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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. One division of the museum—Environment, Culture, and Conservation (ECCo)—through its two departments, Environmental and Conservation Programs (ECP) and the Center for Cultural Understanding and Change (CCUC), is dedicated to translating science into action that creates and supports lasting conservation of biological and cultural diversity. ECCo works closely with local communities to ensure their involvement in conservation through their existing cultural values and organizational strengths. With losses of natural diversity accelerating worldwide, ECCo's mission is to direct the museum's resources—scientific expertise, worldwide collections, innovative education programs—to the immediate needs of conservation at local, national, and international levels.

The Field Museum
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The Nature Conservancy – Peru

The Nature Conservancy is an international non-profit organization, founded in 1951. It is headquartered in the United States, but also works in more than 30 other countries around the world. The mission of The Nature Conservancy is to preserve the plants, animals and natural communities that represent the diversity of life on Earth by protecting the lands and waters they need to survive. The Nature Conservancy's vision is to conserve portfolios of functional conservation areas within and across ecoregions. In Peru, TNC has three main initiatives: Pacaya Samiria National Park, the forests of the Selva Central, as well as creating a protected area in the Sierra del Divisor region that is a sister conservation area to the Serra do Divisor National Park across the Brazilian border.

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ProNaturaleza – Fundación Peruana para la Conservación de la Naturaleza

ProNaturaleza — the Fundación Peruana para la Conservación de la Naturaleza is a non-profit organization, created in 1984 with the purpose of contributing to the conservation of the natural patrimony of Peru, with particular emphasis on its biodiversity, the promotion of sustainable development, and the betterment of the quality of life of the Peruvian people. In order to achieve these goals, ProNaturaleza executes projects, primarily in natural areas, along three principal lines: the protection of biological diversity, the sustainable use of the natural resources and the promotion of a culture of conservation in the national society.

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Insituto del Bien Común (IBC)

The Instituto del Bien Común is a Peruvian non-profit organization devoted to promoting the best use of shared resources. Sharing resources is the key to our common well-being today and in the future, as a people and as a country; to the well-being of the large number of Peruvians who live in rural areas, in forests and on the coasts; to the long-term health of the natural resources that sustain us; and to the sustainability and quality of urban life at all social levels. IBC is currently working on four projects: the Pro Pachitea project, which focuses on local management of fish and aquatic ecosystems; the Indigenous Community Mapping project, which aims to defend indigenous territories; and the Large Landscapes Management Program, which aims to the creation of a mosaic of sustainable use and protected areas in the Ampiyacu, Apayacu, Yaguas and Putumayo rivers. The mosaic will be constituted by the enlargement of communal lands, a system of regional conservation areas and a national protected area. We are also promoting the participation of indigenous organizations in the creation and categorization of the Zona Reservada Sierra del Divisor. The IBC recently completed the ACRI project, a study of how communities manage natural resources, and distributed the results in a number of publications.

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Organizacion Regional AIDESEP–Iquitos (ORAI)

The Regional Organization AIDESEP-Iquitos (ORAI) is registered publicly in Iquitos, Loreto. This institution consists of 13 indigenous federations, and represents 16 ethnic groups located along the Putumayo, Algodón, Ampiyacu, Amazonas, Nanay, Tigre, Corrientes, Marañón, Samiria, Ucayali, Yavarí and Tapiche Rivers in the Loreto region.

The mission of ORAI is to ensure communal rights, to protect indigenous lands, and to promote an autonomous economic development based on the values and traditional knowledge that characterize indigenous society. In addition, ORAI works on gender issues, developing activities that promote more balanced roles and motivate the participation of women in the communal organization. ORAI actively participates in land titling of native communities, as well as in working groups with governmental institutions and the civil society for the development and conservation of the natural resources in the Loreto region.

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Organizacion Regional AIDESEP–Ucayali (ORAU)

The Organización Regional AIDESEP–Ucayali (ORAU) is registered publicly in Pucallpa, Peru. The institution brings together 12 indigenous federations representing 14 ethnic groups and includes 398 titled native communicites and 48 on the road to formal land titles. The majority of these communities are situated in the Ucayali, Pachitea, Yurúa and Purus watersheds, as well as the Gran Pajonal.

ORAU's mission is to promote the territorial rights of indigenous people, to strengthen bilingual intercultural education via the Atalaya pilot project, and—as part of the Universidad Nacional Indigena de la Amazonia Peruana—to protect indigenous health and value traditional medicine.

ORAU participates in developing community forest management plans, in managing the Reserva Comunal El Sira via the Eco Sira project, in managing the Reserva Territorial del Purus, and in representing indigenous interests in the working group for Zona Reservada Sierra del Divisor/Siná Jonibaon Manán.

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Herbario Amazonense de la Universidad Nacional de la Amazonía Peruana

The Herbario Amazonense (AMAZ) is situated in Iquitos, Peru, and forms part of the Universidad Nacional de la Amazonía Peruana (UNAP). It was founded in 1972 as an educational and research institution focused on the flora of the Peruvian Amazon. In addition to housing collections from several countries, the bulk of the collections consists of specimens representing the Amazonian flora of Peru, considered one of the most diverse floras on the planet. These collections serve as a valuable resource for understanding the classification, distribution, phenology, and habitat preferences of ferns, gymnosperms, and angiosperms. Local and international students, docents, and researchers use these collections to learn, identify, teach, and study the flora. In this way the Herbario Amazonense contributes to the conservation of the diverse Amazonian flora.

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Museo de Historia Natural de la Universidad Nacional Mayor de San Marcos

Founded in 1918, the Museo de Historia Natural 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. It highlights Peru's status as 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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A rapid biological inventory is successful only with the support and energy of many collaborators and partners. We are grateful to everyone who made our work possible, and although we cannot acknowledge each and every individual, we sincerely appreciate the assistance that we received from all.

Members of our advance team—headed by Guillermo Knell, with the close collaboration of Italo Mesones and José-Ignacio "Pepe" Rojas—deserve enormous credit for their superb management of the complicated logistics of the inventory. They received invaluable support in Contamana, the initial staging point, from Wacho Aguirre of CIMA-Contamana. Other key assistance was provided by Carmen Bianchi and Antuanett Pacheco, of Kantu Tours; Max Rivera, of ProNaturaleza-Pucallpa; and the Hostal August in Contamana. Ruben Ruiz, of the Hotel Ruiz in Pucallpa, graciously accommodated our crew both before and after the field work, and provided perfect facilities for the preparation of our initial reports.

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The advance team showed wonderful creativity and determination in entering this remote wilderness, identifying suitable terrain for fieldwork, and preparing heliports, comfortable field camps, and trail networks. The advance team at Ojo de Contaya, led by Italo Mesones, included Edgar Caimata Payahua, Luis Edilberto Chanchari Panduro, Juan Alberto Díaz Ocampo, Elmergildo Gómez Huaya, Samuel Paredes Tananta, Freddy Astolfo Pezo Cauper, Euclides Rodríguez Acho, Hector Rodríguez Mori, Albertano Saboya Romaina, and Moisés Tapayuri Urquia. Our camp on the banks of the Río Tapiche was established by Pepe Rojas, with Ambrosio Acho Mori, Manuel Ilande Cachique Dasilva, Jarbis Jay Flores Shuña, Jimy Angel Mori Amaringo, Elmo Enrique Ramírez Guerrero, Medardo Rodríguez Sanancino, Orlando Ruiz Trigoso, Fernando Valera Vela, Luis Fernando Vargas Tafur, and Limber Vásquez Mori. The advance team at Divisor was led by Guillermo Knell and also included Kherry Marden Barrantes Tuesta, Hernando Benjamin Cauper Magin, Santiago Dasouza Ríos, Hornero Miguel Díaz Ocampo, Wilmer Gómez Huaya, Ezequiel Meléndez Pinedo, Golber Missly Coral, Demetrio Rengifo Cordova, Josue Rengifo Córdova, and Romer Romaina Vásquez. Our cook, Betty Luzcita Ruiz Torres, kept us well fed at each of our camps.

