and Forsyth 1998). Since they depend on mammal dung for food and reproduction, dung beetle populations often reflect mammal biomass, and by extension, hunting intensity. Moreover, dung beetles show high beta-diversity across habitat types and are sensitive to many kinds of disturbance, including logging, hunting, and most types of habitat degradation (Hanski 1989; Halfpfter et al. 1992). Dung beetles also play an important role in ecosystem functioning. By burying vertebrate dung, beetles recycle plant nutrients, disperse seeds, and reduce infestation of mammals by parasites (Mittal 1993; Andresen 1999).

To my knowledge, no one has published a study of dung beetle communities in the Peruvian Andes. Between 1998 and 2003, I sampled dung beetles at several sites in southeastern Peru, both in Amazonian and Andean forests on the eastern side of Zona Reservada Megantoni. The dung beetle diversity in several of the lowland sites (the Río Palma Real area, Los Amigos Biological Station, and Cocha Cashu Biological Station) is among the highest known in the world, with over 100 dung beetle species at a single site. In the Kosñipata valley, adjacent to ZRM, I found that dung beetle diversity decreases with increasing elevation. Many of these dung beetle species show restricted ranges and many remain undescribed.

METHODS

To sample dung beetle communities, I used a combination of baited pitfall traps and unbaited flight intercept traps. Each pitfall trap consisted of two stacked 16-oz (473-ml) plastic cups buried in the ground with the top rim flush against the soil surface. I filled the top cup halfway with water and a small amount of detergent to reduce surface tension. For each dung-baited trap, I wrapped ~20 g of human dung in nylon tulle and suspended the bait above the cups by tying it to a short stick pushed into the ground. Traps were standardized with human dung because it was readily available and is among the most attractive types of dung to most species of dung beetles (Howden and Nealis 1975). To prevent beetles from landing on the bait and to protect the trap from sun and rain, I covered the bait and the cups with a large leaf. I collected the samples every 24 hours, usually for a period of four days, although a few traps were set for only two days. This trapping method and trapping period usually provides relatively complete and quantitative descriptions of the diversity, composition, and relative abundances of the beetle community.

Within each of the four sites (Kapiromashi, Katarompanaki upper and lower platform, Tinkanari), pitfall traps were placed along as many trails and habitats as possible, and spaced at least 50 m apart. I installed at least ten traps in primary forest at each

site, and as many traps as possible in additional habitats. I replaced dung baits every two days.

Since many generalist and specialist species of dung beetles use other food resources, I also set pitfall traps baited with rotting fruit (primarily banana), rotting fungus, dead fish, and dead insects. I placed up to three traps with each of these bait types in each of the four sites, spacing them at least 50 m apart.

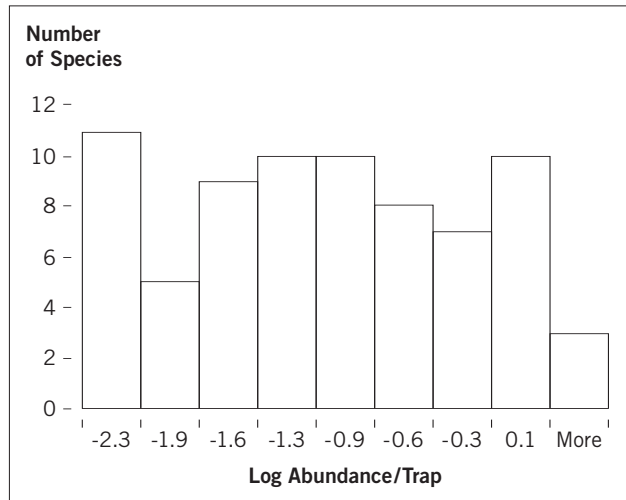
To sample dung beetle species not attracted to any of these bait types, I set flight intercept traps to catch beetles passively without any bait by stretching a rectangular sheet of dark green nylon mesh (1.5 x 1 m) between two sticks, and placing trays of soapy water beneath the mesh, to catch beetles flying into the mesh (Figure 7C). One or two flight intercept traps were placed at each site.

I identified and counted beetles the same day they were collected, preserved voucher specimens in alcohol, and deposited these specimens in the Museo de Historia Natural de la Universidad Nacional Mayor de San Marcos in Lima, Peru, and at Princeton University in Princeton, New Jersey, USA. Additional specimens will eventually be deposited in the U.S. National Museum of Natural History of the Smithsonian Institution in Washington, D.C.

RESULTS

I recorded 71 species and 3,623 individuals of dung beetles during 15 days of sampling in Zona Reservada Megantoni. Judging from my collections from Madre de Dios, I estimate that ~10-35 of the dung beetle species are new to science. Using EstimateS (Colwell 1997), a software program that predicts species diversity based on sampling effort, I evaluated the efficacy of my sampling during the inventory. Although additional sampling would register more species, in two weeks I managed to sample the majority of dung beetle species at the four inventory sites. Extrapolating from my dung beetle research in Manu and other Peruvian sites, I estimate that additional sampling would register ~120 species of dung beetles for the entire Zona Reservada.

Figure 14. Dung beetle species abundance distribution for all sites in the Zona Reservada Megantoni. Rarer species shown at left.



Dung beetle communities in Megantoni contained an unusually high number of rare species (Appendix 2, Fig. 14). Twelve species were trapped only once, and an additional five species were trapped twice, suggesting that these species are naturally rare or near the edge of their distributional limits. Several species, such as *Coprophanaeus larseni* and a new species of *Eurysternus*, appear to be genuinely rare throughout their range. As a point of comparison, the most common species, *Ontherus howdeni*, was represented by 446 individuals.

Kapiromashi

At this lowest site, I sampled dung beetles in primary forest, secondary forest, *Guadua* bamboo, and a wide, dry gravel riverbed. Of the 41 species I found at this site, 39 were encountered in primary forest, 23 in bamboo, and 20 in secondary forest. Only 4 species were trapped in the riverbed. Beetle abundance was highest in primary forest, followed in descending order by secondary forest, bamboo, and riverbed. I captured 16 species in only one habitat type. Two species of *Canthidium* were found only in flight intercept traps and may specialize on an unusual food or microhabitat. I trapped one individual of *Coprophanaeus larseni* in a carrion-baited pitfall trap in upper primary forest.

This species appears to be very rare and was recently described on the basis of just three specimens.

Katarompanaki lower platform

This lower platform contained mostly tall, mature forest very distinct from the vegetation of the upper platform. I sampled only in primary forest at this site and found 30 species. Beetle abundance here was just slightly lower than in the primary forest of Kapiromashi. I captured 3 species (2 *Canthidium* spp., 1 *Ateuchus* sp.) only in flight intercept traps, and these species may specialize on unknown resources. I captured one individual of a species of *Bdelyrus* in a fruit-baited trap. This dung beetle genus is poorly represented in museum collections, probably because of its unusual diet. Some *Bdelyrus* species may specialize on the detritus that collects in bromeliads or in tangled lianas, and other species have been attracted to rotting fungi.

Katarompanaki upper platform

The upper platform was characterized by unusual, stunted vegetation with low tree diversity growing on hard acidic rock with little or no soil and a thick humus layer. This site had only ten dung beetle species and low beetle abundance. Two of the species (*Deltochilum* sp. nov. aff. *barbipes* and *Uroxys* sp. 6) were not found in the lower platform and appear to be new to science.

Tinkanari

At the highest site, I sampled beetles in tall primary forest (~15-25 m tall), intermediate primary forest (~5-15 m tall), short forest/open shrub (~0-5 m tall), *Chusquea* bamboo, and young regrowth forest along a landslide. Thirteen of the 14 species found at this site were in tall primary forest, 8 in secondary forest, 5 in intermediate-height primary forest, 5 in bamboo, and 3 in short forest/open shrub. Abundance was highest in tall primary forest, followed by bamboo, secondary, intermediate, and short forest. I found four species in only one habitat type: 3 in tall primary forest and 1 in short forest/open scrub. Two of these were species of *Canthon*, a genus rarely found in this elevational range, and both species appear to be new to science. This site

contained a higher proportion of nocturnal species (64%) than the lower sites. Although I sampled several species at carrion and in flight intercept traps, these same species were also attracted to dung. I did not collect any dung beetle species at fruit or fungus traps at this site.

Community patterns across habitats and sites

Across the four sites, species richness and abundance decreased with increasing elevation, with the exception of the upper platform at Katarompanaki, which exhibited lower species richness and abundance than Tinkanari (Table 3). This pattern likely reflects the distinct, stunted vegetation and low mammal biomass on the upper platform of the Katarompanaki tablelands. Within each site, species richness and abundance varied greatly among habitat types (Table 4), with several general trends. Tall primary forest (~15-25 m tall) always contained the highest diversity and abundance of dung beetles, followed by intermediate-height forest (~5-15 m tall), secondary forest, and bamboo, and finally by scrub and open habitats (~0-5 m tall).

Species composition varied greatly among sites, and across habitats within sites (Table 4). Most species (80%) showed restricted elevational ranges of 300 m or less. The sites closest in elevation shared the most species; the most widely separated sites shared only one species. Similarity indices (Sorenson abundance and Morisita-Horn) among all sites were very low. When species did

occur at more than one site, they were typically abundant at one site yet represented by one or a few individuals at another, suggesting that they may have been collected near the limits of their range at one of the sites. Within sites, habitats most similar in forest height, forest structure, and soil seemed to have the most similar species composition of dung beetles. Although larger species of dung beetles are often less abundant than smaller species, Zona Reservada Megantoni contains uncommonly high abundances of large species such as *Dichotomius planicollis*, *D. diabolicus*, *D. prietoi*, *Phanaeus meleagris*, *P. cambeforti*, and *Oxysternon conspicillatum*.

The areas we visited were almost completely pristine. Human disturbances within the reserve could harm dung beetle populations. At the lowest-elevation site, Kapiromashi, we found evidence of past hunting activity (old hunting trails, planted bananas) and observed fewer mammals, particularly monkeys, than expected. Although dung beetles were most abundant at this site, abundance standardized by sampling effort (21.9 individuals/trap) was lower than I expected at 850 m asl and was only slightly higher than the beetle abundance at the Katarompanaki lower platform (19.3 individuals/trap). Natural disturbance regimes also affected dung beetles. In Kapiromashi and Tinkanari I found much lower beetle diversity and abundance in

Table 3. Dung beetle diversity and abundance across four sites in the Zona Reservada Megantoni, compared to 8 sites in Valle Kosñipata, Manu.

	All Megantoni (4 sites)	Kapiromashi	Katarompanaki, lower platform	Katarompanaki, upper platform	Tinkanari	Valle Kosñipata, Manu (8 sites)
Elevation sampled (m)	730-2,210	730-900	1,350-1,500	1,600-1,900	1,950-2,210	650-3,200
# 24 hr traps	238	70	56	27	75	297
Species observed	71	41	30	11	14	82
Species predicted (ACE)	79	48	38	15	17	
Individuals	3,623	1,533	1,081	169	840	4,246
Individuals/trap sample	15.2	21.9	19.3	6.3	11.2	14.3
Rare spp (1 trap)	12	9	8	4	3	
Rare spp (2 traps)	5	2	2	1	1	
Shannon diversity index	3.30	2.93	2.16	1.52	1.42	
Simpson diversity index	18.01	13.95	5.16	2.96	2.86	

Table 4. Similarity comparisons in dung beetle composition across sites and habitats in the Zona Reservada Megantoni and Parque Nacional Manu.

Site 1	Site 2	S Obs 1	S Obs 2	Shared S	Sorenson	M-H
All sites Megantoni	All sites Manu	71	82	49	0.43	0.47
Kapiromashi	Katarompanaki	41	33	11	0.15	0.11
Kapiromashi	Tinkanari	41	14	1	0.00	0.00
Katarompanaki	Tinkanari	33	14	6	0.06	0.02
KAT Tall mixed forest	Short <i>Clusia</i> forest	26	10	8	0.07	0.19
TIN Tall mixed forest	Open shrubs	13	3	2	0.01	0.06
KAP Primary forest	Secondary forest	34	20	20	0.33	0.59
TIN Primary forest	Secondary forest	13	8	8	0.15	0.87
KAP Primary forest	<i>Guadua</i> bamboo	34	23	21	0.14	0.60
TIN Primary forest	<i>Chusquea</i> bamboo	13	5	5	0.38	0.95
S Obs 1	# species observed in Site 1	M-H	Morisita-Horn community similarity index			
S Obs 2	# species observed in Site 2	KAP	Kapiromashi			
Shared S	# species shared	KAT	Katarompanaki			
Sorenson	Sorenson-abundance index	TIN	Tinkanari			

Table 5. Resource partitioning among dung beetles at three sites in the Zona Reservada Megantoni.

Site	# Species	>dung	no dung	day	night	crep	>1 hab	1 hab
All	71	24%	10%	45%	41%	14%	68%	32%
Kapiromashi	41	24%	12%	51%	29%	20%	61%	39%
Katarompanaki	33	18%	12%	36%	52%	12%	–	–
Tinkanari	14	14%	0%	29%	64%	7%	71%	29%
>dung:	species attracted to dung and other food type			crep:	crepuscular species			
no dung:	species never attracted to dung			>1 hab:	species found in more than 1 habitat type			
day:	diurnal species			1 hab:	species only found in 1 habitat type			
night:	nocturnal species							

secondary forest than in primary forest (Table 4). Areas colonized by bamboo had much lower beetle diversity and abundance than primary forest.

Resource partitioning

In response to competition within a large species assemblage, dung beetles partition resources in several ways. Species range from generalists to specialists and partition resources by food type, diel activity, and habitat selection, among other ways. I found that 24% of all the beetle species in the reserve were generalists attracted to another type of food in addition to dung

(Table 5). These other foods included fungus, fruit, and carrion. Ten percent of all species collected were never attracted to dung, suggesting that they specialize exclusively on other food resources. No Neotropical dung beetle species are known to specialize only on particular types of dung (Howden and Nealis 1975; Larsen, unpubl. data).

Species were fairly evenly split between diurnal and nocturnal species (45% and 41% respectively). The remaining 14% of species had crepuscular habits. Despite my sampling across several habitats at each site, 32% of

all species were restricted to a single habitat type. The amount of overall resource partitioning decreased with increasing elevation (Table 5). At higher elevations, more species responded solely to dung baits, and fewer species are never attracted to dung. In these higher elevations nocturnal species dominated the community, and species moved more freely among habitat types. This decrease in resource partitioning corresponded with a decrease in dung beetle diversity and abundance.

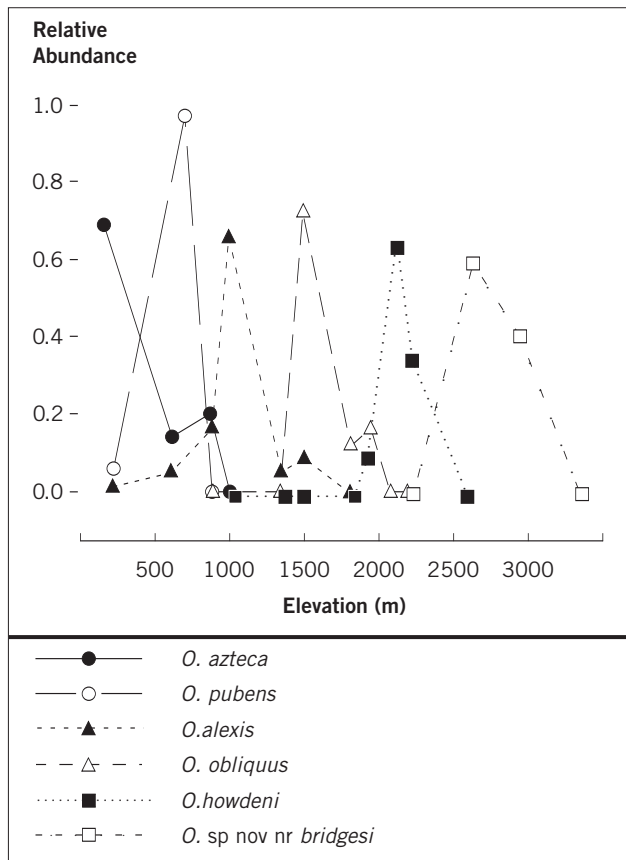
Congener segregation

Across inventory sites in Megantoni, I observed elevational segregation of species in the genus *Ontherus*. This genus probably experienced a species radiation in the Andes and is one of the few dung beetle genera that are more diverse and abundant in the mountains than in the nearby lowlands. Since the species collected in Megantoni showed a similar distributional pattern to those collected in Manu, I combined the data collected from the two regions. Each species of *Ontherus* is replaced by another species at increasing elevation (Fig. 15). The *Ontherus* species distributions do not seem to correspond to ecotones between vegetational zones; the underlying factors determining their distributions remain unknown. However, since the congeners are so similar in size, morphology, diel activity, and diet, interspecific competition is likely to be intense and may prevent sympatric coexistence.

DISCUSSION

Zona Reservada Megantoni spans a broad range of elevations and habitat types and contains an unusually high diversity of dung beetles. Dung beetle diversity decreases with increasing elevation, and encountering 71 dung beetle species between 730 and 2,210 m asl is exceptional. Many of the beetle species in Megantoni have restricted ranges (80% of species have altitudinal ranges narrower than 300 m). Many species are habitat specialists and ~10-35 are probably species new to science.

Figure 15. Congener segregation by elevation in the genus *Ontherus* for combined sites from the Zona Reservada Megantoni and Parque Nacional Manu.



Comparison with Valle Kosñipata, Parque Nacional del Manu

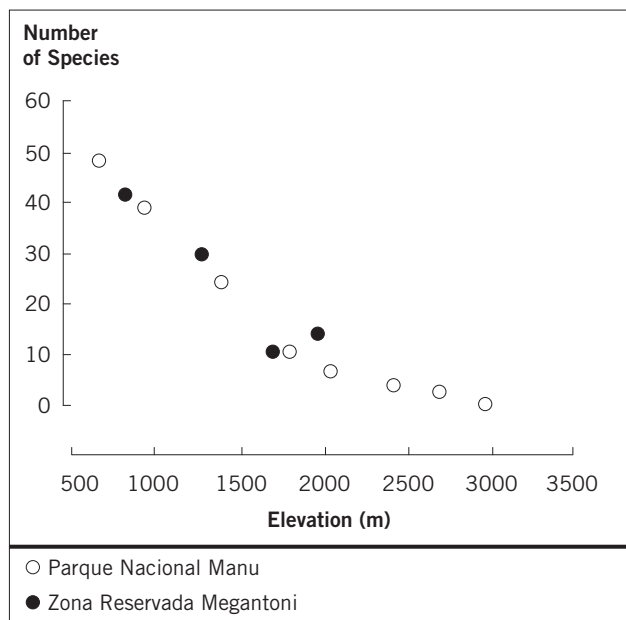
In November 1999, I collected 82 species of dung beetles in Valle Kosñipata, in the buffer zone of Parque Nacional Manu. This site lies less than 100 km to the south of Zona Reservada Megantoni and encompasses a similar elevational range (see Figure 1). Pending direct comparison of specimens, I estimate that 31% of the beetle species I collected during the rapid inventory are unique to Megantoni and not found in Manu. In Manu I encountered more species, but I also sampled at twice as many sites (8) and within a broader elevational range (650-3,200 m) (Table 3). In direct comparisons of elevational diversity between Manu and Megantoni, several trends emerge (Fig. 16). The lowest inventory

site, Kapiromashi, and the upper platform of the middle-elevation site, Katarompanaki, display levels of species richness similar to levels expected at corresponding elevations in Manu. In contrast, the lower platform of Katarompanaki, which contains tall, mature forest, and the higher elevation site, Tinkanari, both exhibit considerably higher dung beetle diversity than would be expected at equivalent elevations in Manu. Beetle abundance per trap was nearly equivalent between Manu and Megantoni.