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Tyana Wachter, Rob McMillan, and Brandy Pawlak assisted at every stage, from the initial organization before our departure to the inventory itself through the completion and dissemination of this report. Sergio Rabiela prepared the satellite images. Dan Brinkmeier, Kevin Havener, and Nathan Strait prepared beautiful maps and visual materials that were critical to communicating about our work. Lucia Ruiz helped us tremendously by editing the chapter on the legal situation of the territorial reserves. Brandy Pawlak, Tyana Wachter, and Doug Stotz, as always, were master copyeditors and proofreaders. We also had the assistance of a talented pool of translators: Patricia Álvarez, Malu S. P. Jorge, Pepe Rojas, Susan Fansler Donoghue, Tyana Wachter, Paúl M. Velazco, and Amanda Zidek-Vanega. Jim Costello and his staff at Costello Communications continue to display great skill (and patience) in overseeing the design and production of this report.

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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	6–24 August 2005
Region	Sierra del Divisor—known by its indigenous residents as *Siná Jonibaon Manán*, or "Land of the Brave People"—is a mountain range that rises up dramatically from the lowlands of central Amazonian Peru (Fig. 2A). This band of mountains runs roughly north to south and straddles the Peru–Brazil border. To the west of the Sierra del Divisor lies the Serranía de Contamana (Fig. 2A), which forms a narrow arc near the small town of Contamana. East of the Serranía de Contamana sits a remote, eye-shaped ring of ridges and valleys known as the Ojo de Contaya. Finally, to the south of the Sierra del Divisor, an isolated set of volcanic cones jut out of the lowlands (Figs. 1, 2A, 2B). Within central Amazonian Peru, the Sierra del Divisor is part of a series of low mountains that forms a broken chain extending from near the banks of the Río Ucayali eastward to the border with Brazil (Figs. 2A, 2B). The region lies mostly within the department of Loreto, but also stretches into the northernmost section of the department of Ucayali. Collectively, the entire complex of mountains—Sierra del Divisor, Serranía de Contamana, Ojo de Contaya, and the volcanic cones—is known as the Sierra del Divisor/Siná Jonibaon Manán Region. Zona Reservada Sierra del Divisor (which was established after our inventory) comprises this same region (Fig. 2A).
Biological Inventory Sites	The biological team surveyed three sites within Zona Reservada Sierra del Divisor (the "Zona Reservada," Figs. 3A, 3B). The first was near the center of the Ojo de Contaya complex (Ojo de Contaya, Fig. 3A). The second was along the upper Río Tapiche, in the lowlands adjacent to the Sierra del Divisor (Tapiche, Fig. 3B). The third was within the Sierra del Divisor itself, near the border with Brazil (Divisor, Fig. 3B).
Organisms Studied	Vascular plants, fishes, amphibians and reptiles, birds, medium to large mammals, and bats.
Social Inventory Sites	The social team visited 9 of the 20 communities situated in and around the Zona Reservada (Fig. 2A), in four different drainages: the Río Abujao (C.N. San Mateo), the Río Callería (C.N. Callería, C.N. Patria Nueva, Guacamayo, Vista Alegre), the Río Tapiche (C. N. Limon Cocha, Bella Vista), and the Río Ucayali (C. N. Canchahuaya, Canelos).
Social focus	Cultural and social assets, including organizational strengths, and resource use and management.

REPORT AT A GLANCE

Highlights of biological results

One of the most remarkable features of the Zona Reservada is the high concentration of rare and range-restricted species. Several of these species are known only from this region and occur in restricted habitats (e.g., the stunted forests on tops of sandy ridges).

Our inventory documented:

01 A bird species (Figs. 7C, 7D) previously known only from one ridge in Brazil, adjacent to the Zona Reservada; our record during the inventory was the second anywhere and the first in Peru.

02 A large community of primates, including species globally threatened or not previously protected within the Peruvian park system (SINANPE) (Figs. 8A, 8D).

03 Refuges of plant and animal species threatened elsewhere in the Amazon with commercial overexploitation and extinction.

04 Several dozen species of plants, fishes, and amphibians potentially new to science, as detailed below.

The number of rare and endemic species in the region is spectacular, even though, compared to other sites in Amazonia, the species richness itself may not be extraordinary (Table 1). Below we highlight some of our most interesting findings, including the discovery of species not previously known to science or reported from Peru, important range extensions of poorly known species, and discovery of substantial populations of threatened species.

Table 1. Number of species registered and estimated in Zona Reservada Sierra del Divisor.

Inventory site	Vascular plants	Fishes	Amphibians and reptiles	Birds	Large mammals
Ojo de Contaya	500	20	29	149	23
Tapiche	750	94	40	327	31
Divisor	600	24	32	180	18
Total for inventory	over 1,000	109	109	365	38
Estimate for the Zona Reservada*	3,000–3,500	250–300	over 200	570	64

* We did not visit the sites in the region typical of Amazonian lowland forest, where expected numbers of species are high but expected endemism is low, but we include the richer Amazonian sites in our estimates of total species richness.

Vascular plants: We recorded nearly 1,000 species of the 2,000 predicted to occur in the central and eastern portions of the Sierra del Divisor Region. All sites we visited during the inventory were on sandy soils with low productivity.

When richer soils (present in areas north and south of the sites that we visited) are taken into account, we estimate a flora of 3,000–3,500 species for the region. At least ten species of plants encountered during the inventory are new to science, including several new trees. Among these are a miniature *Parkia* (Fabaceae) previously known only from photographs taken in Cordillera Azul, a national park in the Andean foothills ca. 675 km to the west. An abundant species in the stunted forests at Ojo de Contaya and Divisor appears to be a new species of *Pseudolmedia* or *Perebea* (Moraceae). In addition, two tree species in the Clusiaceae, a *Moronobea* and a *Calophyllum* (Fig. 4J), also potentially are new.

We found the majority of rare and/or new species in the stunted forests that dominate the ridge tops of the Ojo de Contaya and Divisor sites. We recorded reproductive individuals of several species of commercially valuable trees, such as *cedro* (*Cedrela* sp.) and *tornillo* (*Cedrelinga cateniformis*), that increasingly are threatened in other parts of Peru.

Fishes: We recorded 109 species of fishes during the inventory, and estimate that 250–300 species occur within the Zona Reservada. At least 14 species of fish found during the inventory are new to science or are new records for Peru. Fish species richness varied considerably from site to site. At the Tapiche camp (located on a major river and encompassing a variety of aquatic habitats), we recorded 94 species, whereas the low-productivity streams in Ojo de Contaya and Divisor harbored 20 and 24 species, respectively.

We recorded a variety of economically important fishes along the Tapiche, including fishes important for downstream human communities, such as *sábalos* (*Brycon* spp. and *Salminus*), *boquichico* (*Prochilodus nigricans*), *lisa* (*Leporinus friderici*), and *tigre zúngaro* (*Pseudoplatystoma tigrinum,* Fig. 5D), as well as ornamental fishes, such as glass fish (*Leptagoniates steindachneri,* Fig. 5B), *lisas* (*Abramites hypselonotus*), and a *Peckoltia* sp. (*carachama,* Fig. 5A).

Amphibians and reptiles: We recorded 109 species during the inventory, including 68 amphibians and 41 reptiles. Fourteen of these species (12% of the total number of species encountered) remain unidentified. Several of these probably are species new to science, including an unidentified species of *Eleutherodactylus* frog at the Divisor camp. Apart from a single species of salamander, all of the amphibians were frogs and toads. We registered 21

Highlights of biological results (continued)

snakes, 17 lizards, 2 turtles, and 1 caiman. At least two species are new records for Peru: a frog, *Osteocephalus subtilis*, found at both Ojo de Contaya and Divisor, and a coral snake, *Micrurus albicinctus* (Fig. 6E), found at Tapiche that represents a new venomous snake species for Peru.

Birds: We recorded 365 bird species in the three inventory sites. We estimate that 570 bird species occur in the Zona Reservada, including the avifauna predicted to occur in sites with richer soils in the northern and southern portions of the region. We registered several rare and patchily distributed species associated with forests on sandy soils, such as Rufous Potoo (*Nyctibius bracteatus,* Fig. 7A) and Fiery Topaz (*Topaza pyra*).

Our most outstanding record was the Acre Antshrike (*Thamnophilus divisorius,* Figs. 7C, 7D), which we found in the stunted ridge-crests forests at Ojo de Contaya and Divisor. This species previously was known from a single ridge in Brazil; our inventory indicates that the bulk of its population occurs within Peru. Along the Tapiche we recorded various endangered and/or threatened species including Blue-headed Macaw (*Primolius couloni*) and large numbers of various tinamou species. We encountered game birds (guans, *Penelope*; and curassows, *Mitu*) at all of our three sites. We were surprised to register an Oilbird (*Steatornis caripensis*) at the Divisor camp. Unexpected in Amazonia because they roost and breed in caves, it seems likely that small colonies of Oilbird live in the caves of the Sierra del Divisor mountains.

Mammals: We recorded 38 species of medium and large mammals during the inventory, almost two-thirds of the 64 species we estimate for the entire region. Of these, 20 species are considered threatened by the IUCN, CITES, or INRENA. The majority are primates: we found 13 species of marmosets and monkeys, with 12 species present at a single site (Tapiche)—a remarkable species richness for primates in the western Amazon.

Among the primates, two species are especially rare and poorly known: Goeldi's marmoset (*Callimico goeldii,* Fig. 8D) and red uakari monkeys (*Cacajao calvus,* Fig. 8A). This is the first protected area in Peru in which both species occur.

We found sizeable populations of several widespread large monkeys that are commonly hunted, such as black spider monkey (*Ateles chamek*) and common woolly monkey (*Lagothrix poeppigii*). We also found two other species vulnerable to hunting: the giant armadillo (*Priodontes maximus*) and the South American tapir (*Tapirus terrestris*).

Human Communities and Highlights of Social Inventory: Voluntarily isolated Iskonawa live in the southeastern portion of the Divisor region, within the Reserva Territorial (R.T.) Isconahua[1], a 275,665-ha area established in 1998. Two additional Reservas Teritoriales[2] (Yavarí-Tapiche and Kapanawa) have been proposed, but not established, in the northern and western portions of the region (Fig. 10B).

Several temporary camps have been established for larger-scale resource extraction in the north (logging along the Río Tapiche, Fig. 9A) as well as in the south (timber and mining concessions overlapping with the R.T. Isconahua) (Fig. 9B). Otherwise, human presence within most of the Zona Reservada appears to be minimal, with a few temporary dwellings established along rivers for small-scale resource extraction (e.g., medicinal plants, hunting, and fishing).

At least 20 communities—including indigenous people, many of whom have been resident for generations, and more recently arrived colonists—live adjacent to the Zona Reservada (Fig. 2A). Members of these communities depend on subsistence agriculture and low-impact use of natural resources (Fig. 11A). Resource extraction is largely for household consumption, although in some communities there is a small amount of commerce based on forest products. These neighboring communities value their forest-based lifestyle, which they perceive as threatened by outsiders and by large-scale, commercial, extractive industries (Fig 9B). Several communities have organized themselves to promote local, sustainable practices of resource use.

Main threats

The main threats stem from large-scale extractive industries: logging, mining, and oil exploration (Fig 9B). Pervasive logging in Amazonia poses an enormous threat to populations of the most commercially valuable timber species, often leading to local extinctions. There are proposed logging concessions in the north that overlap with the Zona Reservada and with the proposed Reserva Territorial Yavarí-Tapiche. Illegal logging is active even in the heart of the Zona Reservada (Fig. 9B). In the west and south, mining and oil exploration proposals ring the borders of the Zona Reservada, and in several places overlap with the Reserva Territorial Isconahua.

Other threats come from over-exploitation of wildlife. Illegal, commercial fishing is a concern for communities living around the edges of the Zona Reservada, especially in the north and south. On the upper Río Tapiche, we encountered eight species of fishes that are an important part of the Amazonian fisheries, including

1 Peruvian indigenous organizations use the spelling "Iskonawa," but the official name of the territorial reserve is "Isconahua."

2 Territorial reserves are now known as *Reservas Indigenas* in Peru, per a new law concerning areas designated for voluntarily isolated indigenous peoples (Law Nº. 28736, 2006; see chapter about the legal status of the territorial reserves).

REPORT AT A GLANCE

Main threats (continued)	scaly fishes such as *Brycon* spp. and *Salminus* (*sábalos*), *Prochilodus nigricans* (*boquichico*), *Leporinus friderici* (*lisa*), and large catfishes, such as *Pseudoplatystoma tigrinum* (*tigre zúngaro,* Fig. 5D). These species were relatively abundant. Many of them migrate seasonally to the headwaters to spawn. The Zona Reservada may prove to be crucial in the life cycle of these fish species, which are important to the livelihoods of human communities living downstream. Also on the Río Tapiche, we found populations of two species of Amazonian turtles, *Podocnemis unifilis* (*taricaya*) and *Geochelone denticulata*, that are eaten by local people. Birds that are hunted throughout Amazonia, such as curassows (*Mitu tuberosum*) and guans (*Penelope jacquacu*), were present at all three sites we sampled. Impressive quantities of tinamous were observed at Tapiche. We observed a small flock of Blue-headed Macaws (*Primolius couloni*) at the Tapiche camp. This species is almost entirely restricted to Peru, with a few sightings from immediately adjacent portions of Brazil and Bolivia, and was recently listed as endangered by BirdLife International. We recorded 20 species of medium and large mammals that are considered threatened by IUCN, CITIES, or INRENA; 13 are primates. Some species are listed for their ecological rarity (Goeldi's monkey, *Callimico goeldii*, Fig. 8D; red uakari monkey, *Cacajao calvus,* Fig. 8A), and others because they experience heavy hunting pressure throughout Amazonia (e.g., South American tapir, *Tapirus terrestris*; giant armadillo, *Priodontes maximus*). We regularly encountered several monkey species that are hunted throughout their range and are among the first primate species to face local extinction (black spider monkey, *Ateles chamek*; and common woolly monkey, *Lagothrix poeppigii*).
Current status	Upon leaving the field in August 2005, we immediately formed the Sierra del Divisor/Siná Jonibaon Manán Work Group. Composed of indigenous and conservation organizations dedicated to the region, the Work Group is focused on creating a united front of participating institutions to overcome the overwhelming threats to the region and to provide, as quickly as possible, strict and effective protection both to the indigenous groups in voluntary isolation and to the biological and geological treasures in the region. The consensus-building effort resulted in the joint indigenous-conservationist request for Zona Reservada Sierra de Divisor, which was established on 11 April 2006 (*Resolución Ministerial 0283-2006-AG*; 1.48 million hectares; Fig. 2A). Protected status was our most urgent recommendation as we left the field, given the magnitude and intensity of the threats to the region. This joint

request for Zona Reservada came with the explicit understanding that the Work Group is committed to developing a strong, consensus recommendation for the final categorization of the Zona Reservada, to be presented and worked through with INRENA's official Categorization Committee (*Comisión de Categorización*).

Principal recommendations for protection and management

01 **Implement effective protection of Zona Reservada Sierra del Divisor.** Protection of the Zona Reservada is urgent. Accelerating fragmentation of the region by roads, mining, oil exploration, and development constitutes an irreversible threat (Fig. 9B). Immediate and effective protection is crucial for the survival of indigenous peoples living in voluntary isolation as well as for the unique biological and geological conservation targets in the region.