Patterns of diversity and resource partitioning

Dung beetle diversity and abundance were highest in the tallest mature forest and at lower elevations. This pattern might reflect decreased resource availability associated with lower mammal biomass at higher elevations and in shorter and more open forest. The high abundance of large dung beetles in Megantoni is a strong indication that the habitats are intact and contain many large mammals, since large beetle species are often the most sensitive to disturbance and require plentiful dung. These large beetle species are the most functionally important for burying dung and dispersing seeds.

Figure 16. Comparison of elevational pattern of dung beetle species richness in the Zona Reservada Megantoni and Parque Nacional Manu.



The ways in which dung beetles partitioned resources according to food type, habitat, and diel activity may help explain how such a large number of species can coexist while competing for similar resources. With a natural reduction in species diversity at higher-elevation sites, I also observed less resource partitioning. Debate is still intense over the mechanisms that enable species coexistence, particularly in the highly diverse tropical lowlands. My results suggest that a high degree of resource partitioning in response to competitive interactions could play a strong role in facilitating species coexistence in species-rich sites. The pattern of *Ontherus* congener segregation with elevation provides additional evidence that competition could structure dung beetle communities and determine species distributions.

THREATS, OPPORTUNITIES, AND RECOMMENDATIONS

Very few pristine areas of forest connect puna with lowlands. Aside from containing many endemic species, such corridors are essential for animal movement, especially in response to climate change and global warming. Species with narrow elevational ranges, including many of the dung beetles in Megantoni, may be the most sensitive to global warming and to local changes in climate associated with deforestation.

Hunting pressures would almost certainly decrease beetle abundance and could lead to local species extinctions. In turn, local extinctions of many dung beetles would disrupt the functions performed by beetles, such as seed dispersal and parasite control, which affect other animals and plants in the ecosystem. Protecting dung beetles, particularly the larger species so abundant in Megantoni, will safeguard some of the functional interactions among species that maintain ecosystem integrity.

The best way to conserve dung beetles and their functional roles in the ecosystem is to maintain large areas of intact habitats and to minimize the impacts of hunting. Studying the elevational and latitudinal distributions of dung beetle species in these

Andean montane and premontane areas could contribute to understanding how species will respond to climate change and deforestation, as well as to mitigating species extinctions in one of the most species-rich and biologically important regions in the world.

FISHES

Authors/Participants: Max H. Hidalgo and Roberto Quispe

Conservation targets: Fish communities in streams and other aquatic habitats that drain the intact forests between 700 and 2,200 m asl; endemic Andean species such as *Astroblepus* (Figures 8B, 8D), *Trichomycterus* (Figures 8E, 8F), *Chaetostoma* (Figure 8A); species highly specialized on fast-flowing waters and restricted to elevations above 1,000 m; pristine aquatic habitats in the Peruvian Andes that support healthy populations of native species; headwater streams of the Río Ticumpinía and Río Timpía (Figure 3K), which harbor a unique ichthyofauna

INTRODUCTION

The drainage network of Zona Reservada Megantoni (ZRM) forms part of the watershed of the lower Río Bajo Urubamba (Cusco Department). In the past six years several studies have documented the biodiversity and the conservation status of the fish communities of this region, especially in areas near the Amazonian basin (Ortega et al. 2001). To date, few studies have surveyed fish in tributaries of the lower Urubamba above 700 m elevation, mainly because the rugged terrain and steep slopes are difficult to reach and streams in the area are not navigable.

Our primary goal was to inventory the ichthyofauna in the suite of aquatic habitats found in ZRM, with an emphasis on streams above 700 m elevation in the eastern region. Many rivers and streams that originate on highland slopes (~4,000 m) drain the ZRM and provide habitats for species uniquely adapted to aquatic Andean environments. Compared to other Andean sites, fish communities in the ZRM have remained isolated from human influence. Our inventory provided a unique opportunity to document an unknown ichthyofauna in an area of high conservation value.

METHODS

Collection and analysis of biological material

We collected fishes using several different netting methods, including a 7 x 1.8-m net with a 5-mm mesh, a 3 x 1.2-m net with a 2-mm mesh, an 8-kg cast net, a dip net, and a small aquarium net. We seined areas near riverbanks and in the main channel with the large nets. Nets also functioned as fish traps when placed at the base of rapids; we removed rocks from these rapids and chased fish towards the nets. We used the cast net to take repeated, more quantitative samples of fish. At each sampling station, we repeated the various fishing methods until we obtained a representative sample. Local guides accompanied and assisted us at each site.

We preserved all specimens in a 10% formalin solution for 24 hours and transferred them to 70% alcohol for long-term preservation. The specimens were labeled, prepared, and packed for transport to Lima.

The majority of fishes were identified in the field. For species that we suspected could be new to science, we took photographs to send to specialists. For the purposes of the rapid inventory, we classified unidentifiable species as morphospecies, as in previous inventories in Yavarí and in Ampiyacu, Apayacu, Yaguas, and Medio Putumayo (Ortega et al. 2003, Hidalgo and Olivera 2004). All specimens were deposited at the Museo de Historia Natural-UNMSM in Lima and are now part of the museum's Ichthyological Collection.

Selection of sampling stations

We took GPS coordinates at each sampling station, and we referenced points to the base camp, recording the physical characteristics of each station (Appendix 3). Sampling efforts were variable and were greater in the larger aquatic environments. We constructed trails to survey a variety of aquatic habitats, and at the first site we followed the course of the Río Ticumpinía to inventory areas upstream and downstream from the base camp. We never used boats in this inventory.

In Kapiromashi, we sampled fishes in the Río Ticumpinía and in tributary streams. We conducted river sampling primarily in areas with sandy beaches,

rapids, and braided channels around river islands. We also sampled tributary streams along transects extending ~200 m upstream from their confluence with the main river.

In Katarompanaki and Tinkanari, we established trails along the river course and tried to sample upstream and downstream areas equally. We sampled all streams accessible by trail. Only in Tinkanari did we sample a lentic environment, a small blackwater pond.

Description of sites and aquatic environments

We sampled aquatic habitats in Kapiromashi (four days), Katarompanaki (five days), and Tinkanari (five days), surveying 23 sites, 8 at the first and third campsites and 7 at the second campsite (Appendix 3). These sites corresponded to 17 streams and 6 sites along the Río Ticumpinía. In Kapiromashi, all collection sites were whitewater rivers, in Katarompanaki all were blackwater rivers (or blackwater mixed with whitewater), and at the third site we sampled mainly whitewater rivers. At the first site, we were able to sample all the aquatic habitats that we identified in the Kapiromashi area. At the second site, we were unable to sample either the rivers that feed the Ticumpinía or the area where smaller streams enter the main tributaries below the tablelands. At the third site, we were unable to reach the Río Timpía or the large blackwater lakes that we saw from the helicopter.

Kapiromashi (~750-900 m asl)

This site was in the Río Ticumpinía valley (Figure 3C). We sampled streams draining areas between 750 and 900 m elevation. The Río Ticumpinía harbors the largest number of fish species and sustains the largest fish biomass when compared to the smaller streams in the area. The river is an eastern tributary of the lower Urubamba, and their confluence lies ~6 km north of the Pongo de Maenique (see Figure 2).

The Río Ticumpinía is a medium-sized, whitewater river that turns green during the dry season. Its highly sinuous channel is 30-50 m wide, dotted with islands of variable size (1 km long near base camp, Figure 3C). Bed sediments contain small and medium-

sized rocks, with sandy beaches in the bends of the river and muddy areas where the rocky islands connect with the main channel. During the rapid inventory the average river depth was 80 cm, with a maximum depth of 1.5 m. The river changed ~150 m in elevation over ~5 km. Large sandy beaches lined the riverbanks in several areas; in others, vertical, vegetation-covered walls defined the channel.

The Ticumpinía contains many rapids that can generate differences as great as 3 m in water level over distances of ~50 m, and can create a strong current. Because of this current, we were unable to sample the area where the Ticumpinía forms, near the confluence of the Shakariveni to the south and an unnamed river to the north, despite its short distance from base camp (~5 km). We did sample the shallow, slow-moving water in the narrow channels around river islands. Streams feeding the Río Ticumpinía were generally small (up to 4 m wide) and characterized by completely transparent water and a mixture of cobble, gravel, and sand in the streambed.

Katarompanaki (~1,360-1,700 m asl)

Our campsite was situated on a tableland between the rivers that form the Ticumpinía, at 1,769 m. We sampled all aquatic habitats that we could reach by trail between 1,360-1,700 m asl, traveling between two platforms on the tablelands. Streams in this area apparently drain toward a northern confluent of the Río Ticumpinía and the majority lay on the higher platform (1,700 m asl). Only one stream drained the forest on the lower platform (1,360 m asl).

The aquatic habitats of the platforms differed in their geomorphology and riparian vegetation. Vegetation on the high platform was dominated by arboreal *Clusia* spp. (Clusiaceae), whereas the lower platform contained more diverse vegetation, with taller trees, a closed canopy, and many fruiting species (see Flora and Vegetation). The streams of the upper platform were generally small (up to 4 m wide and 1.2 m deep), with turbulent blackwater, cobbles and moss-covered boulders, and steep slopes (~ 30°). These characteristics

distinguished streams at this site from those at Kapiromashi and Tinkanari.

The stream draining the lower platform (1,360 m) was the largest sampled near this camp (up to 13 m wide) and was distinct from all other streams surveyed in the inventory. Slippery bedrock covered the entire width of the channel for at least 500 m and we found several pools up to 1.5 m deep. After 500 m, the bed sediment changed and boulders created small waterfalls, similar to those in the tributaries of the Tinkanari.

Tinkanari (~2,100-2,200 m asl)

This site was situated near the headwaters of the Río Timpía, in the mountain range that forms the eastern border of ZRM. We sampled all aquatic habitats accessible by trails between ~2,100 and 2,200 m asl. Some streams drain directly into the Río Timpía; others drain into larger streams that later flow into the Río Timpía.

Tree ferns and tall canopy trees dominated the riparian vegetation. Slopes of rivers were variable, with gentle slopes in small streams, and steep slopes and waterfalls (~1-6 m in height) in the larger streams. Nearly all streams were whitewater, varying in width (2-13 m) and containing a heterogeneous mix of cobbles, boulders, and fine gravel. Along a 1-km transect in the largest stream, we observed some deep pools up to 2 m deep, usually below waterfalls.

During the helicopter flight to this camp, we noticed several large blackwater lagoons (~100 m diameter) near the Río Timpía. Close to the campsite we found a small blackwater pond; however, we suspect the biota of this pond differs from the much larger lagoons. This pond measured 25 m across and 1.8 m deep and had a large mat of algae and a muddy bottom. Grasses and orchids grew around its edges. The pond likely occurs close to the water table. Despite intense effort, we did not collect a single fish in the pond and did not include this sample in the data analysis. We suspect the larger lagoons do contain fishes, given their proximity to the Río Timpía.

RESULTS

Species diversity and community structure

The 3,132 individual fishes registered during the inventory include 22 species, 13 genera, 7 families, and 2 orders (Appendix 4). Of these 22 species, only 8 have been identified to species (36%) and at least 10 require more detailed study (in *Astroblepidae*, *Trichomycteridae*, *Cetopsis* and *Chaetostoma*) for identification.

For several species we will need to consult monographs, museum specimens, and specialists. We cannot confirm identifications for any species of *Astroblepidae* or *Trichomycteridae*, as few studies of these groups exist. Several probably represent species new to science, e.g., *Astroblepus* sp. C (S. Schaefer, pers. comm., Figure 8D). Peruvian species of *Chaetostoma* (*carachamas*) currently are being revised, and we expect to find species new to science in this group as well, such as *Chaetostoma* sp. B (N. Salcedo, pers. comm., Figure 8A). *Cetopsis* sp. is an undescribed species known from the lower Urubamba (R. Vari, pers. comm., Figure 8G).

Fish communities in ZRM consist exclusively of fishes in the orders Characiformes and Siluriformes. Some of the Characiformes species are also found in lowland forest streams and widely distributed in Amazonia (*Astyanax bimaculatus*, *Hoplias malabaricus*). We also recorded species restricted to south-central Peru, especially to streams above 300 m asl in the Urubamba, Pachitea, and Perené drainages (*Creagrutus changae*, *Ceratobranchia obtusirostris*), or to streams draining the foothills of the transition zone between lowland and upland forest (*Bryconamericus bolivianus*, *Hemibrycon jelskii*). Among the Siluriformes, the majority of the species are catfish and lack scales. One of these is *Rhamdia quelen*, a species with broad distribution in the Peruvian Amazon. Some species in the *Trichomycteridae* are probably restricted to the Andes in central and southern Peru, and at least one species (*Trichomycterus* sp.1) also occurs in the lowland areas of the Urubamba and Manu, as well as around Tambopata.

With the exception of *Hoplias malabaricus* (*huasaco*) and *Rhamdia quelen* (*cunchi*), adult fishes are

small, measuring less than 15 cm, and in the Characidae, less than 10 cm. We collected some *Astroblepus* sp. B that are 15 cm in length, a size rarely observed in scientific collections (Figure 8H). The other 3 species of *Astroblepus* we found were more typical sizes, with the largest individuals measuring ~7 cm.

About 10 of the species are fished locally for subsistence by the indigenous communities near the Zona Reservada (Appendix 4), principally Timpía and Sababantiari. With the exception of *Astroblepus* sp. B (Figure 8H), all of the species fished for food we found were in the Río Ticumpinía and surrounding streams.

Diversity by site

Kapiromashi

With 17 species (9 of Siluriformes and 8 of Characiformes), this site supported the highest species richness of the three inventory sites. All families registered in the inventory were present here (Appendix 4), and fish abundance in streams near this camp was the highest of any site in the inventory (85% of total individuals). In the Characiformes alone, 80% of the individuals registered during the inventory were recorded at Kapiromashi. None of the species registered here was present in streams at the other inventory sites.

We collected only one or two individuals of some species (Appendix 4). Other genera, such as *Ceratobranchia*, *Astyanax*, and *Hemibrycon*, were more abundant and common in several habitats. Although less abundant than the Characidae, *Chaetostoma* was common and occurred at densities similar to those observed in the upper part of the Río Camisea (300 to 450 m asl; Hidalgo 2003). *Chaetostoma* was more abundant in rivers than in streams; it may be a food for various species of aquatic birds and for river otters. Overall, sampling species of *carachamas* was difficult as they inhabit turbulent waters, and their abundances may be greater than our estimates.

Fishes in Kapiromashi represent various functional feeding groups. The majority of the omnivorous species are Characidae (*Astyanax*, *Bryconamericus*, *Ceratobranchia*, *Hemibrycon*, *Knodus*, *Creagrutus*) and Trichomycteridae. All of the species of

Loricariidae are herbivores, feeding on algae by scraping their teeth on rocks and submerged logs. Very little is known about the feeding ecology of *Astroblepus*, but probably they also eat algae growing on hard substrates characteristic of the turbulent streams of the Andes, or feed on the abundant aquatic insects that inhabit these environments.

In aquatic habitats where bed sediments are composed of clay, we observed tunnels made by carachamas, also observed previously in the Bajo Urubamba. *Ancistrus* species use the tunnels to make nests. *Chaetostoma* and *Ancistrus* lay sticky eggs on boulders or inside submerged logs and guard their nests.

Among the predators, the largest (and one of the few piscivores that we registered in the inventory) was *Hoplias malabaricus* (*huasaco*), which can measure up to 50 cm in length. This species generally prefers areas of less current where it sits and waits for its prey. Other predators, like larger individuals of *Rhamdia quelen*, are nocturnal predators that actively search for their food. *Cetopsis* (Figure 8G) likely prefers aquatic insects or small fishes, both of which are abundant in the Río Ticumpinía.

Katarompanaki

At this site we collected three fish species, two *Trichomycterus* (Figures 8E, 8F) and one *Astroblepus* (Figures 8B, 8H). Compared with Kapiromashi, Katarompanaki had very few species, but all were different. The fish community composition at the second site might reflect the isolation of its aquatic habitats from main river channels or physical characteristics of the higher-elevation streams.

Fish sampling was difficult at this site. Compared with species found in streams near the first campsite, species collected at this site were cryptically colored, blending in with the bed sediments where they live and eat (*Trichomycterus*) or attaching themselves to the substrate (*Astoblepus*), where they are almost impossible to observe.

In the streams of the upper platform (~1,700 m), we registered only *Trichomycterus* sp. C (Figures 8C, 8E), a species present at low abundances in almost all

streams sampled. In the large stream of the lower platform (~1,360 m), we registered *Trichomycterus* sp. D (Figure 8F) and *Astroblepus* sp. B (Figures 8B, 8H). Of the three sites, this one had the lowest abundance of individuals (4% of total) and species (13%).

Tinkanari

Here we registered five species of fishes, three *Astroblepus* and two *Trichomycterus*. All of the species found in streams near the Katarompanaki camp were present here, but two *Astroblepus* species were unique to Tinkanari. Fish abundance was higher here (11% of total) than at Katarompanaki.

Streams at this site are whitewater and rocky, with steep slopes, all potentially favourable conditions for *Astroblepus* species. Species of *Astroblepus* inhabit all streams here, and in two streams we found three species living in sympatry. Species of *Astroblepus* have a ventral mouth, pelvic and pectoral fins with hooks, and an abdominal musculature unique among the Siluriformes. These morphological adaptations allow *Astroblepus* to climb and attach to steep, turbulent, lotic environments, including cliff faces (Figure 3H), with little difficulty. According to S. Schaefer (pers. comm.), finding several species of this genus coexisting within a stream is unusual.

Great variation in morphology exists within the Astroblepidae, and we have only a rudimentary understanding of their systematics. We cannot confirm that the three species we observed are truly distinct from each other. However, based on our preliminary observations and consultations with specialists, the probability that they are different taxa is high, and at least one species is likely new to science.

Noteworthy records

Despite low overall species richness, we documented substantial populations of fishes in streams within these intact highland forests. Because of the geographic isolation of the watersheds, many of these species are likely endemic to the area (Vari 1998, Vari et al. 1998, De Rham et al. 2001). In particular, species in the families Astroblepidae and Trichomycteridae have

unique adaptations that allow them to live in the turbulent waters of these highland streams. At least three species we collected are new to science; these include *Cetopsis* sp. (Figure 8G), *Chaetostoma* sp. B (Figure 8A), and *Astroblepus* sp. C (Figure 8D) and, pending further revisions, will likely include species of Trichomycteridae as well.

DISCUSSION

Comparisons with adjacent areas (Urubamba and Manu)

This study is the first inventory of fishes in ZRM. We studied fish communities between elevations of 750 and 2,200 m asl, where diversity and abundance of fishes are lower than in the Bajo Urubamba (202 species; H. Ortega, pers. comm.) and the Río Manu (210 species; Ortega 1996), the areas adjacent to ZRM. Both the Bajo Urubamba and the Manu are large drainages, flowing into the Amazonian lowlands and creating multiple microhabitats with high species richness and fish biomass.

In the Urubamba, only two inventories surveyed streams above 500 m elevation. Eigenmann and Allen (1942) reported 21 species in the Alto and Medio Urubamba (~700 m), similar to the richness encountered in ZRM (22 species). Species overlap between ZRM and the Alto and Medio Urubamba is high in the Characiformes and Siluriformes: the two faunas differ only in the two species of electric fishes registered in ZRM. These electric fishes are found in the lower sections of the Bajo Urubamba, but not the Alto or Medio Urubamba.