02 **Develop strong consensus for the final categorization and eventual zoning of Sierra del Divisor/Siná Jonibaon Manán.** The joint request from indigenous and conservation organizations to Peru's president, to grant immediate protection to Sierra del Divisor through the category of "Zona Reservada," came with the explicit understanding that Zona Reservada is a provisional category. The next step is for the Sierra del Divisor Work Group to analyze priority sites for indigenous and conservation groups and to develop suitable recommendations for the official Categorization Committee (Comisión de Categorización) established by INRENA.

The latest map of priorities, as discussed in the Work Group meeting of 5 December 2006 (Fig. 10C), leads us to the preliminary recommendation of a complex of protected areas composed of two Territorial Reserves neighboring a National Park (Fig 10D). Our guiding vision is full support from both indigenous and conservation organizations for the final categorization.

03 **Anchor the protection and management of the Sierra del Divisor/Siná Jonibaon Manán Region on a solid collaboration among indigenous federations, local villages, and conservation organizations.** All are crucial for successful protection of this threatened and unique landscape.

04 **Strengthen the legal mechanisms to offer solid protection to indigenous people living in voluntarily isolation.** Until recently, Reserva Territorial was the category assigned to lands with indigenous peoples living in voluntary isolation. However, the category lacked a strong legal backing (as is shown in Sierra del Divisor, where mining concessions were granted in the heart of the Reserva Territorial Isconahua). The Sierra del Divisor/Siná Jonibaon Manán Work Group joined others in pursuing a law that would protect voluntarily isolated indigenous peoples. The law, passed in 2006, still needs substantial modifications to afford

Principal recommendations (continued)

adequate protection. Revising and strengthening this legal framework is a vital next step for the protection of uncontacted indigenous peoples throughout Peru.

05 **Rescind the mining concessions that overlap with the Reserva Territorial Isconahua.** The presence of mining activities directly contradicts the purpose of the Reserva Territorial, putting at risk the health and livelihood of indigenous people living in voluntary isolation (Fig. 9B).

06 **Adjust the borders of the Zona Reservada to exclude the villages along the Río Callería and in Orellana** (as shown in Fig. 2A, 10C). These communities should not be included within a protected area.

07 **Collaborate with local communities to develop locally based protection and management plans.** Communities bordering the Zona Reservada strongly support protection for the area and its resources.

08 **Establish areas of strict protection to protect the voluntarily isolated peoples.** In close collaboration with the indigenous organizations, assign the highest category of protection to the portions of the Zona Reservada where indigenous peoples are believed to live in isolation. If ever these indigenous peoples opt for contact with civilization, appropriate studies must be conducted to determine the actual size of the lands to be titled in their names.

09 **Involve the Matsés in the zoning, management, and stewardship of the northernmost section of the Zona Reservada (Fig. 2A, 10C, 10D).** This section of Amazonian lowlands is used by indigenous Matsés communities (Vriesendorp et al. 2006) and they are the natural stewards of these lands.

Long-term conservation benefits

01 The area's geological and climatic diversity are unique in Amazonia. The resulting high levels of biodiversity and endemism make Sierra del Divisor one of the highest conservation priorities in Peru.

02 The new Zona Reservada is contiguous with the 1.49-million-hectare Parque Nacional da Serra do Divisor and several other protected areas just across the border in Brazil, creating a binational conservation corridor that stretches from the Río Amazonas in the north to the Río Madre de Dios in the south. The western border of the Zona Reservada is nearly contiguous with the Parque Nacional Cordillera Azul, linking these isolated mountains to the main body of the Andes (Fig. 2B).

03 There currently are few people within the limits of the Zona Reservada. Careful categorization and zoning of the area, in cooperation with leaders of

indigenous organizations, will respect the territorial rights of indigenous peoples in voluntary isolation.

04 The area's scenic beauty and natural riches will be a major tourist attraction for Ucayali and Loreto. Special attractions include hot springs (where hundreds of macaws congregate for the mineral-rich water), volcanic massifs rising out of lowland forest, and 13 species of primates.

Why Sierra del Divisor?

Rocky towers rise like exclamation marks over the surrounding lowlands. A hot, sulfurous spring bubbles up from deep underground and the mist swarms with Scarlet Macaws attracted to minerals in the water. A great expanse of sandstone mesas and ridges, cut off from the rest of the world, stands unexplored in the endless Amazonian lowlands.

This is Sierra del Divisor, locally called Siná Jonibaon Manán, a complex of isolated mountains set like gems in Peru's Amazonian lowlands. Nowhere else in Amazonia is there comparable diversity of geology and climate. The jumble of ancient rock formations rising up in the midst of younger formations catch thunderstorms coming off the Amazonian plains. In the resulting mosaic of rain shadows, tall humid forests stand side by side with severely stunted shrublands. And many yet-to-be-described organisms, occurring here and nowhere else, live alongside the distinct flora and fauna that biologists already have registered.

Future alternatives for these forests are stark. Unless a unified, concerted group of people take effective action now, the loggers and miners working in and around the region will further invade and dissect its forests. This fragmentation will profoundly impoverish the unique plant and animal communities of the region, and catastrophically endanger its indigenous populations.

The new Zona Reservada creates a binational conservation expanse and an enormous conservation opportunity that is contiguous with a million-hectare conservation complex in Brazil (including the Parque Nacional da Serra do Divisor, Fig. 2A). Protection and successful stewardship of Sierra del Divisor will set an example of collaboration between two different constituencies—the conservation organizations and the indigenous communities—that will serve as a model to strengthen the protection of both the environment and traditional cultures in Peru.

Conservation of the Sierra del Divisor

CURRENT STATUS

The Sierra del Divisor/Siná Jonibaon Manán Region encompasses a jumble of overlapping proposals by conservation groups, indigenous peoples, and large-scale commercial enterprises. Immediately after we returned from the inventory in August 2005, we formed the Sierra del Divisor/Siná Jonibaon Manán Work Group to resolve several of these conflicting proposals and to build a strong consensus for effective protection of the area. Composed of the indigenous and conservation organizations dedicated to the region, members of the Work Group include the Organización Regional de AIDESEP–Iquitos (ORAI), Organización Regional de AIDESEP–Ucayali (ORAU), Asociación Interétnica de Desarrollo de la Selva Peruana (AIDESEP), The Nature Conservancy–Peru (TNC), Pronaturaleza, Instituto del Bien Común (IBC), Derecho, Ambiente y Recursos Naturales (DAR), Centro de Investigación y Manejo de Áreas Naturales (CIMA), Sociedad Peruana de Derechos Ambientales (SPDA), Centro para el Desarrollo del Indígena Amazónico (CEDIA), Centro de Datos para la Conservación (CDC), and The Field Museum.

After a constructive year of joint efforts, the central goals of the Work Group remain (1) joining forces of the participating institutions to surmount the relentless threats to the region (mining, oil, illegal logging, lack of legal backing for Reservas Territoriales) and (2) developing viable mechanisms, as quickly as possible, to provide strict protection for the indigenous groups in voluntary isolation and the biological and geological treasures in the region. The Work Group devoted itself to working simultaneously on building a strong consensus proposal for safeguarding Sierra del Divisor/Siná Jonibaon Manán while strengthening the legal status of Reserva Territorial. We formed working subgroups and continue to meet regularly.

Our joint effort succeeded in the consensus indigenous-conservationist request for Zona Reservada Sierra de Divisor, which was established on 11 April 2006 (*Resolución Ministerial 0283-2006-AG*; 1.48 million hectares; Fig. 2A). Protected status through a Zona Reservada was our most urgent recommendation given the magnitude and intensity of the threats to the region. The joint request for Zona Reservada—a provisional designation within the Peruvian national

protected areas system (SINANPE)—came with the explicit understanding that the Work Group committed itself to building a consensus recommendation for the final categorization of the Zona Reservada, encompassing the indigenous and conservation visions, to be presented and worked through with INRENA's official Categorization Committee (*Comisión de Categorización*).

The Zona Reservada currently encompasses the Reserva Territorial ("R.T.") Isconahua (275,665 ha; Fig. 2A). The R.T. Isconahua was established to protect the rights and livelihoods of voluntarily isolated Iskonawa. Reserva Territorial is a designation outside the purview of SINANPE and is administered by national indigenous institutions (AIDESEP and INDEPA). There are two additional proposals for Reserva Territorial status in Sierra del Divisor: the proposed R.T. Kapanawa (504,448 ha) lies in the central and western parts of the Zona Reservada, while the proposed R.T. Yavarí-Tapiche (1,058,200 ha) partially overlaps the northern portion of the Zona Reservada.

The large-scale commercial enterprises in the region vary from proposed to established concessions. Some mining concessions, approved in 2004, are operational in the heart of the R.T. Isconahua. While none of the five oil concessions have yet been granted, all overlap partially with the Zona Reservada. Logging concessions in the north along the Tapiche drainage already are established and operational.

In December 2006, the Work Group requested that INRENA postpone its decision for final categorization of the Zona Reservada by four months to April 2007. The additional time will allow for crucial workshops in the region and gathering of data necessary for a consensus proposal for categorization. The recent joint map of conservation and indigenous priority areas, as discussed in the Work Group meeting of 5 December 2006, appears here as Figure 10C. The map does not yet include the priorities of ORAI and still needs additional input to reach full consensus.

CONSERVATION TARGETS

The following species, forest types, biological communities, and ecosystems are of particular conservation concern in Zona Reservada Sierra del Divisor. Some of the conservation targets are important because they are unique; rare, threatened, or vulnerable elsewhere in Peru; key resources for the local economy; or Amazonia; or fulfill crucial roles in the function of the ecosystem.

Biological Communities

- Vast stretches of intact forest that form a corridor in Peru with Parque Nacional Cordillera Azul to the west, the proposed Reserva Comunal Matsés to the north, and in Brazil with the Parque Nacional da Serra do Divisor to the east (Figs. 2A, 2B)
- Rare and diverse geological formations that occur nowhere else in Amazonia and include a series of sandstone ridges in the west (Serrania de Contamana, Ojo de Contaya) and east (Sierra del Divisor), and volcanic cones in the south (El Cono) (Figs. 2A, 2B)
- A glorious mosaic of soil types: rich, high-diversity soils in the north; poor-to-intermediate fertility soils that harbor endemics in the central portion of the area; and volcanic soils in the south
- Headwaters of the upper Río Tapiche, which are crucial for the migration and reproduction of fish species (including commercially important ones), and the headwaters of at least ten other rivers that originate in the region
- Streams that drain soils of poor-to-intermediate fertility and may represent important speciation centers for various fishes
- Stunted forests on poor soils occurring principally on hill crests (Figs. 3H, 3I)

Conservation Targets (continued)

	Vascular Plants	▪ Populations of timber species (such as *Cedrela* sp. and *Cedrelinga cateniformis*) that are logged at unsustainable levels elsewhere in Amazonia ▪ Species endemic to habitats unique to the region, including several species new to science growing on sandstone ridges (*Parkia*, *Aparisthmium,* Fig. 4C)
	Fishes	▪ Species of *Hemigrammus, Hemibrycon, Knodus,* and *Trichomycterus* (Fig. 5E) that are present in remote streams and likely restricted to the region ▪ Species of Cheirodontinae present in the Río Tapiche and principal tributaries, including *Ancistrus*, *Cetopsorhamdia* (Fig. 5C), *Crossoloricaria*, and *Nannoptopoma*, which are probably restricted to the region ▪ Species of importance for fisheries that represent significant sources of protein for local human communities, such as *Pseudoplatystoma tigrinum* (Fig. 5D)*, Brycon* spp.*,* a *Salminus* sp.*, Prochilodus nigricans,* and a *Leporinus* sp. ▪ Ornamental species of Cichlidae, Gasteropelecidae, Loricariidae, Anostomidae, and Characidae with commercial value and susceptible to overharvesting ▪ Unique fish communities in the aquatic environments of Ojo de Contaya
	Amphibians and Reptiles	▪ Species of economic value (turtles, tortoises, and caiman) that are threatened in other parts of their distributions ▪ Rare species that represent new records for Peru (*Osteocephalus subtilis* and *Micrurus albicinctus,* Fig. 6E) ▪ Amphibian communities that reproduce and develop in forest and stream environments (*Centrolene, Cochranella, Hyalinobatrachium, Colostethus, Dendrobates,* and *Eleutherodactylus*) (Figs. 6A, 6B, 6D)

	Birds	▪ Acre Antshrike (*Thamnophilus divisorius,* Figs. 7C, 7D), a recently described species endemic to the region ▪ Rare or poorly known bird species that are associated with white-sand or stunted forests, such as Rufous Potoo (*Nyctibius bracteatus,* Fig. 7A), Fiery Topaz (*Topaza pyra*), and Zimmer's Tody-Tyrant (*Hemitriccus minimus*) ▪ Macaws, especially the Blue-headed Macaw *(Primolius couloni*), which is restricted to a small population living almost exclusively in Peru ▪ Game birds (tinamous, cracids) that typically suffer from hunting pressure in other parts of Amazonia
	Mammals	▪ A large and diverse primate community of 15 species (13 recorded during this inventory and an additional 2 known from previous inventories) ▪ Two rare and patchily distributed monkeys, Goeldi's monkey (*Callimico goeldii,* Fig. 8D) and red uakari monkey (*Cacajao calvus,* Fig. 8A) ▪ Healthy populations of heavily hunted large mammals, such as black spider monkey (*Ateles chamek*), common woolly monkey (*Lagothrix poeppigii*), and South American tapir (*Tapirus terrestris*) ▪ Carnivores with large home ranges, such as jaguar (*Panthera onca*) and puma (*Puma concolor*)
	Human Communities	▪ Extensive cultural knowledge of the environment ▪ Lifestyles compatible with low-impact use of natural resources (Figs. 11A, 11D) ▪ Strong local commitment to environmental protection and to sustainable use of natural resources (Fig. 11D) ▪ Organizational capacity for the protection of natural resources

THREATS

The biological and cultural integrity of the region face serious and immediate threats, including:

Illegal logging

Logging poses a primary threat to timber species, and often a secondary threat to mammal and bird populations hunted by loggers. Illegal logging is evident in and around the Zona Reservada, occurring well within the heart of the Zona Reservada along the Río Tapiche (Figs. 9A, 9B). To the north, logging concessions overlap with the proposed Reserva Territorial Yavarí-Tapiche (Figs. 9A, 10B).

Mining and oil exploration

Impacts of mining and oil exploration are typically first observed in nearby streams and rivers and then cascade to fishes and the terrestrial fauna. Concessions for mining and for oil exploration overlap in the south with the Zona Reservada and Reserva Territorial Isconahua (Fig. 9B).

Unregulated commercial fishing

Commercial fishing operations can gravely impact fish populations. Freezer-equipped fishing boats allow commercial fishers to store large fish catches and can accelerate local extinctions of fish populations. Moreover, some fishermen use explosives or poisons—techniques that are indiscriminate in their effects and are damaging not only to fish populations, but also to other aquatic fauna and habitats. Unregulated commercial fishing ranks high among the concerns of communities living near the borders of the Zona Reservada.

RECOMMENDATIONS

Zona Reservada Sierra del Divisor is among the highest conservation priorities in Peru. Immediate threats to the biological and cultural values of the region generate the urgency for protection. The threats range from mining concessions to illegal logging; from plans for a major highway through the area, to additional mining and oil interests. Of our rapid inventories to date, this region demands the swiftest action.

Below we highlight a set of recommendations to secure effective conservation of the region before degradation and fragmentation transform the landscape.

Protection and Management

Designate protected status

01 **Develop strong consensus for the final categorization and eventual zoning of the Sierra del Divisor/Siná Jonibaon Manán Region.** The joint request from indigenous and conservation organizations to Peru's president, to grant immediate protection to Sierra del Divisor through the category of "Zona Reservada," came with the explicit understanding that Zona Reservada is a provisional category. The Sierra del Divisor Work Group committed itself unanimously to analyzing priorities for indigenous and conservation stakeholders as the base for building suitable recommendations to the official Categorization Committee (Comisión de Categorización) established by INRENA.