As part of the environmental impact assessment (EIA) of the Camisea natural gas pipeline (Camisea EIA 2001), 33 species of fishes were reported in various tributaries of the Alto Urubamba and the Río Apurímac (610-1,250 m asl). Additional collections were made in the Río Cumpirosiato (tributary of the Alto Urubamba). Species composition in ZRM is similar to that of fish communities sampled in the EIA; however, the total abundance registered in our study was much greater

(3,132 individuals in 23 sites vs. ~300 individuals in 12 sites). Both Camisea EIA (2001) and Eigenmann and Allen (1942) surveyed aquatic environments along the western slopes of the Urubamba along the Cordillera de Vilcabamba, as well as the Río Apurímac valley. Neither study evaluated fish communities along the eastern slopes, where ZRM lies.

In Manu, Ortega (1996) collected fishes between 600 and 1,000 m asl in the Alto Madre de Dios (between Salvación and Pilcopata), registering 25 species. Species richness is similar to that of ZRM, but community composition differs at the species level for several genera (*Creagrutus*, *Hemibrycon*, *Trichomycterus*, and maybe *Astroblepus*). In addition, other genera (*Bario*, *Hemigrammus*, *Gymnotus*) characteristic of the Amazon lowlands were absent in ZRM, and *Bario* has never been recorded in the Bajo Urubamba.

In the Alto Madre de Dios, Ortega also reported certain genera that we expected to find inhabiting foothill streams of ZRM (up to ~1,000 m), such as *Parodon* and *Prodonotocharax*, which are both represented in the Bajo Urubamba. Like the Urubamba, the Alto Madre de Dios has electric fishes (*Gymnotus*), the most diverse and frequently encountered genus in the Amazon lowlands and floodplain. Additional inventories would probably register these species in ZRM.

The differences in community composition between ZRM and the Alto Madre de Dios may reflect topographic differences in the two watersheds. In contrast to Manu National Park (Madre de Dios), the rugged topography of the Río Timpía and Río Ticumpinía, with their many waterfalls, seems to have limited the dispersal of species present in the lowlands (lower Urubamba) to areas above 500 m.

Comparison with other areas in Peru

Species richness in ZRM is typical of highland regions, and comparable to that of other higher-elevation inventories. Ortega (1992) lists only 80 species above 1,000 m elevation in Peru, including all of the aquatic habitats of the western and eastern Andean slopes. These species account for less than 10% of the freshwater fish diversity of Peru (Chang and Ortega 1995).

In the Río Perené watershed (600-900 m asl), Salcedo (1998) reported 45 species. When this watershed is compared to ZRM, similarities exist in species composition of the Characiformes and generic composition of the Siluriformes (except *Cetopsis* sp. nov. in ZRM). In the Río Pauya watershed (Parque Nacional Cordillera Azul), De Rham et al. (2001) reported 21 species of fishes between 300 and 700 m asl, in genera similar to those of fish communities in ZRM. Nonetheless, several fishes in the Río Pauya inhabit only the lower part of the watershed. For the Cordillera del Condor, Ortega and Chang (1997) reported 16 species inhabiting streams between 850 and 1,100 m, including a new species of *Creagrutus*.

In the Cordillera de Vilcabamba, Acosta et al. (2001) concentrated their efforts on collecting aquatic invertebrates and evaluating the limnology of streams draining the slopes of the Apurímac valley (1,700-2,400 m asl). One *Trichomycterus* sp. and one *Astroblepus* sp. were collected during this study. Although neither has been identified to species, they may be different from species found in ZRM. As in ZRM, abundance of these two species was low.

In summary, the ichthyofauna of ZRM contains a surprising richness of fishes adapted to its turbulent waters, abundant fish populations, and several new species. Considering the areas still unstudied (see Results), we estimate that ZRM contains close to 70 fish species. Fish inventories in the Andes are scarce, and this inventory fills an important gap in our knowledge of Peru's freshwater fishes.

THREATS, OPPORTUNITIES, AND RECOMMENDATIONS

Opportunities for conservation and research

The natural ichthyofauna in many aquatic environments in the Peruvian Andes has been drastically reduced by changes in water quality after habitat alteration (e.g., deforestation, pollution), and often several exotic species have successfully invaded the natural habitats. In Lake Titicaca, the introduction of rainbow trout

(*Oncorhynchus mykiss*) and the Argentine *pejerrey* (*Odonthesthes bonariensis*), combined with habitat degradation, has resulted in the near extinction of *Orestias cuvieri*, the largest species in a genus endemic to the high Andes (~4,000 m) between Peru and northern Chile. In the Alto Urubamba watershed, trout are widespread in natural environments and are cultivated throughout the watershed. This degradation is absent in ZRM. Megantoni offers the unparalleled opportunity to conserve aquatic habitats that are still free of nonnative invasive species (see Figures 3H, 3K).

The protection of the headwaters of several rivers and other intact aquatic habitats within ZRM is critical for preserving the hydrologic cycle in these watersheds, as well as the natural ichthyofauna. The ichthyofauna of ZRM remains unknown in several areas: the lower part of ZRM, from 500 to 700 m asl; the Río Yoyato drainage; the upper Río Timpía; the aquatic habitats of the mountains between the Río Ticumpinía and the Pongo de Maenique; habitats between 900 and 1,500 m asl; the Río Urubamba where it passes through the Pongo del Maenique; the blackwater lagoons of the upper Río Timpía; the ponds of the high-altitude grasslands (puna); and the aquatic ecosystems inside ZRM west of the Pongo, including part of the Río Saringabeni.

Opportunity is great for studies of the ecology, evolution, and biogeography of restricted or endemic species in the highland habitats of these mountains. Studies of beta diversity in this area are of special research interest, especially since we observed very little overlap between species at the three inventory sites. We also expect that future studies may shed light on the potential for isolation and vicariance to promote speciation in fishes, especially *Astroblepus* and *Trichomycterus*.

Threats and recommendations

Colonization of ZRM could threaten the quality of aquatic ecosystems. For the most isolated areas of ZRM, such as the headwaters of the Timpía (Figure 3K) and Ticumpinía, and some of the high-altitude grasslands, colonization is a minor threat. However, if local

authorities continue to promote land colonization in the area, perhaps even these seemingly inaccessible territories may become threatened.

The extraction of hydrocarbons is perhaps the largest threat to ZRM, as the Camisea gas operation lies just ~40 km north of the Zona Reservada. The next few years may see increased exploration for gas deposits along the lower Urubamba. Additional gas exploration risks polluting the lower Urubamba and altering migration patterns of fishes reproducing closer to the headwaters (up to ~500 m asl), affecting local fish distributions and possibly reducing game fish species. Surveillance of fish communities, in addition to monitoring resource use by local fishermen, will be critical to understanding how to protect the lower Urubamba drainage.

An additional threat for the ichthyofauna of ZRM is the constant use of natural toxins (known locally as *barbasco* or *huaca*) for fishing (Figure 12A). For several ethnic groups that inhabit the lower Urubamba, this is a traditional fishing method, along with arrows, harpoons, and nets. Casual observations suggest these natural toxins harm fish communities and other aquatic biota, but few scientific studies in Peru quantify this damage, especially at a population level evaluating cumulative effects. We recommend investigating the effects of fishing toxins on aquatic communities, and complementing these studies with workshops or environmental education programs or both, to reduce toxin use in local communities.

We suggest an integrated management plan for the watersheds of ZRM, from the headwaters of the Timpía to the Ticumpinía and other aquatic ecosystems. ZRM is a refuge for native fishes that are rapidly disappearing from other parts of the Peruvian Andes. A refuge in this region will conserve ecosystems that are threatened by colonization and development in other areas of Peru.

AMPHIBIANS AND REPTILES

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Conservation targets: Communities of anurans, lizards, and snakes typical of middle-elevation slopes in southeastern Peru (1,000-2,400 m asl); amphibian communities in streams; populations of rare species and species with restricted distributions, including *Atelopus erythropus* and *Oxyrhopus marcapatae* (Figure 9B); new amphibian species including an *Osteocephalus* (650-1,300 m asl, Figure 9E) and a *Phrynopus* (1,800-2,600 m asl) also known from the Kosñipata valley, at least one new species of *Eleutherodactylus* (1,350-2,300 m asl), a *Centrolene* (1,700 m asl, Figure 9H), a *Colostethus* (2,200 m asl), one possibly new species of *Gastrotheca* (2,200 m asl, Figure 9F), and a *Syncope* (1,700m) that is the most southerly record of this genus in Peru; a new species of snake (*Taeniophallus*, 2,300 m; Figure 9D); new species of lizards, including a *Euspondylus* (1,900 m asl, Figure 9A) also present in Vilcabamba, and three other unidentified lizards (*Proctoporus*, *Alopoglossus* [Figure 9C], and *Neusticurus*) living on the isolated tablelands in Megantoni; lower elevation (< ~700 m) populations of yellow-footed tortoises (*Geochelone denticulata*) hunted for food

INTRODUCTION

Sampling of the herpetofauna in the Urubamba valley was not systematic before this inventory. Scattered reports exist of amphibian and reptile species that occur between Kiteni and Machu Picchu (Henle and Ehrl 1991, Reeder 1996, Köhler 2003). In 1997, amphibian and reptile communities were sampled as part of the environmental assessment for natural gas explorations in Camisea (Icochea et al. 2001). More extensive inventories were conducted in the Kosñipata valley in the higher elevations of Parque Nacional (PN) Manu (Catenazzi and Rodríguez 2001). A rapid inventory in the Cordillera Vilcabamba sampled areas at 2,100 and 3,400 m asl in PN Otishi and along the slopes of the Río Tambo and Río Ene, and in Reserva Comunal Machiguenga (~ 1,000m) in the Urubamba valley (Rodríguez 2001). In 1999 an expedition on the outskirts of Comunidad Nativa Matoriato, ~5 km north of Zona Reservada Megantoni (ZRM), found several common lowland species of amphibians and reptiles (CEDIA 1999).

Nevertheless, the amphibians and reptiles of ZRM were virtually unknown before the rapid inventory. Judging from our data from similar elevations in the Kosñipata valley (Catenazzi and Rodríguez 2001), we expected to encounter 50 to 60 species of amphibians in the range sampled during this rapid biological inventory. We found 51 species (Appendix 5).

Here we report our results from three inventory sites (650-2,350 m asl) within Megantoni, and compare our observations with the herpetofauna known from other sites on the eastern slopes of the Peruvian Andes. In particular, we highlight groups characteristic of similar elevations in nearby regions and compare amphibian and reptile communities between ZRM and other protected areas in the National System of Protected Areas in Peru (SINANPE), such as PN Manu and the Vilcabamba conservation complex (PN Otishi, RC Machiguenga, RC Ashaninka).

METHODS

We recorded anurans, snakes, and lizards at every site. We focused our sampling efforts on anurans, which have greater abundances than snakes and lizards, and better-known distributions.

We sampled during the day and at night, using a mix of visual and auditory surveys. From surveys of frog calls we determined relative abundance of species in different habitats. We focused on streams and humid areas and conducted several intensive surveys of leaf litter. During the inventory, the ichthyological team collected several tadpoles.

We photographed, identified, and released species we could positively identify. For potentially new species or species that are difficult to identify in the field, we fixed specimens in 10% formaldehyde solution, preserved them in alcohol, and deposited them at the Museo de Historia Natural of the UNMSM in Lima. We recorded calls of several species for comparison with recordings from the Kosñipata valley, or to write the first scientific descriptions of their calls.

We sampled for 170 hours over 19 days in three inventory sites. Our sampling effort differed

among sites. At Kapiromashi, we sampled mostly at night for 4-6 hours until 11 P.M. At the two higher-elevation sites, we sampled most extensively during the day and visited trails and stream edges from 6 until 10 P.M. In the Katarompanaki tablelands, we spent ~65% of our time on the upper tier (~1,700 m asl) and ~35% on the lower tier (~1,350 m asl). Other members of the inventory team, particularly Guillermo Knell and Daniel Rivera, contributed observations and captured animals.

We surveyed a variety of habitats.

At Kapiromashi, we sampled along the beaches and channels of the Río Ticumpinía, seasonal streams, low-elevation streams, alluvial forests, and bamboo-dominated forest (*pacales*, Figure 3E). Here we also sampled several microhabitats including vegetation along trails and streams up to 2 m in height, palm leaf litter, water-filled internodes of bamboo stems, tree buttresses, light gaps, and pools in streams.

At Katarompanaki and Tinkanari, we sampled hillside forests, fast-moving streams (including two in Katarompanaki with sandstone substrates), streams on the upper platform of the tablelands, waterfalls, pools, and stunted forests. We sampled most intensively leaf litter, vegetation along trails and streams, moss, epiphytic bromeliads, tree buttresses, and arboreal ferns. During the helicopter ride between Katarompanaki and Tinkanari, we saw several blackwater lagoons (~1,500-2,000 m asl) but were unable to sample these.

RESULTS

We encountered 51 species of amphibians and reptiles: 32 amphibians, 9 lizards, and 10 snakes. Slightly more than 20% are species new to science: 7 anurans, 4 lizards, and 1 snake (See Appendix 5). Our inventory increased the known geographic and elevational distributions of several species and even a few genera. Megantoni is the southernmost distributional record in Peru for *Syncope*, including an undescribed species, and the lowest elevation recorded for *Phrynopus* and *Telmatobius*.

One-fifth of the herpetofauna in ZR Megantoni is new to science. This landscape also harbors several endemic reptiles. Moreover, the herpetofauna

complements the diversity found in PN Manu and RC Machiguenga in the Vilcabamba mountains, with only minimal overlap between these areas.

Kapiromashi

At this low-elevation site (650-1,200 m asl), we registered 13 amphibians, 3 lizards, and 2 snakes. We encountered mostly species typical of the lowlands but found here at the upper elevational limits of their distributions. Notably, we found *Epipedobates macero* (Figure 9G), a rare poison dart frog restricted to the Purús in Brazil, PN Manu, and the basin of the Río Urubamba. This record extends the elevational range of *E. macero* to 800 m from the previous record of 350 m, where the species was described in Manu. We also registered an undescribed species of *Osteocephalus* (Figure 9E), a rare arboreal frog also encountered between 650 and 1,300 m asl in the Kosñipata valley. The *Osteocephalus* was the only species recorded at this site and unknown from the lowlands. *Eleutherodactylus danae* also occurs in the Kosñipata valley, and our record of a juvenile here extends its distribution westward toward the Urubamba valley, and to lower elevations than previously recorded.

Overall, we did not encounter many species of anurans, most likely because our inventory occurred after the breeding season. At these latitudes in Peru, anuran mating seasons generally end in April, and afterward adults are quiet and difficult to find. Despite searching extensively in the abundant bamboo stands, we did not encounter *Dendrobates biolat*, a species typical of these habitats in PN Manu. If it does occur, its density may be very low.

Snakes were rare at this site, especially on the beaches of the Río Ticumpinía, where we had expected to find them sunning themselves. Lizards were similarly scarce. We found only one *Anolis* in the forest (similar to *fuscoauratus* but probably another species), and *Ameiva ameiva* and *Kentropyx altamazonica* near the river beaches. In the bamboo forests on the forested slopes (~1,000 m) we encountered what might have been *Stenocercus roseiventris*, but it escaped before we could identify it decisively.

Katarompanaki

From this site we surveyed two platforms differing in elevation and habitat types. Solid rock underlies the riverbeds on both platforms, but much taller forest grows on the lower platform.

Upper platform

On the higher platform (1,760-2,000 m asl) we found 8 species of anurans, 3 lizards, and 3 snakes. Generally, the habitat of the upper platform, a stunted nutrient-poor forest, is not favorable for anurans, and the area's isolation and small size may prevent colonization of many species. In the streams, we encountered 3 breeding glass frog species (Centrolenidae); 2 are known from the Kosñipata valley. One species, a *Centrolene* (Figure 9H), is without a doubt new to science. We know of two other undescribed species in this genus; one occurs further north in PN Otishi and the other in the Kosñipata valley.

The most abundant species at this site, an *Eleutherodactylus* in the *rhabdolaemus* complex (within the *unistrigatus* group), appears restricted to Megantoni and has not been recorded in neighboring Manu or Vilcabamba where other members of this complex occur. In the short, moss-covered vegetation on the upper edge of the platform we captured a *Euspondylus* lizard new to science, but the animal escaped and we salvaged only the tail. Although undescribed, this species has been reported in similar habitats in Llacahuaman in the Cordillera de Vilcabamba, reaching 2,600 m asl (Icochea, pers. comm.). We registered a potentially new species of *Proctoporus*, different from *P. guentheri* reported from similar elevations in Vilcabamba by Icochea et al. (2001). We also registered an apparently undescribed species of *Neusticurus*, recorded previously from Santa Rosa (~800 m asl), in the Inambari basin, Puno Department, ~230 km southeast of Megantoni (L. Rodríguez, unpubl. data).

The most surprising record at this site was a minute frog (14 mm), in the genus *Syncope* (Microhylidae), found in moss on the forest floor. Previously these tiny frogs were known only from

Cordillera del Sira (Pasco; Duellman and Toft 1979) and Cordillera Azul (San Martín); the Megantoni record is the southernmost for this genus in Peru. Moreover, the Megantoni specimen might be new to science. We found an *Eleutherodactylus* of the *discoidalis* group that may also be new to science.

Lower platform

We spent only two nights collecting on the lower platform (1,350 m asl). No species were actively reproducing in the streams here, but we did register *Bufo typhonius* sp.2, *Eleutherodactylus mendax*, and *E. salaputium*, as well as *Phyllonastes myrmecoides*. Snakes were abundant here, especially *Clelia clelia*.

Tinkanari

Our third inventory site covers elevations (1,800-2,600 m asl) that have been poorly surveyed in Manu. During our rapid inventory of this high-elevation forest, we found 10 species of anurans, 2 lizards, and 4 snakes. One of the most notable records, *Atelopus erythropus*, is known only from the holotype (Boulenger 1903, Lötters et al. 2002) and populations in the Kosñipata valley (Rodríguez and Catenazzi, unpubl. data). The Megantoni population of *A. erythropus* is apparently unaffected by the chytrid fungus that is severely reducing populations of several species of the same genus in Central and South America.

The largest of all frogs found at this site was an arboreal marsupial frog, *Gastrotheca* sp. (Figure 9F), similar to *G. testudinea* (W. Duellman, pers. comm.). *Gastrotheca* sp. was nearly ubiquitous, with males singing from the canopies in almost every habitat. The species appears different from other undescribed species of *Gastrotheca* reported from similar elevations in Manu and Vilcabamba and is likely new to science. While sampling in the leaf litter, we discovered a small *Phrynopis* cf. *bagrecito*, known from higher elevations in Manu but never before reported from such low elevations.

In less than an hour of sampling, we captured more than 30 individuals of an *Eleutherodactylus* along the banks of a fast-moving stream. The species is restricted to Megantoni, has extremely variable coloration, and is

similar to the other species in the *E. rhabdolaemus* complex occurring in the corridor between Manu and Vilcabamba (Rodríguez 2001). The *Eleutherodactylus* species was active during the day, apparently feeding on flies and other abundant Diptera along the stream. We encountered a reddish-bellied species of *Bufo* of the *veraguensis* group, which we are still trying to identify.

The breeding season had ended by the time we visited this site, and we found juveniles or tadpoles of *Telmatobius* and *Colostethus* in some of the streams. Given the juvenile morphology and the elevation of this site, the *Colostethus* is likely a new species. We also found Centrolenidae tadpoles but could not identify the species.