On 5 December 2006, the Work Group created the first joint map of conservation and indigenous priority areas within the Zona Reservada (Fig. 10C). Because ORAI was unable to participate in this meeting, (1) ORAI priorities do not yet figure on the map, and (2) the ORAI proposal for a Territorial Reserve still needs to be reconciled with on-the-ground reports provided by previously uncontacted Matsés. Despite the missing information from ORAI, the priority map led us to the preliminary recommendation of a complex of protected areas, composed of two Territorial Reserves and one National Park (Fig. 10D).

On 12 December 2006 the Work Group sent a joint letter to INRENA, supporting the request from the indigenous organizations (ORAI, ORAU, AIDESEP) for four additional months to gather crucial data. By April 2007 there should be a final recommendation for the categorization of Zona Reservada Sierra del Divisor that integrates the vision of an efficiently protected area addressing both indigenous and conservation priorities.

02 **Establish appropriate categorization and zoning to provide strict protection to all areas where indigenous peoples reportedly live in voluntary isolation (Figs. 10B, 10C).**

RECOMMENDATIONS

Protection and Management (continued)

03 **Establish appropriate zoning to ensure continued traditional use by the Matsés of the northeasternmost corner of the current Zona Reservada (Figs. 10C, 10D).**

04 **Redefine the limits of the protected area to exclude existing settlements (Figs. 10C, 10D).** Several small settlements exist inside Zona Reservada Sierra del Divisor, especially along the Río Callería. These settlements and the adjacent areas used by community members should be removed from the Zona Reservada. The limits of the already existing Reserva Territorial Isconahua also must be adjusted to eliminate the current overlap with the titled lands of the native community of San Mateo.

05 **Capitalize on the opportunities of the binational conservation corridor with the adjacent protected areas in Brazil.** By coordinating management of the Zona Reservada in Peru with the Parque Nacional da Serra do Divisor and several extractive indigenous reserves in Brazil, the protected lands would total more than 3 million hectares.

Ensure broad participation in conservation efforts

06 **Combine efforts of interested indigenous federations and conservation organizations to promote immediate protection and co-management for conservation of Zona Reservada Sierra del Divisor.** Both groups share concern for (a) the indigenous peoples living in voluntary isolation in the wilderness of the Zona Reservada, and (b) the biological and geological treasures in the region. Working together, the two constituencies must stress the importance of the region to the highest levels of government and secure effective protection of the region for eventual co-management.

07 **Act immediately with local residents and local and regional institutions to counter illegal activities.** Invasion of the region by commercial activities is rampant, yet neighboring communities openly express their desire to protect the area. Conservation and indigenous organizations concerned with the region should coordinate and mobilize local residents to patrol the region and to curb illegal activities. The locally based protection system should be discussed with the regional governments of Ucayali and Loreto, and with the appropriate unit of the national government (INRENA), and then implemented promptly.

08 **Establish strong partnership among conservation groups, indigenous federations (national, regional, and local), government agencies (protected areas and indigenous rights), and funding entities for efficient protection action in the region.** Only through tight partnerships and constant communication at all levels will it be possible to implement a long-term

plan to protect the area while maintaining and improving the quality of life of neighboring villages. Activities in the buffer zone of the Zona Reservada must attract ecologically compatible economic investments that reduce the income gap of local residents.

09 **Develop an effective system of co-management so that the entire unit is fully protected.** Although this will require a tremendous amount of work because there is no precedent in Peru, it is of paramount importance for the well-being of all cultural and biological values in the Zona Reservada and its surrounding buffer zone.

Resolve conflicts

10 **Secure legitimacy and solid legal backing for indigenous peoples in voluntary isolation.** Historically, *Reserva Territorial* was the category used in Peru to protect tracts of wilderness that shelter indigenous groups who chose to live without contact with western civilization. These lands, now termed *Reservas Indigenas*, should receive the strictest protection until the indigenous group, of its own accord, seeks contact. Without an explicit request for contact, the area must remain strictly protected (*zona intangible* in Peru) to safeguard the lives of peoples highly vulnerable to contact with common western diseases.

At present, the category of Reserva Indigena still lacks the appropriate definition and legal backing to secure strict conservation of the land and its peoples (see chapter about the legal status of territorial reserves). This lack of protection is markedly evident throughout the history of Reservas Territoriales in Peru. Not only do these areas receive no protective action, they are usually fragmented by government-approved roads, oil pipelines, and mining concessions, and they are mercilessly invaded by illegal loggers and miners. Without a powerful and effective mechanism in place to secure the Reservas Indigenas—with appropriate regulations, responsible entities, and adequate funding—the Sierra del Divisor/Siná Jonibaon Manán Region and its peoples will be exposed to severe dangers (Fig. 9B).

11 **Deactivate the mining concessions that have been granted inside Reserva Territorial Isconahua (Fig. 9B).** Immediate removal of these concessions is imperative for protection of the lives of the indigenous peoples in voluntary isolation and for the conservation of unique geological formations in Amazonia.

12 **Evaluate the proposed Reserva Territorial Yavarí-Tapiche and the proposed Reserva Territorial Kapanawa and accommodate the boundaries to protect voluntarily isolated indigenous peoples (Fig. 10B).**

RECOMMENDATIONS

Protection and Management (continued)	13 **Resolve the status of the proposed logging concessions that overlap with the Reserva Territorial Yavarí-Tapiche proposed by AIDESEP (Figs. 9B, 10B).** Clarification of the boundaries of the logging concessions and the proposed Reserva Territorial Yavarí-Tapiche should be a high priority after evaluation of the Reserva Territorial proposal. The overlap between these two proposals needs to be resolved to ensure definite, protected boundaries for Zona Reservada Sierra del Divisor and for noncontacted indigenous peoples.
Further inventory	01 **Continue basic plant and animal inventories, focusing on other sites and other seasons.** Survey aquatic habitats in the headwaters of rivers in the highlands of the Ojo de Contaya and the Sierra del Divisor, such as the Rios Blanco, Zúngaro, Bunyuca, Callería, and Utuquinía. The ancient volcanic cones and the surrounding forests and streams in the southeastern portion of the Zona Reservada are a high priority for both aquatic and terrestrial inventories. We recommend inventories during other seasons of the year, particularly during the wet season (October–March) when amphibians are more active and easier to sample. 02 **Map the large geological formations within the Zona Reservada.** Our few water and soil samples from Ojo de Contaya and the Sierra del Divisor did not survey the full range of habitats within the region, nor did we survey the geological variability of the underlying rocks. 03 **Search for the Acre Antshrike (*Thamnophilus divisorius*) at additional localities.** We anticipate that this bird species, endemic to the Sierra del Divisor region, will be found in suitable habitat throughout the region. The habitat—stunted forests on ridge crests—is patchily distributed; it should be determined whether the antshrike occurs at all sites with sufficient habitat. 04 **Continue surveys for bird specialists of white-sand habitats with nutrient-poor soils.** We suspect that some of the rare and poorly known white-sand bird species, currently known from only one or a few localities each within the Zona Reservada, are more widespread. Inventories should focus on documenting the distribution and relative abundances of these species. 05 **Search for bird species that nest at cliff faces, caves, and waterfalls of the Ojo de Contaya and Sierra del Divisor sites.** We strongly suspect that Oilbird (*Steatornis caripensis*) and some swifts (Apodidae), otherwise known only from the Andean foothills west of the Río Ucayali, nest in similar habitats in the Sierra del Divisor region.

Research

01 **Evaluate the impact of fishing by local communities.** Determine which species of fishes are most commonly captured, the relative abundances of these species, and the locations of the most heavily fished waters. A baseline evaluation of the fish resources of the area will be critical for the long-term management of fish populations in rivers within the Zona Reservada.