Snakes were abundant at this site. We found a new species of *Taeniophallus* (Figure 9D), only the third Peruvian species in this genus. In two nights of sampling we found three individuals of *Oxyrhopus marcapatae* (Figure 9B), a species endemic to southeast Peru and known from the Río Urubamba valley and the Marcapata valley (Río Inambari) at elevations reaching 2,600 m (Machu Picchu) and 2,450 m (Wayrapata, between the Apurímac and Urubamba watersheds). In the stunted forest, we found two individuals of *Bothrops andianus*.

We observed several lizards including a *Prionodactylus* sleeping in a tree hollow, and three *Euspondylus* cf. *rhami* individuals along the riverbank. Little is known about the taxonomy of *Euspondylus*. Although they are closely related to *Proctoporus*, more collections and taxonomic work are necessary to identify the specimens.

DISCUSSION

The herpetological communities of the three sample sites have little in common with one another or with neighboring Kosñipata. Certain lowland species found at Kapiromashi (15 anurans and 4 reptiles) occur both in Kosñipata and Megantoni. At higher elevations on the Katarompanaki tablelands we registered 3 anurans and many reptiles that do not occur in Kosñipata, with only 4 species shared between the sites (2 *Eleutherodactylus*

and 2 Centrolenidae). Other species we found at Katarompanaki appear to be new to science, including 1 frog (*Syncope*) and 3 lizards (*Alopoglossus* sp. [Figure 9C], *Euspondylus* sp. [Figure 9A], *Neusticurus* sp.). On the lower platform of the Katarompanaki tablelands, we found 2 species that did not occur on the higher platform: *Bufo typhonius* sp. 2 and *Phyllonastes myrmecoides*. The most abundant species of frogs in both Megantoni and Kosñipata are *Eleutherodactylus* spp. of the *rhabdolaemus* complex. The species described in Kosñipata as *E. rhabdolaemus* is apparently replaced in Megantoni by a similar species that is highly variable in its ventral coloration; it is common in Katarompanaki and Tinkanari. No lizards were shared among any of the inventory sites.

Frog breeding systems vary among sites and contribute to the differences in community structure. In Kapiromashi, at least 7 of the 12 anurans we found reproduce aquatically and bear live offspring. Only 3 of the 11 species found in Katarompanaki and 4 of the 10 species found in Tinkanari have aquatic reproduction. The availability of breeding sites for directly developing frogs or aquatic breeders can influence species richness and abundance.

The amphibian and reptile communities of Tinkanari (2,000 m) are difficult to compare to those of other sites, because many taxa remain incompletely identified. We have not yet identified the species of Centrolenidae and *Telmatobius* tadpoles, and they may also occur in Kosñipata. However, at least 2 species, *Atelopus erythropus* and *Phyrnopus* sp., are also found in the streams of both the Río Manu and the Río Alto Urubamba. The snakes *Chironius monticola* and *Bothrops andianus* are high-elevation species present in Megantoni, Kosñipata and Vilcabamba. Only *C. monticola* is known to have a wide distribution and extends southward to Bolivia. The other 3 snake species we found have restricted ranges, and 1 is new to science (*Taeniophallus*, Figure 9D).

Differences among Megantoni, Manu, and Vilcabamba

Zona Reservada Megantoni connects Parque Nacional Manu and the protected areas in Vilcabamba (RC Machiguenga, PN Otoshi, and RC Ashaninka, see Figure 1). We compare Megantoni to the adjacent protected areas to highlight its unique herpetological communities and its contribution to conservation within the SINANPE. Our inventory sites provide important points of comparison, especially the Tinkanari site in Megantoni, which is uniquely situated between the Urubamba and Manu watersheds, with streams flowing both to the Río Timpía and to tributaries of the Río Manu.

We can compare species richness of frogs across elevations in the three protected areas (Fig. 17). Data from PN Manu reflect intensive sampling between 500-3,800 m asl in the Kosñipata Valley (Catenazzi and Rodriguez, 2001). For the Vilcabamba comparison we use data collected during a rapid inventory (Rodríguez 2001). Overall, numbers of frogs are substantially lower

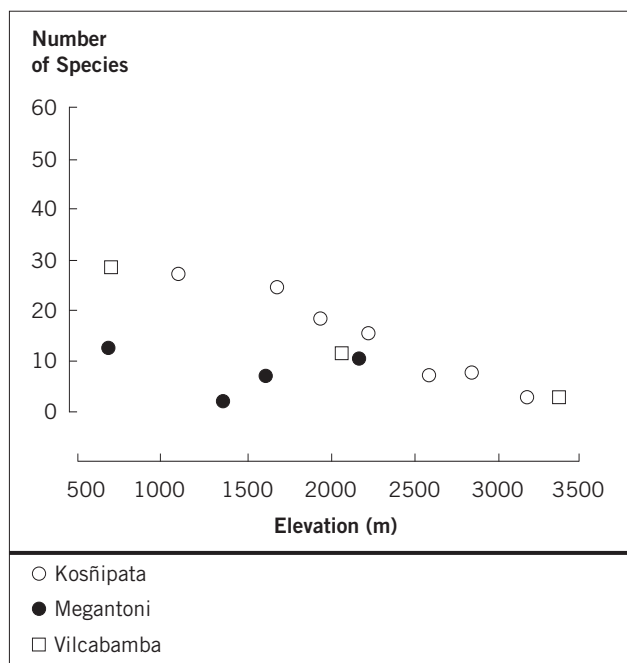
in Megantoni compared to Manu. The lower richness in Megantoni likely stems from our rapid sampling and the coincidence of the inventory with the end of the frog breeding season.

Hylidae were uncommon at the Megantoni inventory sites, although we suspect they are abundant at the beginning of the rainy season. In the Kosñipata valley we observed species of *Hyla* in nearly all of the streams and brooks between 500 and 2,400 m. Species of *Hyla* such as *H. armata* and *H. balzani* also have been reported in the higher parts of the Río Apurímac valley in Ayacucho (Duellman et al. 1997).

Habitat types may partially explain the scarcity of Hylidae in Megantoni. In Kapiromashi most of the streams draining the slopes along the Río Ticumpinía are seasonal and can sometimes dry up completely and create an unfavorable environment for Hylidae tadpoles. Moreover, most of the streams with their flat sandstone beds have fast-flowing currents unsuitable for tadpoles. However, we did observe reproduction of some species, including *Cochranella spiculata* and other unidentified tadpoles, in these streams. At Katarompanaki, the absence of Hylidae may reflect the isolation and small size of the tablelands.

Tinkanari may support more species than Kosñipata. Several genera found at Tinkanari were not found at Kosñipata at similar elevations (2,100-2,300 m). These include *Colostethus*, found below 1,600 m in Kosñipata, and *Phrynopus* and *Telmatobius*, found above 2,400 m in Kosñipata. The greater number of genera and families present in Tinkanari could reflect particular habitat characteristics or faunal exchange between the Manu and Urubamba watersheds. Surface area of habitats at 2,100-2,300 m asl is greater in Megantoni than at similar elevations in Kosñipata and could provide a greater diversity of habitats and ecological niches for amphibians. Without data from the adjacent high-elevation parts of the Río Cumerjali valley (a tributary of the Río Manu) we cannot confirm which species are present both in Megantoni and Kosñipata.

Figure 17. Number of amphibian species registered in the Zona Reservada Megantoni, Valle Kosñipata (PN Manu), and the northern part of Vilcabamba (PN Otishi).



THREATS, OPPORTUNITIES, AND RECOMMENDATIONS

ZRM conserves abundant populations of montane amphibians and reptiles, including at least ten new species, as well as geographic and elevational range extensions for some species and genera. We encountered pristine communities and found substantial populations of species and genera that are rare and threatened in other highland areas. Megantoni protects a broad range of habitats along the elevational gradient between puna and the lowlands, sheltering amphibian and reptile species from potential damage from global climate change.

Few direct threats exist to amphibian and reptile communities in Megantoni, since few people inhabit the area, and access to the area is difficult. We did not encounter commercially hunted species of lizards or turtles, but one species of turtle (*Geochelone denticulata*) is hunted by native communities near Megantoni. Future studies should evaluate hunting impact on population densities and structure.

At middle and high elevations, the rapid diffusion of a chytrid fungus from Central America towards the Andes has in recent years precipitated a dramatic decline and extinction of amphibian populations in Ecuador, Venezuela, and northern Peru. Species living in highland brooks and streams, such as *Atelopus* toads and glass frogs (Centrolenidae, see Figure 9H), are particularly susceptible, especially as the fungus may broaden its elevational range as global temperatures rise (Ron, Duellman, Coloma and Bustamante 2003).

We found no evidence of chytrid fungus in the amphibian populations in Megantoni. We took skin samples from *Cochranella spiculata* (2 individuals), *Hyalinobatrachium cf. bergeri* (1), and *Atelopus erythropus* (2) and ran histological tests to determine if these individuals were infected. All results were negative, suggesting that the fungus has not yet reached Megantoni. Nonetheless, we urge surveillance of the fungus. If the chytrid fungus were to reach southern Peru, it could dramatically reduce amphibian diversity

at higher elevations in Megantoni and surrounding protected areas.

We recommend more detailed inventories of the regional herpetofauna, especially during warmer and wetter months from August through March, when most amphibians are breeding. In addition, we recommend further studies of the reptiles of the entire region, as several species are endemic to the high elevations of the Urubamba valley and Vilcabamba, and this area forms the northern distributional limit for species on the Urubamba and Inambari slopes. In the unsampled high-elevation areas (e.g., puna) additional inventories are not likely to add substantially to the number of protected species within the SINANPE, as many of these species will likely occur in Manu as well.

BIRDS

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Conservation targets: Healthy populations of game birds (Tinamidae and Cracidae), often overhunted in more populated sites; Black Tinamou (*Tinamus osgoodi*, Figure 10C), Scimitar-winged Piha (*Lipaugus uropygialis*, Figure 10D), and Selva Cacique (*Cacicus koepckeae*, Figure 10E), species of Vulnerable worldwide status, each known from fewer than ten sites; healthy populations of Military Macaw (*Ara militaris*, Figure 10A), a species of Vulnerable worldwide status, and Blue-headed Macaw (*Propyrrhura couloni*), a rare and local macaw in Peru; pristine avifaunas of upper tropical forest, montane forest, and puna; corridor between Parque Nacional Manu and protected areas in the Cordillera de Vilcabamba for large, low-density, highly mobile species (raptors, parrots, nomadic resource-following species)

INTRODUCTION

Little ornithological information exists for the humid foothill forests along the Río Urubamba. Most ornithological surveys in the northern parts of Cusco Department concentrate on the more accessible drier forests, humid lowland forests, and the upper Urubamba valley above Quillabamba. The upper Urubamba has been studied fairly well, but mostly in higher elevations (Chapman 1921, Parker and O'Neill 1980, Walker 2002). The foothills that divide the

Urubamba into upper and lower sections are essentially unknown.

Ornithological studies at similar elevations in the Cordillera de Vilcabamba and the Kosñipata valley provide important points of comparison with our rapid inventory of the foothills of Zona Reservada Megantoni. Terborgh and Weske (1975, 340-3,540 m asl) and members of two rapid inventories (Schulenberg and Servat 2001, 1,700-2,100 m asl, 3,300-3,500 m asl; Pequeño et al. 2001, 1,500-2,445 m asl) surveyed the Cordillera de Vilcabamba, an isolated massif between the Río Apurímac and Río Urubamba, to the west of Megantoni. When we discuss Vilcabamba, we refer almost exclusively to the more thoroughly studied sites on the Apurímac side of the range. On the eastern side of Megantoni, the road following the Kosñipata valley forms the eastern border of Parque Nacional Manu and is the next nearest area well-studied ornithologically between 750 and 2,300 m in elevation (Walker, Stotz, Fitzpatrick, and Pequeño, unpubl. ms.; pers. obs.). Between the Vilcabamba and Kosñipata sites, species turn over, with some reaching their southernmost points of distribution in the former, and others reaching the northernmost limits at the latter. Our ornithological survey work in the Zona Reservada fills a large information gap (approximately 200 km) in the distribution of foothill and Andean bird species in southern Peru.

METHODS

We conducted avifaunal surveys at each of the three camps by walking trails from 15 to 30 minutes before sunrise until at least midday, although two days at Katarompanaki (1,360-2,000 m asl) were lost due to inclement weather. When possible, we tried to walk different trails each morning, surveying all available habitats, and with the exception of the southern side of the Río Ticumpinía at Kapiromashi (760-1,200 m asl), we visited all trails at each site. In the afternoons, we skywatched or walked trails to see if other species were present that had been missed during morning surveys, often remaining in the field until dusk or just thereafter.

We registered species by sight or sound while walking trails, using cassette recorders to tape bird voices and a digital camera to document several species. Voice recordings will be deposited at the Macauley Library of Natural Sounds of the Cornell Laboratory of Ornithology.

Because of our limited time at each site, we did not use any quantitative censusing methods. Instead, we kept daily lists of observed birds and noted their abundances. In Appendix 6, these daily estimates are the basis for our relative abundance codes. We include records from non-ornithologist RBI team members—particularly those of Robin Foster, Guillermo Knell, Trond Larsen, Debra Moskovits, José Rojas, Aldo Villanueva, and Corine Vriesendorp—to augment our own observations.

Below, we use the terms “upper tropical,” “subtropical,” and “temperate” to characterize forest habitat types and their associated avifaunas. These terms have a long history of use in Neotropical ornithological literature (e.g., Chapman 1926, Parker et al. 1982, Fjeldsa and Krabbe 1990) and are commonly applied to habitats within the Andean region. The upper tropical zone is the upper elevational limit of typical lowland bird species and usually ascends the foothill slopes up to ~1,000 m. The subtropical zone consists of the middle elevations, starting at ~1,000 m and ascending to ~2,300 m. The temperate zone contains the upper elevations, beginning at ~2,300 m and ascending to treeline, where it is replaced by high-altitude grasslands, known as puna. The avifauna of each life zone contains a characteristic suite of species; avifaunas overlap marginally in transitional elevations between zones. Our estimates for elevational limits are approximations as their ranges may vary with humidity (higher humidity usually extends zones to lower elevations), steepness, latitude, underlying geological materials, and soil types.

RESULTS

The three inventory sites cover non-overlapping elevations ranging from 760 to 2,400 m asl. We

recorded 378 species during our three weeks in the field (Appendix 6). Judging from avifaunal lists from Vilcabamba and Kosñipata for corresponding habitats and elevations within the Zona Reservada, we estimate that approximately 600 bird species occur within Megantoni.

Kapiromashi (~760-1,000 m asl)

Our first camp was adjacent to the Río Ticumpinía, and trails provided access to young and medium-aged river islands, river margin forest, and several terrace forests. Bamboo (*Guadua* spp., locally called *paca*, Figure 3E) was a major component of the forest understory at this site at all elevations, including the medium-aged river island, and we encountered many birds specializing on bamboo (“bamboo specialists,” *sensu* Kratter 1997). Patches of forest with little or no bamboo understory exist but are relatively scarce. We encountered a bird community consisting primarily of birds from the upper tropical zone, with some birds more typical of subtropical elevations present, even on the river islands. Presumably, the humidity trapped within this relatively narrow valley allows some birds to descend to lower elevations. Typical subtropical zone species present along the river include Ocellated Piculet (*Picumnus dorbygnianus*), Cinnamon Flycatcher (*Pyrrhomyias cinnamomeus*), and Slate-throated Redstart (*Myioborus miniatus*). We recorded 242 species at this campsite (Appendix 6).

Birds in pacales (bamboo forest)

The Ticumpinía valley is part of an extensive *Guadua*-dominated forest that continues north into the Urubamba valley and east into lowland Amazonia. The extensive *Guadua* bamboo patches, or *pacales* (Figure 3E), at Kapiromashi housed a suite of species that are closely associated with this habitat (Kratter 1997). Among these were Yellow-billed Nunbird (*Monasa flavirostris*), Rufous-breasted Piculet (*Picumnus rufiventris*), Cabanis’s Spinetail (*Synallaxis cabanisi*), Peruvian Recurvebill (*Simoxenops ucayalae*), Crested Foliage-Gleaner (*Anabazenops dorsalis*), Bamboo Antshrike (*Cymbilaemus sanctaemariae*), Ornate Antwren

(*Myrmotherula ornata*), Dot-winged Antwren (*Microrhopias quixensis*), Striated Antbird (*Drymophila devillei*), Manu Antbird (*Cercomacra manu*), White-lined Antbird (*Percnostola lophotes*), Warbling Antbird (*Hypocnemis cantator subflava*), Yellow Tyrannulet (*Capsiempis flaveola*), White-faced Tody-Tyrant (*Poecilatriccus albifacies*), Flammulated Pygmy-Tyrant (*Hemitriccus flammulatus*), Large-headed Flatbill (*Ramphotricon megacephalum*), and Dusky-tailed Flatbill (*Ramphotricon fuscicauda*). Several bamboo specialists were not encountered, including Rufous-headed Woodpecker (*Celeus spectabilis*), Brown-rumped Foliage-Gleaner (*Automolus melanopezus*), and Ihering’s Antwren (*Myrmotherula iheringi*). Presumably, the elevation of the site is too high for these species. From the air, the *pacales* appear to ascend to nearly 1,500 m asl, an atypically high elevation for *Guadua* bamboo, and an inventory of bamboo-associated species reaching this upper elevational limit would be useful.

Two undescribed species are probably *Guadua* specialists, one a tyrant flycatcher (Tyrannidae) and the other a tanager (Thraupidae), both known from sites near the Zona Reservada. The flycatcher belongs to the genus *Cnipodectes* and is known along the Río Manu, and along the lower Río Urubamba at elevations below 400 m (Lane et al., unpubl. ms.). The tanager appears to represent a new genus with uncertain affinities within the family. To date, only one individual has been observed along the Kosñipata road at San Pedro, at ~1,300 m elevation (Lane, pers. obs.). Both species are likely to occur within the borders of the Zona Reservada, but we were unable to confirm their presence during our brief visit to the *pacales* at the first field site.

Noteworthy records

At Kapiromashi, we observed several notable bird species during our fieldwork. We recorded an evening vocalization, just above the riverbed, that corresponds well to published recordings of Black Tinamou (*Tinamus osgoodi*, Figure 10C), a species with a highly disjunct distribution. In Peru, the nominate subspecies is known from the Cerros de Távora and the Marcapata valley,

Puno Department, west to the eastern edge of Parque Nacional Manu, including the Sierra de Pantiacolla, Consuelo, and San Pedro, about 200 km to the east of Megantoni (Parker and Wust 1994; T. Schulenberg, pers. comm.; pers. obs.). A subspecies (*T. o. hershkovitzi*) is known from the Cordillera Cofán in northern Ecuador and the head of the Magdalena Valley in Colombia (Schulenberg 2002). In addition, unpublished records exist from Parque Nacional Madidi in La Paz Department, Bolivia (T. Valqui, pers. comm.). *Tinamus osgoodi* remains poorly known and the underlying causes of its widely dispersed populations are still a mystery.

Both Military Macaw (*Ara militaris*, Figure 10A), the namesake for the Zona Reservada, and Blue-headed Macaw (*Propyrrhura couloni*) were plentiful at this site, outnumbering all other macaws. Many macaw species are restricted in their distribution by nesting substrates; *A. militaris* nests only on sheer cliffs and is found in South America solely along the Andean foothills. Its densities have been reduced by habitat disturbance and pressure from the pet trade, and Birdlife International (2000) considers its worldwide status Vulnerable. *Propyrrhura couloni* is restricted to southwestern Amazonia and remains more poorly known than most macaws. It seems sensitive to human disturbance, occurring only in large tracts of primary lowland and foothill forest.

On our second morning, we briefly observed a very secretive, low-density, but widespread species, the Rufous-vented Ground-Cuckoo (*Neomorphus geoffroyi*). Normally, the species is observed foraging beside army ant (*Eciton burchelli*) swarms or peccary (*Tayassu pecari*) herds, but we encountered neither nearby. We recorded two ant-following antbirds—Hairy-crested Antbird (*Rhegmatorhina melanosticta*) and Black-spotted Bare-eye (*Phlegopsis nigromaculata*)—despite not observing any large army ant swarms at this site.

Several of our records are small range extensions for particular species. Creamy-bellied Antwren (*Herpsilochmus motacilloides*), a canopy antbird, has been reported from several sites in the Cordillera Vilcabamba, and at Santa Ana, a site on the left bank of the upper

Río Urubamba (T. Schulenberg, pers. comm.). We discovered a single territory of *H. motacilloides* in tall forest (canopy ~30 m), the first record in the mountains on the eastern bank of the Río Urubamba. Perhaps more important was our discovery of a congener, the Yellow-breasted Antwren (*Herpsilochmus axillaris*) at the same elevation. The two species of *Herpsilochmus* seemed to segregate by habitat, with *H. axillaris* more restricted to slopes with slightly shorter-stature forest (canopy ~15-20 m). Our observation of *H. axillaris* is the first for the Urubamba watershed and is the westernmost record of the nominate subspecies (M. Isler and T. Schulenberg, pers. comm.). The central Peruvian subspecies *puncticeps* is known to occur no closer than 250 km to the northwest in Junín Department, with no known records between there and Megantoni.

Until recently, the Yellow Tyrannulet (*Capsiempis flaveola*) was known from only five sites in Peru. Only within the last ten years has this rather small, inconspicuous species been found to be fairly common in southeastern Peru, with records from the lower Río Urubamba (Aucca 1998; T. Valqui, pers. com.), the lowlands at the mouth of the Kosñipata valley (Lane, pers. obs.), and nearby Parque Nacional Manu (Servat 1996). We found *Capsiempis* common in the *pacales* at Kapiromashi campsite during the inventory. However, a population (representing a different subspecies) of *C. flaveola* has been found common in non-bamboo habitats in northern San Martín Department (Lane, pers. obs.).

The sheer abundance—higher than either of us has witnessed at Kosñipata—of the recently described Cinnamon-faced Tyrannulet (*Phylloscartes parkeri*) is noteworthy. This species is known from several foothill localities from Pasco Department south and east to Beni Department, Bolivia (Fitzpatrick and Stotz 1997). Its characteristic vocalization is the best clue to its presence, and at Kapiromashi this was a ubiquitous sound, particularly around forest gaps and along the river.

Finally, we encountered a group of five individuals of Selva Cacique (*Cacicus koepckeae*, Figure 10E), a species described from Balta, Ucayali

Department, by Lowery and O'Neill (1965). After its description, the cacique remained essentially unknown until rediscovered by Gerhart near Timpía (Schulenberg et al. 2000, Gerhart 2004). Since this rediscovery, an additional specimen was collected at Paratori, near the Río Camisea (Franke et al. 2003). Another recent sight record was made near Cocha Cashu in Parque Nacional Manu (Mazar Barnett et al. 2004). An additional, unconfirmed sighting exists from the upper Río Cushabatay drainage, within Parque Nacional Cordillera Azul (Lane, pers. obs.). Given the proximity of Kapiromashi to the Timpía and Camisea sites, our observation is not unexpected; however, it is the highest elevational record for the species.

Migration

We observed migrating birds at Kapiromashi. Large swarms of swallows moved along the river, mainly the austral migrant race of Blue-and-white Swallow (*Pygochelidon cyanoleuca patagonica*) traveling from their breeding grounds in temperate southern South America. We readily identified individuals of this subspecies by their less extensive dark undertail coverts and heavily worn plumage, and they were often present in flocks numbering up to 300. We routinely spotted several individuals, presumably resident birds, of the nominate race *cyanoleuca* among these migrants, distinguished by their entirely dark undertail coverts and “cleaner” plumage. Similarly, large groups of Southern Rough-winged Swallows (*Stelgidopteryx ruficollis*) passed along the river independent of local pairs, suggesting an influx of migrant birds of this species, presumably also from southern populations.

On an older river island, we saw a single Vermilion Flycatcher (*Pyrocephalus rubinus*), an austral migrant. Most boreal migrants had already departed for North America, but along the river we heard two species still lingering in the area, Western Wood-Pewee (*Contopus sordidulus*) and Olive-sided Flycatcher (*Contopus cooperi*).

Species expected but not encountered

Several species normally common in tropical humid forest were strangely absent from Kapiromashi, including large guans, herons, motmots, *Ramphastos* toucans, *Selenidera* toucanets, various species of *Pteroglossus* aracarís, *Celeus* and *Piculus* woodpeckers, Red-billed Scythebill (*Campyloramphus trochilirostris*), Yungas Manakin (*Chiroxiphia boliviana*), and Tropical Parula (*Parula pitiayumi*). These apparent absences may reflect our limited time at this site; however, some species are usually obvious and ubiquitous, and our lack of records may represent a real absence, one that we cannot explain. We expect that additional field work at the lowest elevations of the Zona Reservada will add most, if not all, of these species to the list of its avifauna.

Katarompanaki (~1,300-2,000 m asl)

The second camp was situated near the lower edge of a sloping, hard-rock platform that extended from ~1,650 to 2,000 m asl. The plant community is dominated by *Clusia* spp. (Clusiaceae) and *Dictyocaryum lamarckianum* (Arecaceae) palms and grows on a spongy layer of slowly decaying material. The low-diversity forest on this platform is stunted, with tree canopies ~15 m high at the lower edge of the plateau, but as low as 2 m at the upper edge.

A trail descended from the upper plateau to a lower terrace with richer, taller forest (average canopy height ~25 m) ranging in elevation from 1,300 to 1,600 m. On the lower platform, the composition of the avifauna is more typical of lower subtropical and upper tropical zones. However, because it was far from camp, we spent little time exploring this taller forest and undoubtedly missed many species. We recorded 103 species at this campsite (Appendix 6).

Avifauna of the upper and lower platforms

Between the upper and lower platforms, the avifauna differed markedly. On the upper platform, flocks were scarce and were composed of nine core species: Spotted Barbtail (*Premnoplex brunnescens*), Mottle-cheeked Tyrannulet (*Phylloscartes ventralis*), Russet-crowned

Warbler (*Basileuterus coronatus*), Three-striped Warbler (*Basileuterus tristriatus*), Common Bush-Tanager (*Chlorospingus ophthalmicus*), Yellow-throated Tanager (*Iridosornis analis*), Blue-winged Mountain-Tanager (*Anisognathus somptuosus*), Bluish Flowerpiercer (*Diglossa caerulescens*), and Deep-blue Flowerpiercer (*Diglossa glauca*). Nearly all of these species, with the exception of the *Basileuterus* warblers, were restricted to the upper platform and not found in the flocks on the lower platform. Some species from the lower platform forest reached the lower edge of the upper platform, where the stunted forest was tallest. These species included Versicolored Barbet (*Eubucco versicolor*), Slaty Antwren (*Myrmotherula schisticolor*), *Tangara* tanagers, and Orange-bellied Euphonia (*Euphonia xanthogaster*). Among the nonflocking species we observed in the elfin forest, three hummingbirds were present in high densities: Bronzy Inca (*Coeligena coeligena*), Booted Rackettail (*Ocreatus underwoodii*), and Long-tailed Sylph (*Agelaiocercus kingi*). Three antbirds were also fairly common here: Blackish Antbird (*Cercomacra nigrescens*), Ochre-breasted Antpitta (*Grallaria flavirostris*), and Slaty Gnateater (*Conopophaga ardesiaca*). Ornate Flycatcher (*Myiotriccus ornatus*) was ubiquitous on both platforms, occurring at higher densities than we had ever seen before. Scaly-crested Pygmy-Tyrant (*Lophotriccus pileatus*) was common as well.

In the taller forest on the lower platform, flocks were more plentiful and contained far more species. We noted a higher density of terrestrial insectivores, including Rufous-breasted Antthrush (*Formicarius rufipectus*), Short-tailed Antpitta (*Chamaeza campanisona*), Scaled Antpitta (*Grallaria guatemalensis*), and *Conopophaga ardesiaca*. Some flock-following midstory flycatchers were present, including Slaty-capped Flycatcher (*Leptopogon superciliaris*) and Marble-faced Bristle-Tyrant (*Phylloscartes ophthalmicus*). *Herpsilochmus motacilloides* was heard in the canopy and seemed more numerous than at the first camp.

Noteworthy records

Overall bird diversity was relatively low at Katarompanaki, but we recorded several noteworthy species. Nearly every member of the rapid inventory team (other than the ornithological team) reported a large, black tinamou, some on a daily basis, mostly from the taller forest but also from the lower end of the upper platform. These sightings were almost certainly *Tinamus osgoodi* and suggest the species is common. Moreover, these records indicate that *T. osgoodi* in Peru occurs at higher elevations than previously suspected. An unpublished list for Parque Nacional Manu lists an elevational range of 900-1,350 m, whereas sightings at Katarompanaki ranged from 1,400 to 1,650 m. We flushed a large tinamou on our last day but were unable to confirm its identity, and the only tinamou heard at this site was Brown Tinamou (*Crypturellus obsoletus*).

Herpsilochmus motacilloides occurred at Katarompanaki and Kapiromashi. These records suggest that this antwren is a widespread canopy insectivore in tall forests, at least on the western end of the mountain range that includes the Megantoni sites, from ~800 to 1,600 m. The species remains unknown from the Manu area; however, the western portion of the park has never been surveyed by ornithologists, and *H. motacilloides* may occur there.

Cercomacra nigrescens has two distinct populations in Peru: a lowland form that is widespread in western Amazonia but largely restricted to riverine habitats and second growth (subspecies *fuscicauda*), and two highland subspecies (*aequatorialis* and *notata*) found in tangles and stream edges from Ecuador through the central Peruvian Andes. The two groups are easily separable by song and may merit species-level recognition (M. Isler, pers. comm.). Our observations of the race *notata* indicate that the Urubamba valley is the southern terminus of its range. Although not recorded by us within the Zona Reservada, we heard the lowland subspecies *fuscicauda* in river-edge vegetation at Timpía, not far outside the borders of Megantoni.

Conopophaga ardesiaca is a species primarily known from the Bolivian *jungas*, but it reaches

southeastern Peru as far northward as Cusco Department. Our record from Katarompanaki is apparently the only one from the Urubamba drainage and represents the northwestern terminus of the species' distribution. We did not encounter a congener, the Chestnut-crowned Gnateater (*C. castaneiceps*), a species known to extend from Colombia south to the Kosñipata valley (Walker, Stotz, Fitzpatrick, and Pequeño, unpubl. ms.). The two species co-occur in Kosñipata, replacing one another across an elevational gradient. With more field surveys, we expect *C. castaneiceps* will be found within Megantoni.

Andean *Scytalopus* tapaculos comprise several species groups of nearly indistinguishable forms best identified by voice, locality, and elevation. The species complex containing *S. atratus* and *bolivianus* (White-crowned and Bolivian tapaculos, respectively) is particularly unresolved (Krabbe and Schulenberg 1997). Typically, members of this complex occur at lower elevations than other species in the genus and are difficult to distinguish from each other. At Kosñipata, a dark-crowned form is known to occur from ~1,000 to 2,200 m asl (Walker, Stotz, Fitzpatrick, and Pequeño, unpubl. ms.). On the basis of voice and plumage, the population we observed at Katarompanaki (and at the third site, Tinkanari) appears to be the same as the form at Kosñipata.

Our record of Hazel-fronted Pygmy-Tyrant (*Pseudotriccus simplex*) seems to mark the northwestern distributional limit for the species. We regularly heard its high-pitched trilled song early in the morning along streams between 1,600 and 1,700 m asl. A congener, Bronze-olive Pygmy-Tyrant (*P. pelzelni*), appears to replace this species on the Vilcabamba side of the Río Urubamba (Pequeño et al. 2001) and extends north from the Vilcabamba to Colombia.

Never seen by us but well described by other rapid inventory team members was a *Lepidothrix* manakin occurring from ~1,400 to 1,650 m asl. On two occasions, researchers observed a black manakin with a white crown and blue rump, most closely resembling Blue-rumped Manakin (*L. isidorei*), a species not known south of Huánuco Department. In southeastern Peru we

would expect to encounter a similar species, Cerulean-capped Manakin (*L. coeruleocapillus*), with a distinctly blue crown. The identity of the birds observed at Katarompanaki remains unclear. With luck, further field surveys in the area will answer this question.

At Katarompanaki, we observed *Anisognathus somptuosus somptuosus* further south than any previous records. In the Kosñipata valley it is replaced by the southern subspecies (*A. s. flavinucha*) that extends southeast into Bolivia (Lane, pers. obs.). The two forms have very distinct voices and their distributions within Manu deserve further research. The two forms almost certainly occur in PN Manu and may even overlap there. If so, these two subspecies may merit recognition as distinct species.

Species expected but not encountered

The elfin forest on the upper plateau is very similar in structure to poor-soil forests in northern Peru (e.g., Cordillera del Cóndor, northern San Martín Department; and Cordillera Azul). Typically, this habitat type supports a suite of specialized species, including Royal Sunangel (*Heliangelus regalis*), Cinnamon-breasted Tody-Tyrant (*Hemitriccus cinnamomeipectus*), Lulu's Tody-Tyrant (*Poecilotriccus luluae*), and Bar-winged Wood-Wren (*Henicorhina leucoptera*); however, we did not encounter these elfin forest specialists at Katarompanaki. The nearest populations of any of these species is more than 1,000 km to the northwest (*Henicorhina leucoptera*, La Libertad Department), and the elfin forest in Megantoni may be too isolated geographically from source populations to allow colonization. Also, the elfin forest patches in Megantoni may be too small to harbor their own local endemic specialists.

We did not register *Glaucidium* pygmy-owls at Katarompanaki. Many small bird species in the elfin forest responded actively to imitations of the voice of Subtropical Pygmy-Owl (*G. parkeri*); they may recognize it as a potential predator. *G. parkeri* is known from isolated ridge forests as nearby as Vilcabamba and Manu (Robbins and Howell 1995; Walker, Stotz, Fitzpatrick, and Pequeño, unpubl. ms.), and perhaps,

with additional field work, this pygmy-owl may be found within the Zona Reservada.

The stunted forest habitat on the upper plateau appears similar to forests found in northern San Martín Department that harbor several species of large antpittas (*Grallaria*). But we did not register any large antpittas on the upper plateau. Even the typically widespread *Grallaria guatemalensis* was encountered only in the taller forest on the lower terrace. Large antpitta species may inhabit the plateau but may have remained undetected because our inventory coincided with the postbreeding season for many bird species, when they are most silent.

We expected to encounter *Pyrrhomyias cinnamomeus* at high densities on the upper plateau, as it is common within this elevational range in elfin forests of Parque Nacional Cordillera Azul (Lane, pers. obs.). However, we observed only a single individual at Katarompanaki, in the taller forest near the lip of the upper plateau.

Tinkanari (~2,100-2,400 m asl)

The third camp was on a gradually sloping, broad saddle ranging from 2,100 to 2,400 m in elevation. Most of this area was covered in tall forest (average canopy height ~15-25 m) with an understory dominated both by tree ferns, and *Chusquea* (Poaceae) bamboo and its close relatives. Near the southwestern end of the ridge, elfin forest grew (canopy height ~2-7 m) on a harder rock surface and shared many bird species with the upper plateau forest at Katarompanaki, because of their similar forest structure.

Near the northeast edge of the saddle, a depression collected water, creating a swampy forest and even a small pond. Although the vegetation in the swamp forest was relatively short, the patch was small enough that we did not observe differences in the local avifauna in this area, with one exception. A Least Grebe (*Tachybaptus dominicus*) was only observed in this pond, by another researcher. Two trails ascended the slope on the north end of the saddle to ~2,300-2,350 m. At higher elevations we observed bird species more

typical of the temperate altitudinal zone, including Crowned Chat-Tyrant (*Ochthoeca frontalis*), White-collared Jay (*Cyanolyca viridicyana*), Spectacled Redstart (*Myioborus melanocephalus*) and Hooded Mountain-Tanager (*Buthraupis montana*) reaching their highest densities at, and sometimes entirely restricted to, these elevations. We recorded 140 species at this campsite (Appendix 6).

Avifauna of tall forest

Given its elevation, Tinkanari supported a species-rich bird community, likely reflecting the taller forest, rich plant diversity, and high insect and fruit abundance. Flocks were often huge, with more than 20 species present on a regular basis. We encountered high densities of tanagers and other frugivorous birds, and Chestnut-crested Cotinga (*Ampelion rufaxilla*) was present in higher densities than we had ever seen before.

We encountered several species usually more prevalent at lower elevations, such as Wattled Guan (*Aburria aburri*), Squirrel Cuckoo (*Piaya cayana*), Rufescent Screech-Owl (*Megascops ingens*), Golden-olive Woodpecker (*Piculus rubiginosus*), Montane Foliage-gleaner (*Anabacerthia striaticollis*), Buff-browed Foliage-gleaner (*Syndactyla rufosuperciliata*), *Myrmotherula schisticolor*, *Formicarius rufipectus*, *Pseudotriccus simplex*, *Myiotriccus ornatus*, Chestnut-breasted Wren (*Cyphorhinus thoracicus*), and *Myioborus miniatus*. Game birds were abundant and tame, including Sicklewinged Guan (*Chamaepetes goudotii*), *Aburria aburri*, and Andean Guan (*Penelope montagnii*).

Avifauna of elfin forest

The small patches of elfin forest, largely confined to the southwestern end of the saddle ridge, shared many species with the upper plateau at Katarompanaki. Additionally, we registered several species more typical of temperate elevational zones: Violet-throated Starfrontlet (*Coeligena violifer*), Trilling Tapaculo (*Scytalopus parvirostris*), Grass-green Tanager (*Chlorornis riefferii*), and Dark-faced Brush-Finch (*Atlapetes melanolaemus*). Many of these species are usually found near treeline, above 2,900 m. Their presence may reflect similarities

between the vegetation structure of elfin habitats and treeline habitats.

Noteworthy records

Our most exciting discovery was a population of Scimitar-winged Pihas (*Lipaugus uropygialis*, Figure 10D), a species known, in Peru, previously from a single site: Abra Marancunca in Puno Department. From Puno, the species occurs eastward along the humid Bolivian *yungas* to Cochabamba Department (Bryce et al., in press). Our record is a range extension of more than 500 km to the northwest and suggests the species may occur along other mountain ranges in Cusco and Puno Departments, such as within Parque Nacional Manu. We photographed the species (Figure 10D) and tape-recorded calls and a flight display. We believe this flight display has never been witnessed before.

We typically detected the pihas by the loud, squeaky vocalizations that we consider their “contact call.” Usually, they were encountered in pairs or groups of as many as four individuals that vocalized simultaneously, producing a loud burst of noise that carried quite a distance. Pihas responded strongly to playback of these calling bouts, readily approaching to inspect the source. The birds normally remained in the midstory and subcanopy (between 4 and 8 m) of moderate-stature forest (canopy ~15 m) and moved actively, switching perches frequently and noisily. Their peculiar primary wing feathers made a loud swishing sound in flight as they moved through the foliage. We observed a single foraging attempt, when an individual was seen sallying approximately 2 m upward for a fruit or insect (the item was not seen clearly) from a cluster of leaves as it changed perches. Their perching attitude was normally hunched forward. Toward midday, groups were quiet and sat motionless for more extended periods, as is typical of other *Lipaugus* species. During such periods of inactivity, the pihas perched more upright.