02 **Research the reproductive biology of fishes in the Zona Reservada.** Confirm whether there are seasonal movements during periods of reproduction into the headwaters of rivers draining the mountain ranges in the region.

03 **Investigate the feasibility of developing aquaculture in the region with native fish species.** Aquaculture might provide a significant source of protein for communities in the area. Prime candidates for feasibility studies include fast-growing native species, such as *boquichicos* (*Prochilodus nigricans*), *sábalos* (*Brycon* spp. and *Salminus*), and cichlids. Explore the possibility that aquaculture could be used to restock populations of rare fish species, such as *arahuana* (*Osteoglossum bicirrhosum*).

04 **Document range limits of species and biogeographic barriers in the region.** Several species pairs of birds apparently replace one another within the Zona Reservada in the absence of any obvious geographic barrier (such as a large river) and with no apparent concordance of distributional limits between different pairs of species. The region offers a unique opportunity to investigate the roles of history and habitat heterogeneity in determining bird species distribution.

05 **Study small mammals and bats throughout the Zona Reservada.** The communities of small mammals and of bats in the region remain almost entirely unknown. A particularly interesting habitat for study would be the stunted forests on ridge crests, which may harbor habitat specialists.

06 **Investigate the presence at Ojo de Contaya of two apparently different forms of black spider monkey (*Ateles chamek*).** The two forms of *Ateles* differ only in the color of the bare facial skin (red vs white to blackish), as far as we could determine. We do not know the taxonomic status of these two forms; they may represent individual variation within a single species, or two different sympatric species.

07 **Investigate the habitat preferences of red uakari monkey (*Cacajao calvus*).** Our observation of this rare monkey on ridge crests or at sites far from *Mauritia* palm swamps was completely unexpected. We recommend

Research (continued)	determining whether this species is less closely associated with palm swamps than previously reported (or whether they migrate seasonally).
Monitoring (of conservation targets) **and survey** (of other species)	01 **Survey fish, and game (bird, mammal) populations.** Collect data on the identities and relative abundances of the most frequently fished or hunted species, and sites within the region where fish or game are most abundant. Such information will provide the baseline data on game populations and will allow for recommendations of potential no-hunting areas that could serve as source populations. 02 **Create a practical monitoring program that measures progress toward conservation goals established in a long-term management plan for the region.** 03 **Document illegal incursions into the area, via the established patrolling system** (see Recommendation 07, under Protection and management, above).

The Zona Reservada provides an enormous opportunity to protect a unique part of Amazonia, with all of its biological, cultural, and geological features intact. The Zona Reservada:

01 **Protects unique geological features.** Sierra del Divisor is geologically distinct from the rest of the Amazonian region and constitutes the only mountains in the Peruvian Amazon (Fig. 2B).

02 **Forms a binational conservation area,** directly adjacent to Brazil's Parque Nacional da Serra do Divisor (to the east) and close to Parque Nacional Cordillera Azul in Peru (to the west; Fig. 2A).

03 **Protects indigenous peoples living in voluntary isolation (Figs. 2A, 10B).**

04 **Shelters a biological community rich in globally endemic, rare, and threatened species of plants and animals,** including species of commercial value that are overexploited in other regions.

05 **Enables a partnership with residents of neighboring villages,** many of whom share a common vision of protecting the natural resources that sustain their livelihoods (Figs. 11B, 11E).

Technical Report

REGIONAL OVERVIEW AND INVENTORY SITES

Author: Robin B. Foster

Zona Reservada Sierra del Divisor ("the Zona Reservada"), 1.48 million hectares in size, includes the only mountain ranges in the Peruvian Amazon (Fig. 2B). Emerging from the Amazon plain, these low mountains extend from the Sierra del Divisor in the north; into Acre, Brazil to the east; and into Madre de Dios, Peru in the south. The mountains in the region are separated from the Andes by the Río Ucayali and lower Río Urubamba in the north and the lower Río Manu and Río Madre de Dios in the south, but are contiguous with the Andes in the region of the Fitzcarraldo Divide. We use "Sierra del Divisor/Siná Jonibaon Manán Region" to refer to both the series of low mountains (Serranias de Contamana, Ojo de Contaya, Sierra del Divisor, volcanic cones) and adjacent lowlands within the Zona Reservada.

The low mountains in the region are geologically distinct from most of the rest of the Amazon Plain and were raised by the same continental forces that lifted up the Andes. Erosion has exposed the older, underlying, Cretaceous strata, which in most of the Amazon Plain are covered by younger Tertiary and Quaternary sediments. In the highest elevations even older rock is exposed, poking its way up through the Cretaceous strata. An irregular rectangle of geological fault lines surrounds the Sierra del Divisor region. On the eastern (Sierra del Divisor) and western (Serrania de Contamana) margins these faults have created an upthrusted mountain wall with a steep outward face and a more gradual inner slope. In the north, the elliptic ring of low, outwardly sloping mountains forming the Ojo de Contaya appears to harbor within its borders a largely horizontal set of eroded strata.

The geology of the Divisor area resembles that of the base of the Andes to the west, where presumably the same or similar strata have been uplifted. But in the Andes the band of mostly Cretaceous rock is only a narrow strip along the lower elevations, whereas in the Divisor area such rock forms a broad expanse. In the Divisor area, the Cretaceous strata are diverse and overwhelmingly composed of quartz sandstones and other, looser, sand sediments. Even the broad expanses of old floodplain terraces in the center of the area consist of reworked sand sediments. At all of our sites white sandy soils dominated most of the ridges, slopes, and even the youngest floodplain, creating very acidic environments for plant growth.

There are occasional pockets and thin layers of richer strata that form clays, but they appear to be relatively unimportant on a landscape scale.

The greatest exception to the nutrient-poor conditions described above is the volcanic area on the southeast side of the Zona Reservada (Fig. 2A). In overflights of this area we observed a small but rugged mountain range that borders an apparently very deep fault. This area appears to be mostly or entirely igneous in origin and is roughly 4-5 million years old. These mountains are dense with volcanic cone and crater-shaped peaks with steep slopes. Some peaks are outliers, such as the isolated, symmetrical peak known as "El Cono" at the east end of the mountain range (Fig. 1). This peak is so conspicuous from a distance that it is recognizable on a clear day from the lower ridges of the Andes.

The vegetation covering this volcanic range appears distinct from the rest of the Divisor area, with little or no deciduousness during a dry year. On average tree crowns are fairly broad, but there are few if any emergents. The volcanic range may be the only such landscape feature in the entire Amazon Plain, and it remains unexplored by scientists.

SITES VISITED BY THE BIOLOGICAL TEAM

In October 2002 scientists from The Field Museum, ProNaturaleza, CIMA (Centro de Conservación, Investigación, y Manejo de Áreas Naturales), and INRENA (Instituto Nacional de Recursos Naturales) flew over most of the Zona Reservada, and videotaped the flight. We selected sites for the inventory based on a combination of the overflight video and examination of high-resolution satellite images of the region. We selected inventory sites by choosing areas that had not been visited previously and appeared to be the most interesting ecologically. One of our priority inventory sites, the area near El Cono in the southeast, was dropped from consideration because this area is within Reserva Territorial Isconahua, an area that protects indigenous Iskonawa* living in voluntary isolation.

From 6 to 24 August 2005, the inventory team made a ground survey of three sites. One was in the northern half of the Ojo de Contaya, one was in the floodplain and adjacent terraces of the upper Río Tapiche (that drains most of the northern Sierra del Divisor), and the last was in the heart of the largest section of the Sierra del Divisor itself (Figs. 3A, 3B). Below we describe these sites in more detail and include additional information from overflights (including what we saw as we flew in and out of each field site). The site names refer to the dominant geographic feature of each area.