We observed the flight display only in the evening (~4:30 P.M. until nearly dusk), performed by a lone individual, presumably a male. The display occurred at intervals separated by more than 5 min

and was initiated by the bird as it perched in the distal branches of a canopy tree (often on bare, exposed twigs). We observed only one individual displaying, although we heard another at a distance on a different day. Although the displaying bird used several perches for the display, it seemed to prefer certain perches, particularly in response to playback. After some time sitting motionless, the bird launched from the branch and descended, wings fluttering, in a half-spiral to a lower perch while giving a high, piercing, rising, whistled vocalization in conjunction with three whirring sounds produced by the wings. These vocalizations were different in quality from those given by foraging groups, and not until we were able to see the performer could we identify their source. Between displays, the bird was silent, never giving unsolicited contact calls. The individual gave the typical contact call only in an apparently agitated response to playback of the display vocalization.

We briefly saw one individual of Collared Inca (*Coeligena torquata*). The form present at Megantoni is not the buff-collared form, *omissa*, known from the upper Urubamba valley, but a white-collared form, possibly subspecies *eisenmanni*, previously only known from the Cordillera de Vilcabamba. We are surprised to find these two subspecies present in the same valley. Finding the point in the Urubamba valley where their distributions are sympatric would provide an opportunity to examine their taxonomic status, especially as some ornithologists (e.g., Schuchmann et al. 1999) have suggested that the buff-collared form can be considered a separate species, Gould’s Inca (*Coeligena inca*).

Despite hearing *Campephilus* woodpeckers drumming frequently, we observed only Crimson-bellied Woodpecker (*C. haematogaster*). In the eastern Peruvian Andes, this species has a typical drum pattern of three to four raps (Ridgely and Greenfield 2001; pers. obs.). Most often, we heard longer raps typical of *C. haematogaster*, but we heard birds give double raps on at least two occasions. Normally, *Campephilus* woodpeckers have constrained species-specific drumming patterns (Lane, pers. obs.). In the highlands of Peru, Powerful Woodpecker (*C. pollens*) gives a double rap (Ridgely

and Greenfield 2001). This species is considered unknown south of Junín Department (Berlepsch and Stolzmann 1902, Peters and Griswold 1943), although a report, based on sound identification, exists from the southeastern Cordillera de Vilcabamba (Pequeño et al. 2001). Either *C. haematogaster* may give double raps where *C. pollens* is absent, or a population of *C. pollens* may occur at Tinkanari. We prefer not to include *C. pollens* on our species list, as we did not confirm its identification by sight.

At Tinkanari, our observation of Vermilion Tanager (*Calochaetes coccineus*) is the southernmost record of the species. On the other hand, several records marked the northern end of species' known distributions: *Pseudotriccus simplex*, an abundant species whose song was ubiquitous along streams at dawn; Unadorned Flycatcher (*Myiophobus inornatus*); and *Atlapetes melanolaemus*.

Species expected but not encountered

At Tinkanari, we found dense patches of *Chusquea* bamboo and related genera that elsewhere often support a specialized bird community. However, we observed only Barred Parakeet (*Bolborhynchus lineola*) and Yellow-billed Caciue (*Amblycercus holocericeus*) associated with *Chusquea*. Other species we would expect in such a habitat, all known from as nearby as the upper Río Urubamba valley (Walker 2002), include Maroon-chested Ground-Dove (*Claravis mondetoura*), Inca Wren (*Thryothorus eisenmanni*), Plushcap (*Catamblyrhynchus diadema*), and Slaty Finch (*Haplospiza rustica*).

DISCUSSION

Comparisons among sites

Typically, bird species diversity decreases with increases in elevation. Kapiromashi, the lowest-elevation site, supported the greatest species richness (242), as well as the greatest number of species not shared with other sites, or unique species (199). To our surprise, Tinkanari, the highest-elevation site, had the second

greatest overall species richness (140) and number of unique species (72). Katarompanaki, the middle-elevation site, exhibited the lowest species richness (102) and fewest unique species (17).

One possible explanation for the anomalously low bird species richness at Katarompanaki is that the low-diversity forest at Katarompanaki may support fewer insect and plant resources critical for many bird species. Also, we observed several species at uncharacteristically high or low elevations. In some cases, these records may reflect local geological or climate factors that permit their preferred habitats to exist outside the "expected" elevational range. In other cases, the lack of competitive exclusion (*sensu* Terborgh and Weske 1975) may allow a particular species "ecological release" so that it occurs in an elevational range usually occupied by a congener. Overall, elevational limits provide only loose guidelines for bird species expected at a site.

On a larger scale, we did observe species turnover along the altitudinal gradient. Of the 378 observed bird species, only 16 were shared among all three sites. Between sites, Kapiromashi and Katarompanaki shared 22 species, Kapiromashi and Tinkanari shared 5 species, and Katarompanaki and Tinkanari shared 47 species.

Comparisons with neighboring protected areas

The Megantoni avifauna shares species with both Cordillera Vilcabamba to the west and the Valle Kosñipata to the east. We encountered three species with extremely limited distributions worldwide: *Tinamus osgoodi* (Figure 10C), *Lipaugus uropygialis* (Figure 10D), and *Cacicus koepckeae* (Figure 10E). Of these, *L. uropygialis* is not known from any nearby locality.

For several species, our records in Megantoni extend their distributional limits: in some species farther south, in others farther north. We encountered species outside their previously known ranges at all three inventory sites. A few records extend known species distributions to the east across the Río Urubamba, or to the west, across the mountain range that divides

Megantoni from the Valle Kosñipata and the rest of Parque Nacional Manu. *Calochaetes coccineus* was not previously known east of the Río Urubamba. In Zona Reservada Megantoni we recorded subspecies known from the western side of the Río Urubamba and replaced by another form in the Valle Kosñipata (e.g., *Anisognathus somptuosus somptuosus*). Records of subspecies-level taxa (e.g., within *Coeligena torquata*) suggest that certain subspecies co-occur within Megantoni. The processes maintaining these forms distinct from one another are a mystery; additional fieldwork along the Urubamba and within Parque Nacional Manu is needed.

THREATS, OPPORTUNITIES, AND RECOMMENDATIONS

Pristine forests extending from lowland tropical forest to highland puna habitats are becoming rare in the Andes. Megantoni provides an unparalleled opportunity to preserve extraordinary levels of habitat diversity, safeguard an intact elevational corridor, and protect a diverse bird community. We recommend the strongest level of protection for Megantoni, with an eye toward preserving its remarkable avian diversity, and encouraging additional low-impact ornithological inventories of the area. We recommend that future inventories focus on the *pacales* and the higher elevations, including the temperate altitudinal zone and pristine puna habitats.

The impressive numbers and tameness of game birds at the three inventory sites indicate that little or no hunting occurs within Zona Reservada Megantoni. We observed signs of previous human visitation only at Kapiromashi, the only site where we did not observe large guans or curassows. Tinamous were present in substantial densities at each site, including *Tinamus osgoodi* (Figure 10C), listed as Vulnerable by Birdlife International (2000). The population of this species appears remarkably dense, and the Zona Reservada may protect one of the main population centers for this species. Currently, local

populations of Machiguenga are the only regular hunters visiting the Zona Reservada. Their reliance on bow and arrow results in a relatively low impact on game bird populations. Colonization of the area would guarantee increased hunting pressure on guans and tinamous and introduce higher-impact, shotgun-based hunting. At most sites accessible to hunters with shotguns, their efficiency causes dramatic declines in game bird populations.

We encountered healthy and sizable populations of large macaws, another group of species usually adversely affected by increased human presence. Both *Ara militaris* (*meganto* in Machiguenga, Figure 10A), considered Vulnerable by Birdlife International (2000), and the smaller *Propyrrhura couloni* are locally distributed in much of South America. These species were the two most abundant macaws at Kapiromashi. Zona Reservada Megantoni is an important site for maintaining source populations of these rare parrots.

Two passerine species, *Lipaugus uropygialis* (Figure 10D) and *Cacicus koepckeae*, are known from ten or fewer known localities worldwide each and are listed as Vulnerable by Birdlife International (2000). The effects of habitat destruction on the populations of these two species are unknown. Indeed, even the most basic information on their main habitat requirements and biology are a mystery. Zona Reservada Megantoni will be the first protected area in Peru known to safeguard populations of *L. uropygialis*, and the second for *C. koepckeae*. Strengthening its degree of protection will be an important first step toward a better understanding of these two species as well as the other 600 bird species that occur within its borders.

MAMMALS

Participant/Author: Judith Figueroa

Conservation targets: Carnivores with large ranges, e.g., jaguar (*Panthera onca*, Figure 11A), puma (*Puma concolor*, Figure 11D), and spectacled bear (*Tremarctos ornatus*, Figure 11B); the South American tapir (*Tapirus terrestris*, Figure 11F), whose low reproductive rate makes it particularly vulnerable to overhunting; populations of the South American river otter (*Lontra longicaudis*, Figure 11E) that are threatened elsewhere by contaminated rivers; primates that are subjected to serious hunting pressure in certain portions of their geographic distribution: e.g., red howler monkey (*Alouatta seniculus*), white-fronted capuchin (*Cebus albifrons*), brown capuchin (*Cebus apella*), common woolly monkey (*Lagothrix lagothricha*, Figure 11C), saddlebacked tamarin (*Saguinus fuscicollis*) and *Saguinus* sp.; vulnerable species such as pacarana (*Dinomys branickii*), ocelot (*Leopardus pardalis*), giant anteater (*Myrmecophaga tridactyla*), and giant armadillo (*Priodontes maximus*)

INTRODUCTION

Deforestation is one of the most serious threats to large-mammal communities, creating fragmented habitats and isolating mammal populations within forested patches. Corridors linking these patches are critical to maintaining evolutionary processes and promoting gene flow over larger areas (Yerena 1994). One such corridor, Zona Reservada Megantoni (ZRM), in the southern region of the Tropical Andes Priority Conservation Area, is a critical bridge connecting Parque Nacional (PN) Manu and Vilcabamba (see Figure 1).

Almost no information on mammal communities exists for this area. In 1999, the Centro para el Desarrollo del Indígena Amazónico (CEDIA) conducted a short inventory within the Apurímac, Urubamba, and Pongo de Maenique valleys and found threatened species such *Myrmecophaga tridactyla*, *Panthera onca* (Figure 11A), and *Tremarctos ornatus* (Figure 11B)(CEDIA 1999).

Information on mammal communities does exist for Vilcabamba and PN Manu, the two protected areas adjacent to Megantoni. Studies in Vilcabamba, along the elevational gradient from 850 to 3,350 m, registered 94 species including 27 large and medium-sized mammals weighing more than 1 kg (Emmons et al.

2001, Rodríguez and Amanzo 2001) and 67 small mammals (Emmons et al. 2001, Solari et al. 2001).

Pacheco et al. (1993) generated the first list of mammals for PN Manu, across an elevational gradient from 365 to 3,450 m. Subsequently, this list has been expanded by Voss and Emmons (1996) and most recently by Leite et al. (2003). They report 199 species in Manu with 59 large and medium-sized mammals and 140 small mammals.

METHODS

This inventory was conducted in the dry season between 25 April and 13 May 2004 in three sites between 760 and 2,350 m asl in Zona Reservada Megantoni. With the help of a local guide, I registered medium-sized and large mammals weighing more than 1 kg and included observations made by the other members of the inventory team and the advance trail-cutting team.

I walked alone or with a guide along established trails in all three sites (Kapiromashi, Katarompanaki, and Tinkanari). Walking speed was approximately 1.5 km/h. With a local guide, I surveyed diurnal mammals every day between 7 A.M. and 5 P.M. For two days at each site, we surveyed nocturnal mammals between 8 and 11 P.M. As we walked the trails, passing through the majority of habitat types at each site, we scanned from the canopy to the forest floor to survey both tree-dwelling and terrestrial mammals. We covered 56.3 km during the inventory.

We recorded large and medium-sized mammals using visual sightings as well as secondary clues such as tracks, dens or burrows, scat, food remains, scratches, and scents. We collected vegetative food remains for later identification. In the case of direct sightings, we noted the species, number of individuals, time of observation, activity, and forest type. We also recorded vocalizations when possible with a tape recorder.

To register mammals that are more difficult to observe, we used two complementary methods. First, we established track scrapes, clearing a 1.5-m² area on the forest floor. In the center, we placed a swab doused with animal scents. We used three different scents to attract

felines, canines, and Procyonidae: Bobcat Gland, Pro's Choice No. 3, and Raccoon No. 1 (Carman's Lure). We used Bear Sweet (Minnesota Trapline) to attract Ursidae (the spectacled bear) and Triple Heat (Harmon Deer Scents) to attract Cervidae. We only used track scrapes and scent lures at Kapiromashi and Tinkanari since soil was too difficult to clear at Katarompanaki. In Kapiromashi we placed five track scrapes in bamboo-dominated forest (*Guadua* sp., Poaceae, Figure 3E). In Tinkanari, track scrapes were established in a dwarf/shrub forest. Minimum distance between scrapes was 50 m.

Second, we took photographs using an automatic camera with an infrared sensor, Deer Cam DC-200 model. The camera was placed 60 cm above the ground and programmed to wait one minute between shots. At Kapiromashi, we established the camera on a trail used by *Tapirus terrestris* and *Mazama americana* within bamboo. In Katarompanaki and Tinkanari we placed the camera along a *Tremarctos ornatus* trail in the dwarf/shrub forest.

Also, we interviewed Gilberto Martínez, Javier Mendoza, René Bello, Felipe Senperi, Antonio Nochomi, Luis Camparo, Ronald Rivas and Gilmar Manugari. All are Machiguengas of the Timpía, Matoriato, and Shivankoreni native communities who provided assistance in the field during the rapid inventory. Using Emmons and Feer's (1999) mammal identification field guide, the interviewees identified mammals present in the lowlands (450-600 m asl) within the Zona Reservada. Their observations supplement the results from our inventory sites at higher elevations.

RESULTS

Species inventoried

Prior to fieldwork, we prepared a list of expected mammal species for ZRM based on inventories conducted at similar elevations in PN Manu (Pacheco et al. 1993) and Cordillera de Vilcabamba (Emmons et al. 2001, Rodríguez and Amanzo 2001). Of the 46 expected species, we registered 32 in 7 orders, 17

families, and 28 genera (Appendix 7). These included 1 of 3 expected marsupials, 4 of 8 xenarthrans, 6 of 8 primates, 10 of 13 carnivores, the only expected tapir (Perissodactyla), 4 of the 5 even-toed ungulates (Artiodactyla), and 6 of 8 rodents. During the interviews, the guides reported 12 species commonly observed in the lowlands, 6 of which were expected. Adding the species inventoried in the field and those identified during the interviews, we confirm 44 species for the sampled area in the Zona Reservada and the adjacent lowlands. ZR Megantoni spans a large elevational gradient, from lowland forest (~450 m asl) to puna (4,000+ m). I estimate that 161 small and large mammals—35% of Peru's 460 mammals (Pacheco et al. 1995)—inhabit the entire area.

Kapiromashi (25-29 April 2004)

In five days we covered 18.5 km between 760 and 1,200 m asl. We registered 19 species, including 3 xenarthrans, 2 primates, 6 carnivores, 1 odd-toed ungulate (Perissodactyla), 3 even-toed ungulates (Artiodactyla), and 4 rodents. In this area some members of the Sababantiari community and possibly some colonists practice subsistence hunting.

Despite local hunting, we found abundant evidence of *Tapirus terrestris* (Figure 11F). Along the banks of the Río Ticumpinía, we observed many tracks, representing at least four individuals. Some tapirs shared trails with *Mazama americana*. A member of the advance trail-cutting team observed a tapir on the beach. In addition, the camera trap registered an adult walking along the trail through the bamboo (*Guadua* sp.) at 8:30 P.M. We also found two samples of tapir scat with the remains of *Gynerium sagittatum* (Poaceae) in a forest creek.

On two occasions, the ichthyology team observed *Lontra longicaudis* (a pair and then a solitary individual, see Figure 11E) swimming in the Ticumpinía. During our surveys along the river, we found four samples of otter scat, one den, and many tracks.

Close to the *Lontra longicaudis* tracks we also found *Panthera onca* tracks, from a female and her cub.

On the forested slopes, at 818 m, we saw jaguar tracks again, as well as fresh scat. We heard jaguar vocalizations on three consecutive nights.

We observed abundant signs of *Dasybus novemcinctus*, with nine dens and many tracks in all of the scent scrapes between 725 and 930 m asl. In the forest canopy at 778 m asl, we observed a group of seven *Nasua nasua*: four adults and three young.

We expected to find large primates, such as *Alouatta seniculus* and *Lagothrix lagothricha* at lower elevations at this site. To our surprise, we heard vocalizations only of *A. seniculus*. *Lagothrix lagothricha* (Figure 11C) seemed to be entirely absent. These species principally inhabit undisturbed forests, and their low densities or absence probably reflect local hunting in the area.

In the bamboo patches, we observed two groups of *Cebus apella*, one group at 854 m with four individuals and another with eight individuals at 745 m. In the larger group, we observed a female with young. *C. apella* was the only monkey we observed in this disturbed forest, and it is typically most resistant to disturbance because of its high reproductive rate (Rylands et al. 1997).

We also recorded the poorly known *Dinomys branickii* (White and Alberico 1992). We found a den almost entirely hidden in a *Guadua* forest at 777 m. Nearby, a member of the rapid inventory team observed an individual crossing a creek close to the the Ticumpinía.

We expected to find *Tayassu pecari* and *Pecari tajacu* in Kapiromashi, but we found minimal signs of either. Their virtual absence in the area is curious and may reflect large-scale seasonal migrations or overhunting in the area.

Shakariveni (13-19 April 2004)

The advance trail-cutting team established a camp close to the Río Shakariveni (~950 m asl) in the hope of reaching the Katarompanaki platforms (~1,700 m asl), but the slopes were impossible to climb (see Overview of Inventory Sites). The inventory team did not visit this site. Nonetheless, during the seven days the advance trail-

cutting team worked in the area, they registered 18 mammal species: 3 xenarthrans, 2 primates, 6 carnivores, 1 Perissodactyla, 4 even-toed ungulates, and 2 rodents. The team made several interesting observations, including two *Lontra longicaudis* between the Río Yariveni and the Ticumpinía, a *Tapirus terrestris* walking the beach, a *Puma concolor* (Figure 11D) near the campsite at dawn, and *Leopardus pardalis* tracks. In the bamboo (*Guadua* sp.), they found tracks and a den of *Priodontes maximus*, as well as feeding signs of *Myrmecophaga tridactyla*. The team also found two palms of the genus *Geonoma* (Arecaceae) partially consumed by *Tremarctos ornatus*, with the species' territorial scratchings etched into the bark of a nearby tree.

Katarompanaki (2-7 May 2004)

In five days, we covered 11 km between 1,360 and 2,000 m asl. We registered 10 species including 5 primates, 2 carnivores, and 3 rodents.

On seven separate occasions, between 1,374 and 1,665 m elevation, we observed an enormous group of 28 individuals of *Lagothrix lagothricha* including 6 females with young. They were feeding on fruit and leaves of plants of the following genera: *Ficus* (Moraceae), *Tillandsia* (Bromeliaceae), *Anomospermum* (Menispermaceae), *Wettinia* (Arecaceae), *Matisia* (Bombacaceae), and *Guzmania* (Bromeliaceae—epiphytic, not terrestrial). We observed a group of 4 brown capuchin (*Cebus apella*) individuals at an elevation of 1,760 m. This record is 260 m higher than the elevational range reported by Emmons and Feer (1999).

Of the Neotropical primates, *Saguinus* (tamarins) is one of the most abundant and diverse genera, with extremely variable patterns of face and body coloration (Hershkovitz 1977). Between 1,545 and 1,620 m asl, we observed a group of 8 *Saguinus fuscicollis*, the most subspecies-rich species in the genus. At this same site we observed 10 *Saguinus* of an unknown species. Its coloration pattern was similar to that of *S. fuscicollis*, but with a thicker supraorbital line and uniform body colors, black from the middle upward and reddish toward its lower body. When

interviewed, our Machiguenga guides reported both forms of *Saguinus* and emphasized the color differences between these two forms.

Between 1,890 and 1,904 m asl in the dwarf/shrub forest, we observed 11 signs of the spectacled bear (*Tremarctos ornatus*, Figure 11B), including beds, hairs, and partially consumed pieces of a *Ceroxylum* palm. Our Machiguenga guides listed plants that were part of the bear's diet, including a Lauraceae (*inchobiki* in Machiguenga), *Dictyocaryum lamarckianum* and *Euterpe precatória* (Arecaceae), *Rubus* sp. (Rosaceae), and *Guzmania* sp. (Bromeliaceae, terrestrial). While cutting trail during the week before the inventory, one member of that team observed several bear trails at ~1,530 m.

Between 1,620 and 1,890 m asl we located four *Agouti paca* dens containing the remains of the fruit of the *Dictyocaryum lamarckianum* palm. One of the herpetologists observed a female paca with her offspring at night.

Tinkanari (9-13 May 2004)

In five days, we covered 20.6 km between 2,100 and 2,350 m in elevation. We registered 11 species: 1 marsupial, 2 xenarthrans, 2 primates, 4 carnivores, and 2 rodents.

Lagothrix lagothricha (Figure 11C) was the most abundant species at this site. All biologists observed these monkeys several times in groups of 10 to 20 individuals feeding on the ripe fruits of *Hyeronima* sp. (Euphorbiaceae) in the high montane forest, at 2,150 m. We also found other remains of consumed plants, including *Guzmania* sp. (Bromeliaceae), *Inga* sp. (Fabaceae), and *Calatola costaricensis* (Icacinaceae). In the same area we observed *Cebus albifrons* on four occasions: a group of 4, a group of 15, and 2 solitary individuals.

Signs of the spectacled bear (*Tremarctos ornatus*, Figure 11B) were also abundant. In the dwarf/shrub forest (2,100 m asl) alone we had 28 records of its presence. Most of these were food remains of *Ceroxylum* sp. (Arecaceae), but we also found remains of *Guzmania* sp. (Bromeliaceae) and *Sphaeradenia* sp. (Cyclanthaceae), as well as five

samples of scat full of seeds (species not yet identified), and five dens under the exposed root network of *Alzatea verticillata* (Alzateaceae). In sharp contrast, at 2,230 m in the high montane forest, we found very few signs of the spectacled bear. Here we encountered only the remains of three individuals of *Chusquea* sp. (Poaceae) and on one occasion, a partially eaten tree fern, *Cyathea* sp. (see Figures 5A, 5B, 5H).

Tatiana Pequeño observed a creamy-yellow jaguarundi (*Herpailurus yagouaroundi*) crossing the high montane forest at ~2,200 m asl. This coloration is rare; usually this species varies in color from blackish to a grey-brown, and reddish to a chestnut-brown (Tewes and Schmidly 1987).

Interviews

Observed species

During the interviews, the guides reported all of the species we recorded during this rapid inventory, in addition to 12 other species (6 expected) that they frequently see close to their communities, in forests at lower elevations than those of our sampled sites (Appendix 7). Felipe Senperi, head of the Timpía community, described a doglike mammal eating an *Agouti paca*. After I showed him the illustrations in the mammal field guide (Emmons and Feer 1999), he indicated that the species was possibly a bush dog (*Speothos venaticus*). The interviewees also mentioned that approximately two decades ago, they used to see small groups of giant otters (*Pteronura brasiliensis*) in the Río Shihuaniro, but no signs of them exist today. They told us that this species was intensely hunted in the area for their pelts.

Game species and pets

Locals interviewed indicated that their consumption of *Lagothrix lagothricha* (Figure 11C) coincides with periods of the year when the species finds abundant food in the forest, usually during May and June. They also consume *Mazama americana*, *Tapirus terrestris*, *Tayassu pecari*, *Pecari tajacu*, *Agouti paca*, *Dasyprocta* spp., *Cebus apella*, *Alouatta seniculus*, and *Hydrochaeris hydrochaeris*, which are relatively

abundant in the forests close to their communities. Less frequently, they consume *Cebus albifrons*, *Dasypus novemcinctus*, *Priodontes maximus*, *Dinomys branickii*, *Lontra longicaudis* (Figure 11E), and *Nasua nasua*. Species kept as pets are mostly primates, principally *Saguinus fuscicollis*, *Saimiri* sp., *Aotus* sp., and *Callicebus* sp. A pet adult tapir (*Tapirus terrestris*, Figure 11F) lives in Timpía.

Conservation targets

According to the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), of the 32 species registered in the Zona Reservada, 5 are threatened with extinction (CITES 2004-Appendix I) and 12 are either vulnerable or potentially threatened (CITES 2004-Appendix II). Of these 12 vulnerable or potentially threatened species, 5 are primates. According to the most recent categorization of Peru's wildlife completed by the National Institute of Natural Resources (INRENA), 2 of the 32 registered species are endangered, 5 are vulnerable, and 3 are almost threatened.

CITES designated the spectacled bear (*Tremarctos ornatus*, Figure 11B) as threatened with extinction and INRENA designates it as endangered. The wild populations of spectacled bears are often extremely isolated as well as hunted. Because of habitat fragmentation, populations are confined to relatively small patches of land that remain free of human influence (Orejuela and Jorgenson 1996). Bears are hunted for uses in traditional medicine, for meat, and for their cubs, which are sold as pets (Figuroa 2003a).

Previous studies show that *Tremarctos ornatus* disperses seeds of species such as *Styrax ovatus* (Styracaceae; Young 1990), *Guatteria vaccinioides* (Annonaceae), *Nectandra cuneatocordata* (Lauraceae), *Symplocos cernua* (Symplocaceae; Rivadeneira 2001), and *Inga* spp. (Fabaceae; Figuroa and Stucchi 2003). Because of their capacity to disperse seeds and their need for large home ranges (between 250 ha [Peyton 1983] and 709.2 ha [Paisley, pers. comm.]), spectacled bears almost certainly contribute to forest recuperation (Peyton 1987), and their conservation would indirectly benefit hundreds of other species (Peyton 1999). Zona Reservada

Megantoni has the highest relative density of this species reported in a Peruvian inventory—a clear indication that the area is home to healthy populations of bears.

Lontra longicaudis (Figure 11E) is listed in CITES Appendix I because of past intense hunting for their pelts that left groups of this species living in isolation from one another.

Tapirus terrestris (Figure 11F) is considered vulnerable by CITES and INRENA because its low reproduction rates make it susceptible to overhunting (Bodmer et al. 1997). Nonetheless, we encountered numerous tracks along the Río Ticumpinía and even photographed an individual with our infrared camera, suggesting populations in the area are still relatively unaffected by hunting.

Large primates like *Lagothrix lagothricha* (Figure 11C) and *Alouatta seniculus* are intensely hunted throughout the Amazon for both subsistence and commercial purposes. Because populations of these species have declined and even disappeared in certain portions of Peru, INRENA (2003) listed *L. lagothricha* as vulnerable and *A. seniculus* as almost threatened. CITES Appendix II lists both species.

INRENA (2003) lists *Dinomys branickii* and *Myrmecophaga tridactyla* as endangered and vulnerable, respectively, because of habitat degradation by agricultural activities and deforestation, and because of hunting. Despite their precarious conservation status, they are not directly threatened in Zona Reservada Megantoni. Locals only occasionally consume *D. branickii* and never consume *M. tridactyla* because of its offensive odor and unpleasant taste.

Two of the most threatened species, *Panthera onca* (Figure 11A) and *Priodontes maximus* (CITES 2004-Appendix I), are not hunted in Zona Reservada Megantoni by the Machiguengas living nearby, who also do not hunt *Mazama americana*. According to Machiguenga belief, these species are an important part of the origin of life and they are spiritually revered. Shepard and Chicchón (2001) also report similar hunting restrictions by Machiguenga peoples living along the eastern side of the Cordillera Vilcabamba.

DISCUSSION

Comparisons among the three inventory sites

As expected, the site with the highest species richness was our lowest-elevation inventory site (Kapiromashi), where we encountered 19 mammal species, 14 of which were not found at the other sites. This was the only site where we encountered *Dinomys branickii* and *Myrmecophaga tridactyla* tracks. Nonetheless, most of the species here (except for *Tapirus terrestris*, *Panthera onca*, and *Dasypus novemcinctus*) occurred at low densities (see Appendix 7). We were surprised not to find *Lagothrix lagothricha* here. Hunting by the Sababantiari community and possibly some colonists could be reducing populations of some mammals.

The middle-elevation tablelands at Katarompanaki had the lowest species richness (10) as well as the fewest species found solely at one site (4). However, we did observe more primate species (5) there than at any other site. At higher elevations but with taller vegetation, Tinkanari supported the second-highest species richness (11) with 5 species not encountered at other sites, including *Puma concolor*, *Agouti taczanowskii*, and *Herpailurus yagouaroundi*. In Katarompanaki and Tinkanari we registered high relative abundances of *Lagothrix lagothricha*, making woolly monkeys the most abundant mammal species registered in this inventory. Similarly, spectacled bear (*Tremarctos ornatus*) signs were abundant in both higher-elevation camps, and remarkably, it was the second most abundant species. Of the three inventory sites, both Katarompanaki and Tinkanari supported dwarf/shrub forests and tall montane forests in excellent state of conservation, without signs of human intervention.

Kapiromashi and Katarompanaki shared 3 species (*Cebus apella*, *Agouti paca*, and *Dasyprocta fuliginosa*), as did Kapiromashi and Tinkanari (*Dasyprocta fuliginosa*, *Nasua nasua*, and *Priodontes maximus*). Tinkanari and Katarompanaki shared 4 species (*Cebus albifrons*, *Dasyprocta fuliginosa*, *Lagothrix lagothricha*, and *Tremarctos ornatus*).

Comparisons of Megantoni with Vilcabamba and Manu

As Megantoni connects two large protected areas, we compare the number of species encountered in this inventory with species reports from Vilcabamba and PN Manu (at similar elevations). In Vilcabamba we use the mammal inventories conducted by Emmons et al. (2001) and Rodríguez and Amanzo (2001). Our comparison with PN Manu is less direct because the majority of the published reports on large and medium-sized mammals are from lower elevations (between 200 and 380 m) than those sampled in ZRM (760 m and up) (Voss and Emmons 1996, Leite et al. 2003). Other mammal lists do not report altitudinal ranges (Mitchell 1998) or focus on lower zones and give only few reports of higher elevations (Pacheco et al. 1993). Therefore, we compared our inventory data to PN Manu data from Pacheco et al. (1993).

In the three Megantoni sites, between 760 and 2,350 m asl, we registered 32 species. In five inventory sites in Vilcabamba between 850 and 2,445 m asl, 26 species were registered. Eighteen of these species were shared between the two areas and were mainly carnivores (7 species). The main difference between ZRM and Vilcabamba occurred at elevations below 1,200 m. In Vilcabamba 11 species were recorded between 850 and 1,200 m asl; at Kapiromashi Camp (760-1,200 m asl) we registered 19 species, constituting 73% of all species found in Vilcabamba.

Species richness decreases at higher elevations, and so did the number of shared species. Between 2,100 and 2,350 m asl in Megantoni we recorded 11 species. At 2,050-2,445 m asl in Vilcabamba, 16 species were encountered; only 7 are shared with Megantoni. Species registered only in ZRM were *Cabassous unicinctus*, *Procyon cancrivorus*, *Mazama gouazoubira*, *Myrmecophaga tridactyla*, *Saguinus fuscicollis*, and *Saguinus* sp. The species registered only in Vilcabamba were *Ateles belzebuth*, *Leopardus tigrinus*, and *Mazama chunyi*.

In both Vilcabamba and Megantoni, *Cebus apella* was encountered at higher elevations than those reported in Emmons and Feer (1999). In ZR Megantoni,

we observed *C. apella* at 1,760 m, and in Cordillera de Vilcabamba it was seen as high as 2,050 m. Its presence at higher elevations most likely reflects the seasonal abundance of ripe fruits at these elevations, although higher elevations might provide a refuge from hunting pressures at lower elevations. Oddly, *Panthera onca* (Figure 11A), present at elevations lower than 1,000 m in both ZRM and PN Manu, was not seen in Vilcabamba.

Among the most-common species in ZRM was the spectacled bear, *Tremarctos ornatus* (Figure 11B), a species with one of the broadest elevational ranges in the Andes. In this inventory, we encountered signs of this species between 960 and 2,230 m asl, with the most records in the dwarf/shrub forest at 2,100 m. This species almost certainly occurs at even higher elevations within ZRM. In Vilcabamba, signs of spectacled bears were encountered between 1,710 and 3,350 m asl, with most records at 2,245 m, in the transition between the dwarf forest and the drier inter-Andean valley vegetation. In Vilcabamba researchers inventoried elevations as low as 850 m but did not encounter spectacled bears. However, in PN Manu spectacled bears have been reported at elevations as low as 550 m (Fernández and Kirkby 2002) and as high as 3,450 m (Pacheco et al. 1993), with the most records occurring between 2,360 and 2,830 m in high montane forest (Figuroa 2003b). In 1980, Peyton documented the coincidence of the spectacled bear's elevational and home range with fruiting cycles of various species important in its diet. In ZR Megantoni we observed evidence of the bear's presence in a variety of habitats and interviews indicate that it consumes a diverse diet that changes during the different seasons of the year.

THREATS, OPPORTUNITIES, AND RECOMMENDATIONS

Principal threats

Forest destruction and overhunting damage the structure of wildlife communities. Close to Zona Reservada Megantoni, large-scale deforestation results from agricultural activities (mostly along the lower

Urubamba) and colonization by people who inhabit large areas close to the Pongo de Maenique and along the Río Yoyato.

All of the native communities living next to the Zona Reservada hunt for subsistence. The Kapiromashi Camp, situated close to the Ticumpinía, overlaps with an area used for hunting by the Sababantiari community and some colonists. In Kapiromashi, we did not encounter *Lagothrix lagothricha* (Figure 11C), and we registered *Alouatta seniculus* only once. These are preliminary indications that these species may be overhunted in this site.

Recommendations

Protection and management

Wildlife hunting is extremely important for native communities. In at least 62 countries throughout the world, bushmeat contributes approximately 20% of the animal protein in human diets (Stearman and Redford 1995). In certain parts of the Amazon, indigenous people obtain 100% of their protein from hunting (Redford and Robinson 1991), and bushmeat is probably improving the diet of many colonists (Vickers 1991). Therefore, we place high priority on evaluating the ecological impact of subsistence hunting, in the zones used not only by the Sababantiari community, but also by the communities living next to the Zona Reservada—for example, Timpía, Saringabeni, Matoriato, and Estrella. This research should be directed toward preserving wild mammal populations without reducing the quality of life of subsistence hunters and their families. To complement this research, we recommend an investigation of fishing methods that do not poison watercourses; current practices may harm mammals as well as aquatic species.

The Timpía community, with the help of the Centro Machiguenga, is developing ecotourism activities in areas near the Pongo de Maenique (see Figures 2, 13). Attractions include numerous waterfalls along the Río Urubamba that contribute to the area's scenic beauty, as well as the birds and mammals that live there. These activities should receive technical support so that they can

maximize the potential for income while minimizing or preventing any threats to the wildlife or local cultures. Once a healthy and successful program is underway, it might be replicated in other communities to contribute to the conservation of the remaining natural areas surrounding the Zona Reservada.

Additional inventories

Zona Reservada Megantoni spans a wide range of elevations, from lowland forest to puna, and has a varied and unique geography. Great habitat diversity can promote endemism, especially in small, nonvolant mammals. We recommend studies of smaller mammals, as well as surveys of elevations not sampled during this inventory (<760 m asl and >2,350 m asl).

History of the Region and Its Peoples

BRIEF HISTORY OF THE REGION

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INTRODUCTION

For the traditional inhabitants of the Urubamba Valley, great spirituality and mystery envelops the region of Megantoni. Inaccessible peaks, and abundant fauna—all protected by *Tasorinshi Maeni* (spectacled bear, *Tremarctos ornatus*, Figure 11B)—provide the foundation for the cultures of the Machiguenga and Yine Yami indigenous peoples.

In this section, we give a brief overview of the early influences in the region. We also highlight some of the landscape features that contribute to its inaccessibility, and to the rich biological diversity found in the Zona Reservada Megantoni (ZRM).

EARLY INFLUENCES IN THE REGION

When political powers shifted from Spanish colonial systems to an independent Republic, no major changes occurred in the Amazon region. Under both regimes, the Amazon was a source for natural resources, and the indigenous people were viewed as slaves.

During the eighteenth century, the Piro Indians often traveled to the Alto Urubamba, pillaging women and children and Machiguenga wares, so that they could exchange them for goods at the Spanish market held at the Santa Teresa ranch in Rosalino. During this time, French demands for *Cinchona* bark to make quinine affected both the Piro and the Machiguenga peoples. Around this time, iron tools were probably introduced to the Urubamba Valley.

Also during the eighteenth century, missionaries entered the region but had little success attracting converts. In the nineteenth century, the Urubamba remained isolated, despite the first settlements of *criollos*. At the end of the century, the rubber boom established permanent contact between *criollos* and Machiguenga. The peak of the rubber boom, between 1880 and 1920, marked a severe social, economic, and cultural exploitation of native peoples. Many populations of the lower and middle Urubamba regions were reduced drastically.

During the rubber boom, multi-ethnic work camps to extract rubber sprouted in the region. Workers were drafted via a recruitment system known as *correrías*, which was promoted and implemented by owners of ranches and rubber plantations, in conjunction with a tribal chief or enemy tribe. Children, young men and women, and adult women, were violently stolen from their villages and sold or exploited for labor.

This system prevailed until the first few decades of the twentieth century, when rubber production boomed in Asia and the industry collapsed in Amazonian Peru. Other smaller booms followed, such as that of wild yam, but with a more restricted impact on the regional economy. During the Second World War, the economy rebounded with increased demand for rubber. After the war, the demand for rubber disappeared and created a new economic crisis for the criollo peoples.

Even prosperous communities, like the one that inhabited the mouth of the Río Sepahua, vanished. Some rubber plantation owners began harvesting timber or dedicated themselves to commerce to overcome the economic crisis. But *correrías* remained a common practice for capturing indigenous laborers.

The Dominican Missions and the Summer Institute of Linguistics (SIL) were established in 1949. Both institutions signed a treaty with the Ministry of Education, seeking to integrate indigenous peoples into national society in accord with Catholic and evangelical perspectives. Their evangelical message, combined with indigenous ideologies, resulted in profound social changes in the native communities. As an example, human trafficking in women and children, which was prevalent in the communities until the 1970's, decreased once native children moved to dorms established near Dominican Mission schools.

Indigenous groups formed their current communities in a peculiar manner. Typically, a catholic missionary or native teacher from SIL would convert the dispersed families living in a given area. Subsequently, families concentrated their homes near the school, which initially was only a gathering place but eventually provided them with medical assistance, minimal services,

and small economic projects. Compared to the Dominican Mission in Puerto Maldonado and the SIL in Pucallpa, national, regional, and departmental administrations played a negligible role in founding schools. National government showed little interest in indigenous communities of the region until the discovery of natural gas reservoirs in Camisea. Today on the Alto Urubamba from the Comunidad Nativa Koribeni to the Pongo de Maenique, the Machiguenga are experiencing the impact of a growing population of colonists.

INACCESSIBILITY OF THE AREA

The region remained remote because of its inaccessibility. There are two ways to reach the ZRM from the upper Urubamba. The first is by land, from Calca or Quillabamba to the Qullouno District (see Figure 1). From here, one drives to Estrella and follows a horse path to the boundaries of the ZRM. The second route is via river. One travels by land past Quillabamba until reaching the Ivochote harbor and then continues by outboard motorboat along the Río Urubamba, crossing the Pongo de Maenique, until reaching the mouth of the Ticumpinía. Across the Río Ticumpinía lies the Comunidad Nativa Sababantiari (Figure 1, A20), on the northwestern border of ZRM. From the lower Urubamba, the trip is more straightforward. From the Sepahua, one crosses the Urubamba to reach the mouth of the Ticumpinía and crosses the river to reach Sababantiari.

No detailed records exist of migratory movements between the lower and upper Urubamba. But we know the current inhabitants of the lower Urubamba (the Machiguenga and the Yine Yami/Piro) exchanged goods with Andean settlers. The Pongo de Maenique (Figures 2, 13) invariably impeded both upriver and downriver trips, and indigenous peoples built footpaths scaling mountains and skirting the Pongo. For many years, the Saringabeni–Poventimari route along the Chingoriato pass (west of the Urubamba), and later the Lambarri route, were the only connections between the upper and lower Urubamba.

In the nineteenth century, missionaries and explorers from the Andes used watercrafts suitable for gentler water in trying to cross the rapids, with tragic results that increased the mystery and fear surrounding the Pongo de Maenique. Famous explorers like Coronel Pedro Portillo and Marcel Monnier, traversed the Pongo. They provided the first written testimonies of the spectacular beauty within Megantoni.

The river route is the more important of the two for the transport of passengers and cargo. The hydrological network allows year-round navigation on the Río Urubamba, but rainy-season access only on its major tributaries. The main connection between rivers is that between Ivochote and the Pongo de Maenique (Figures 1, 13). Access to the region is risky and costly because of the Pongo, and this barrier creates a disjunction within the Department of Cusco. The result is a stronger connection among the settlements downriver near Sepahua and Atalaya, in the Department of Ucayali.

The Pongo de Maenique remained barely used as a transportation route until the end of the 1970's, even though colonization of the Urubamba reached its peak during this decade. In the 1980's, three events opened the region to commercial boats from the upper Urubamba: (1) the filming of the movie *Fitzcarraldo* with Megantoni as a backdrop, (2) technological advances in outboard motors, and (3) the natural gas project in Camisea.

Today, 93 watercrafts cross the Pongo de Maenique and further downstream. Upstream, nearly 80 watercrafts operate in the Ivochote-Pongo de Maenique confluence, including 30 that regularly cross the Pongo to reach the lower Urubamba. Once the waterway opened, threats to the lower Urubamba region increased rapidly, including threats to the fragile and rich biodiversity of Megantoni (Figure 1).

SOCIOECONOMIC AND CULTURAL CHARACTERISTICS

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INTRODUCTION

Two clearly distinct cultural groups live in the area surrounding Zona Reservada Megantoni: communities with native populations and rural settlements with colonists (see Figure 1). Throughout the region, there is limited access to basic services.

Colonists focus primarily on commercial agriculture and occupy areas along current and future access routes. Two principal factors underlie the waves of colonization into the region: (1) substantial improvement in the price of coffee and cocoa, and (2) new highway projects into the valley's interior.

The area is ill-suited for agricultural activities, and colonists have limited knowledge of lowland tropical ecosystems. Throughout the region, soils erode quickly and can cause landslides, such as the one in Ocobamba along the Río Yanatile. Soil degradation, along with encouragement from land prospectors motivate farmers to move to new areas. Even though colonists are farming on steep slopes and protected lands, they obtain property titles, which guarantees greater deterioration and poverty.

In contrast, native people communities use traditional survival strategies that depend on the forests that surround them. Although they trade coffee, cocoa, and *achiote* on external markets, these crops do not take priority in their subsistence economy.

In this section, we provide a description of the human demography and socio-cultural characteristics of the native communities and colonists living in the region surrounding Zona Reservada Megantoni. We also give a brief description of the five ethnic groups living in the Megantoni area.

DEMOGRAPHIC DESCRIPTION OF THE AREA

Megantoni, and the great Pongo de Maenique, divide the Urubamba Valley into the upper and lower Urubamba. In the lower or Bajo Urubamba, 12,000

native inhabitants coexist with approximately 800 colonists. In the upper or Alto Urubamba, there are more than 150,000 inhabitants, of which only 4,000 are native Machiguengas (see Figure 1).

Both native communities and colonist settlements string along the banks of the Río Urubamba and its principal tributaries. Inhabitants still rely on the river for both internal and external transportation. The native populations of the Bajo Urubamba are culturally diverse. They have a centralized and linear settlement pattern due to the influence of schools, religious missionaries, and local patrons; schools have contributed significantly to the native population's current sedentary and permanent-settlement lifestyle.

During the mid-1990's, CEDIA conducted studies within the Zona Reservada Megantoni and identified small areas of subsistence plots and huts belonging to the Nanti (also known as Kugapakori) native people (CEDIA 2004, Figura 12E). During our overflight of the region, we observed at least four additional plots and huts of extended families (or clans) not seen during the fieldwork of the 1990s in the upper Timpía.

These groups living in isolation along the upper Río Timpía are Kugapakori (Nanti), and the Río Timpía provides a fluvial corridor to the Parque Nacional Manu from the Reserva Kugapakori-Nahua.

SOCIO-CULTURAL CHARACTERISTICS OF AREAS ADJACENT TO ZONA RESERVADA MEGANTONI

The western, northern, and eastern sectors

Reserva Comunal Machiguenga borders the Zona Reservada's western edge (Figure 1). It covers 218,905 ha and is part of the Vilcabamba conservation complex.

North of Pongo de Maenique, along the right bank of the Río Urubamba where it meets the Ríos Saringabeni and Toteroato, as well as on the left bank where it meets the Ríos Ticumpinía and Oseroato, there are five rural settlements of the Saringabeni and Ticumpinía colonists, with 71 individual plots, including 12 that directly border the Zona Reservada (CEDIA 2002a; Figure 1). The most important of these five

settlements is Kitaparay, with ~34 colonist families from Apurímac, Cusco, and Cajamarca (CEDIA 2001).

The Comunidad Nativa Sababantiari (Figure 1, A20), west of the reserved zone, is one of two native communities bordering the Zona Reservada Megantoni. Approximately 45 inhabitants in 13 Machiguenga and Nanti families live here (CEDIA 2004). Some families in this community are originally from the Comunidad Nativa Ticumpinía, when it was situated at the mouth of the Río Ticumpinía (today it lies in the Chocoriari). These families moved to Sababantiari after the Río Ticumpinía flooded the entire community and their crops. The colonization of these evacuated Ticumpinía lands by the Cooperativa Alto Urubamba and other colonists forced the remaining families (who did not go to Sababantiari) to relocate upriver between the Río Sababantiari and the Río Oseroato. Since the mid 1980s, Nanti (Kugapakori) families, who traveled between the upper Yoyato, the Pongo de Maenique, and the upper Río Ticumpinía, have joined the Sababantiari community. Over time, the entire group settled permanently in the area. At the end of the 1980s, CEDIA and the Ministry of Agriculture began procedures to recognize and title their lands (Rivera Chávez 1988).

Along its eastern and extreme northeastern boundaries, Zona Reservada Megantoni borders Parque Nacional Manu (Figure 1). Manu is home to Machiguenga, Piro, Harakmbut (Amaracaeri, Huachipaeri, Toyeri), populations in voluntary isolation (Mashco-Piro and Nanti/Kugapakori), and a small group of colonists.

To the north, Zona Reservada Megantoni borders the Reserva del Estado A Favor de los Grupos Étnicos Aislados Kugapakori-Nahua (RKN), where uncontacted Kugapakori and Nahua indigenous communities live including several communities experiencing initial contacts with the western world (Figure 1). Covering 456,672.73 ha, the RKN lies in the Districts of Echarate and Sefahua, the Convención and Atalaya Provinces, Departments of Cusco and Ucayali respectively.

*Reserva del Estado A Favor de los Grupos Étnicos
Aislados Kugapakori-Nahua (RKN)*

Machiguengas of the Bajo Urubamba use the word “Kugapakori” to refer to the Nanti people living in the headwaters of the Río Urubamba’s tributaries, between the Río Yoyato, Pongo de Maenique, the rivers Ticumpinía, Sihuaniro, Timpía, Cashiriari, and Camisea (among others), and the streams that feed Río Manu or upper Madre de Dios (Rivera Chavéz 1988).

Nanti/Kugapakori usually have large families and live in groups of 1-3 families per settlement. Each settlement covers an extensive area and contains their huts and farms, and groups move periodically. Their movements can reflect several natural cycles, including rainy and dry seasons, fluxes in reproductive cycles, excess or scarcity of hunted animals, fish, and/or other gathered species, as well as harvests of yucca and plantain crops on their small farms. They leave their farms, along with their hunting/gathering trails, when they migrate in search of food (seasonal), and during their cyclic migrations (for other reasons).

Like “Kugapakori”, “Nahua” is a Machiguenga word. It means “strange people.” The ethnic group refers to itself as the Yora, which means, “we, the good people.” This group belongs to the Pano linguistic family (Reynoso Vizcaino and Helberg Chávez 1986). Yora/Nahua territory extends along both sides of the Río Mishagua, from Parque Nacional Manu to Quebrada Tres Cabezas, and on both sides of the Río Serjali to where this river borders Kugapakori territory. The Yora only sporadically use the resources along the Kugapakori territorial border, but they still consider the area their own. Other indigenous groups and *mestizos* are present along the Yora’s territorial borders. However, the Yora demand that no foreigners enter their territory nor remove resources without their permission (Shinai-Serjali 2001).

The Nanti/Kugapakori ethnic group, like the Yora/Nahua people, is traditionally migratory and relies on the forest for survival. Their subsistence activities—hunting, fishing, and collecting non-timber products—underlie their nomadic lifestyle.

Recently, with ineffective protection of the reserve, and inadequate enforcement of the Peruvian Forestry Law, the presence of illegal loggers and natural gas extraction in the RKN has increased. Block 88 (natural gas extraction site) covers 106,000 ha of Nanti/Kugapakori territory within the reserve. Because of natural gas extraction activities, the Nanti/Kugapakori people have left their lands in the lower Camisea basin to seek refuge indefinitely in Camisea’s headwaters.

Their new sedentary lifestyle in the Camisea headwaters conflicts with the Nanti/Kugapakori’s traditional relationship with the forest, and creates a serious risk to the group’s survival—especially since the large group (more than 300 people living between Montetoni and Marankiato) is likely to exhaust rapidly the hunting, fishing, and gathering resources of this already resource-poor forest. As long as they cannot return to their historical settlement areas in the lower Camisea basin for fear of encountering foreigners and their deadly diseases, malnutrition within the Nanti community will likely continue to increase. Moreover, diseases probably will spread within the community because of the unnaturally high population density of the group. These issues need immediate attention.

One possible solution involves excluding the land within the RKN from Block 88, thereby reducing the natural gas concession to the minimum size necessary to develop the Camisea natural gas project, while simultaneously decreasing the negative impacts on the native community.

The southern sector

On the southern side of ZRM, along the left and right banks of the Río Urubamba at the entrance to Pongo de Maenique, lie six rural colonized settlements (Figure 1). Within the Pomoreni and Yoyato settlements, 19 plots border the Reserve.

The Comunidad Nativa Poyentimari is situated on the Río Poyentimari in the extreme southwestern corner next to the Reserve. This Machiguenga community of 280 inhabitants is one of two native

communities bordering the Reserve (Sabantiari, northwest of the ZRM, is the other).

In 2002, CEDIA and the Proyecto Especial de Titulación de Tierras (PETT, land titling project), conducted fieldwork to verify the Reserve's south-central boundaries and found colonized settlements within the Zona Reservada Megantoni (CEDIA 2002, Figure 1). These settlements are in the Kirajateni-Koshireni and La Libertad sectors; we do not know when they were founded. Abandoned huts were seen in the Anapatia–Manguriari and Sacramento sectors. Sacramento is an area of puna in the extreme southern region of the ZRM next to Parque Nacional Manu. In these sectors, people were in the first phases of colonization (initial deforestation with temporary settlements) and have been in the area for only two years except in the La Libertad sector.

La Libertad (La Convención Province, Quellouno District) is inside of ZRM's borders and is the only sector that has been titled and recorded in Quillabamba's public registry (since 1998). Nonetheless, the inhabitants are unhappy because the land parcels assigned by PETT do not correspond with their plots' actual shapes, borders, or sizes. They have requested that PETT redo the work and correct these errors. Most of the proprietors in this sector have additional plots in other sectors in Huillcapampa, Yavero, and Santa Teresa, and in La Convención Valley. Many titled lands have been recently deforested (within the last two or three years) and a few are already planted with pasture grasses for cattle. La Libertad is home to 20 to 30 landowners.

In Kirajateni-Koshireni (La Convención province, Echarati district; Figure 1), also within the ZRM's borders, ten landholders are in a precarious situation. For the last two years, they have failed to initiate the process to legalize their land. The colonists are settled in the headwaters of the Ríos Yoyato, Kirajateni, and Koshireni (tributaries of the Río Urubamba, Figure 1) on uneven, abruptly changing terrain with elevations from 1,000 to 3,000 m. The soils are extremely acidic, shallow, and rocky, and the land has been classified as inappropriate for agricultural activities and suitable for protection.

NATIVE COMMUNITIES

The native communities belong to two linguistic families. The predominant linguistic group is the Arahua, made up of Machiguenga, Campa (Ashaninka and Kakinte), Nanti/Kugapakori and Yine Yami/Piro. The Pano linguistic family, which is smaller and less influential, is made up of the Yora/Nahua. The ethno-linguistic composition of the region is rather homogeneous because natives belonging to the Arahua linguistic family make up 85.8% of the native population of the area. Their similar languages and customs facilitate communication among the ethnic groups.

Machiguenga

The Machiguengas (Figures 12A, 12C) are the most numerous indigenous group in the area. Access to their territory is extremely difficult. Their lands cover approximately 1 million ha in three adjoining geographic areas in the Andean foothills, between the Alto and Bajo Río Urubamba, the Río Manu, and the Río Alto Madre de Dios.

Machiguenga communities are groups of extended family members. Although their traditional settlement pattern was dispersed and migratory, recently Machiguenga groups have become more sedentary, nuclear, and linear. Their values and belief systems form their cultural identity, and their social system is based on mutual help and reciprocity.

The Machiguenga are described as a society of equality, and their skills and cultural values are well known by Amazonian researchers. They have a subsistence-based economy (hunting, fishing, gathering, agriculture) traditionally focused on satisfying family needs. The little surplus that exists plays an important social role since they share or trade any extra food or goods, reinforcing family ties and solidarity. On a small scale, Machiguenga produce agricultural crops like coffee, cocoa, achiote, rice, and peanuts, as well as dried fish, to trade for spices or money.

Communities along the tributaries of the Río Urubamba are the most traditional with an almost exclusive subsistence-based economy. In contrast,

communities along the main river channel are more closely connected with outside markets, and therefore tend to be centralized and bigger, with more social services. Generally, the relationship between communities and outside markets is becoming stronger, although there are differences in reliance on external markets.

Ashaninka (Campa)

There are two Ashaninka Campa (Figure 12D) groups in the area. One, the Kakinte Campa from the Tsoroja zone, lives in the Río Tambo basin. Two generations ago, they arrived in the region in search of better land. The Kakinte Campa were pressured into leaving their traditional territories (the communities of Kitepampani and Taini) by Andean migrants from Central Peru. The second group is the Ashaninka Campa, with traditional territories between the Tambo and Ene rivers.

Two events triggered their migration out of these territories: (1) during the 1970's the central Amazon was colonized, pushing the Ashaninka out of their territory. They migrated toward Atalaya, then past Bufeo Pozo, and finally settled next to the Comunidad Nativa Miaría. For many years, their settlement was considered an annex of Miaría, but it has been recently recognized and titled as an independent native community; (2) terrorism along the Río Ene was rampant. The Catholic Church intervened in this violent situation and flew the Ashaninka out, relocating them from the Ene and Cutivireni basin to the lower Urubamba, where they live today in the communities of Koshiri, Tangoshiari and Taini.

Yine Yami/Piro

The Yine Yami people are better known as the Piro. Traditionally, the Piro controlled inter-regional trade, the entrance to Río Tambo, and the famous Cerro de la Sal. Moreover, Piro controlled the area close to Cusco and contact with the Andes, acting as intermediaries between Amazonian and Andean commerce. Their communities are Sensa and Miaría, adjacent to the department of Ucayali. The Piros are the principal fish suppliers for the town of Sepahua and are known for their skills in commerce and navigation.

Nanti

The Nanti (Figure 12B) are known by most as “Kugapakori.” This name was given to them by the Machiguenga and it means “angry or wild people” (they aggressively defend their territories and they decided to live in isolation). In contrast, they call themselves, “Nanti,” meaning “good people.”

The Nanti/Kugapakori separated from the Machiguenga, opting to remain isolated from missionaries and other people from mainstream society. News of their existence has circulated since 1750, and in 1972 the first small groups were contacted. One of the Nanti/Kugapakori groups is situated in the settlements called Marankiato and Montetoni, within the Reserva Nahua-Kugapakori. There are also other Nanti/Kugapakori groups living inside of Parque Nacional Manu and within Zona Reservada Megantoni (Figure 12E).

Nahua/Yora

The Nahua/Yora are part of the Pano linguistic family and the Yaminahua group: they live between the Río Misahua (Serjali) and Sepahua. Only in the last 12 years have the Nahua/Yora settled close together. Before 1982, they migrated between the Ríos Yurua, Purús, Mishagua and Parque Nacional Manu to hunt, fish, and collect forest resources. Today they live in the basin of the Río Mishagua, a tributary of lower Urubamba. More than 90% of the Nahua/Yora population lives in the native community of Santa Rosa de Serjali within the Reserva Nahua-Kugapakori.

THE COLONISTS

Colonists are distributed in four different sectors, including (1) Saringabeni-Quitaparay, on both banks of the Río Urubamba, downriver from the Pongo de Maenique; (2) Kuway-Las Malvinas, between the Ríos Timpía and Camisea; (3) Nueva Esperanza-Tempero (Shintorini), downriver from the Río Camisea; and (4) Mishahua, along the border between Cusco and Ucayali (see Figure 1).

The colonization process in the Urubamba basin is different from colonization in the central lowland forest. In the upper Urubamba, Andean small farmers arrived in the region to work temporarily on large haciendas. Over time, they began social movements (as in La Convención) to change the property distribution system and to reallocate land. In 1969, emphasis was set on developing cooperative systems, such as those in the upper Urubamba. Later, some cooperatives moved to the middle Urubamba. Many colonists attempted to settle in the lower Urubamba, but were impeded by the natural barrier created by the Pongo de Maenique.

In 1986, the national government promoted colonization in the area because natural gas deposits were found in Camisea, but the colonization was unsuccessful (Rivera Chávez 1992). More recently, colonists from places like Cusco, Apurímac, and Junín have migrated to the area on their own. Eighty percent are poor farmers, and five percent are involved in commerce between Quillabamba and Sepahua, using one or two boats to transport products from one community to another, or moving their commercial center (using portable tents) among communities. Even though there is only a small group of colonists in the lower Urubamba, they have economic and social power, but little influence when it comes to decision-making.

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