Ojo de Contaya (07º06'57.5" S, 74º35'18.6" W, 250–400 m; 6–12 August 2005)

The first of our camps was in the central complex of steep, high hills of the northern part of the Ojo de Contaya, 53 km east of Contamana. The Ojo is so-named because of an eye-shaped ring of high hills (65 km long and 35 km wide) that surrounds a similarly shaped low depression. Both of these rings surround a central complex of high hills representing an "iris" and "pupil" on the satellite view image (Fig. 3A). Water drains out of the Ojo de Contaya in all directions of the compass through several large winding streams that work their way out of narrow gaps in the border ridges of the "eye" and into the surrounding ancient floodplain terraces. All of this water eventually reaches the Río Ucayali, either north or south of Contamana.

Our helipad was at the crest of a bald hill (*cerro pelado*) covered with a thicket of *Pteridium* ferns (such thickets are known locally as *shapumbales*) with scattered emergent snags of dead trees. This exposed hill, apparently created by fire following lightning strikes, is visible on current satellite images and is the only such clearing we observed in the region (Fig. 3D). We camped in the steep-sided valley below, where a flat bottomland starts to narrow into a steep-sided ravine. The drainage of this area is ultimately to the north, toward the upper Río Tapiche. We saw no evidence of present or past human activity in the area.

The 14.6 km of trails that were cut by the advance team crossed through all the habitats within a

* Spelling of the official name of the reserve differs from that used by the Iskonawa themselves.

ca. 5 km radius in all directions from the camp. Trails followed crest lines of three different ridge systems, as well as traversing steep slopes in reaching each crest. One trail transected five different secondary ridges and ravines. Two trails followed the course of streams and bottomland terraces for several kilometers.

Ridge crests

Most of the high ridges (up to at least 400 m) seen in the central region of the Ojo de Contaya were relatively flat on top, rarely displaying sharp peaks. The few steep landslides from these ridges expose horizontal bands of hard sandstone alternating with softer, mostly sandy layers. This suggests there has been a broad vertical uplift of the whole area, without the steeply angled upthrusts characteristic of the Andes, and even of the Serrania de Contamana just to the west. About half of these ridges are covered with short forest with an even canopy about 10 m high, and the rest covered with tall forest (to at least 30 m high). The short forest clearly is underlain by whitish, quartz-sand soils, and the tall forest seems to be underlain by a sandy clay. Both of these crest forests, as well as the stable slope forests, have a dense mat of roots on the surface under the leaf litter. The short forest is similar in appearance to the short "spongy" forest seen at higher elevations on quartzite substrate of the northern Cordillera Azul on the opposite side of the Río Ucayali (Foster et al. 2001), as well as in the Sierra del Divisor (see below).

Steep slopes

On the overflight, we saw an area in the southern part of the Ojo de Contaya where a group of landslides on steep slopes of the high hills simultaneously had stripped away 10%-20% of the vegetation, clearly the result of a localized earthquake. But other than this site, the slopes mostly are stable when bordering the broader bottomland and are covered with mature forest showing little sign of disturbance. The transition from short forest on the top slopes to tall forest is relatively abrupt. In a few places, rock walls of hard sandstone border the bottomland. In contrast, the slopes adjacent to the narrow ravines are conspicuously dynamic with a high frequency of small "lateral slumps," i.e., landslides that carve out a section of the upper slope and deposit it down below. These slump deposits on the lower slopes reveal a diversity of substrates, ranging from red or yellowish clays to almost pure sand, and are covered with various combinations of pioneer plant species and regeneration of different ages. The small streams alternate between gently sloping areas within rock debris and steeper small cascades up to several meters high over hard sandstone layers.

Valley bottoms

The bottomland terraces are surprisingly flat and mostly range from 50 to 200 m across. The extent to which these terraces occasionally are flooded is not clear, but the inundation probably is temporary. The streams are fast-moving but highly meandering, and frequently form levees up to 5 m high and miniature oxbow lakes when a meander is cut off. The streamsides are mostly steep, sandy banks alternating with sandy beaches, and the clear-water stream bottoms (not tea colored as one might expect in such a sandy area) are conspicuously sandy with occasional "leaf packs" of compressed leaf litter and other organic material.

Tapiche (07°12'30.5" S, 73°56'04.1" W, 220–240 m; 12–18 August 2005)

Our second camp was approximately 73 km to the east of Ojo de Contaya and 145 km northeast of Pucallpa (Fig. 2A). Here we sampled the upper Río Tapiche near the base of the Sierra del Divisor, the largest floodplain in the region. We camped on a high terrace above the east side of the river and from there explored a system of approximately 25 km of freshly cut trails on both sides of the river. The trails traversed successional communities in active river meanders, older terraces, a large *Mauritia* palm swamp, and the lowest slopes of the Sierra del Divisor mountains.

Opposite our camp, adjacent to an oxbow lake on the west side of the river, there was an abandoned human campsite that we estimate was at least four years

old. The extent of forest cutting around the camp was very limited and there were only scattered domesticated plants around the few, crumbling palm-thatch shelters. This suggests that the camp was a temporary stopover for people in transit up and down the river, rather than a year-round settlement.

River meander

During this relatively dry August the fast-moving, meandering river was 15–20 m wide and no more than 1–2 m deep, and the sandy bottom was readily visible through the clear water. At the curves there were often extensive white-sand beaches, but these are relatively stable judging from their narrow, truncated successional bands of vegetation. Thus, despite sharing many of the same successional plant species, these river meanders are not like the rapidly changing meanders of sediment-laden, white-water rivers. The major streams entering the river are like miniature versions of the river itself, though less meandering, and with a somewhat different set of successional species.

The rare oxbow lake near the campsite was a rapidly drying, stagnant pond, mostly surrounded by high, unflooded terrace, with a low levee separating it from the river. Oxbow lakes are more frequent lower on the Tapiche where the active floodplain is much broader. Only a narrow part of the floodplain of the upper Río Tapiche seems to flood, either infrequently or annually. The rest is composed of older, higher floodplain terraces that differ in their drainage characteristics.

Old floodplain terrace and aguajal

Unflooded and well-drained terraces are extensive in the floodplain and are covered mostly with unbroken, high-canopy forest of large-buttressed trees and an open understory. These terraces are becoming a vast plain of low hills as they erode into a network of small gullies less than 5 m below the plain of the terrace. The underlying soils of these terraces, although sandy, appear to have substantial clay content similar to that of the sandy, flooded forests closer to the river. Within the high-canopy forest our trail network traversed one area of several hectares of forest recovering from a large blowdown, presumably because of wind shear from a large downburst out of a passing severe thunderstorm. Other blowdowns are recognizable on the satellite image of the region but are relatively infrequent. Palm swamps, known as *aguajales* and dominated by the large *Mauritia flexuosa* (or *aguaje*) palms, are not frequent in this region. As seen from space, the aguajal on a high terrace close to our camp is one of the largest in the region. Aguajal formation presumably reflects a river-driven process that creates levees high enough to block drainage from shallow depressions in the floodplain. Aguajales appear to be temporary features of the landscape, lasting perhaps 1000 years (or much less), as erosion eats away at the blockage while sediment input from the outside raises the level of the soil. In this region aguajales seem most common below the base of the low mountain range of the Divisor, and at a smaller scale within the broader active floodplain downriver on the Río Tapiche.

We studied an aguajal that was about 2 km in diameter. The east side is adjacent to the mountain foothills and in that area is deeper, more difficult to walk through, and more dominated by *Mauritia* than on the west side. On the west side, where it is penetrated by several steep-sided gullies that drain down to the river, there is more terra firme to walk on between the hummocks at the base of each palm, and much greater diversity and abundance of other plants. Wet clay soils topped with a deep layer of organic material provide a striking contrast to the better-drained, sandy, high terraces and hill slopes that surround the swamp. Humidity near the aguajal appears to support many more trunk epiphytes than in any of the surrounding vegetation.

Upland hill slopes

To the east of our camp, the high terraces make a gradual transition to the Sierra del Divisor mountains. It is as if the terraces were tilted upwards along a gradual slope, becoming a flat but not horizontal surface. The soil is sandier and the trees are tall, as

on the terraces below, but usually with smaller crowns, denser understory, and fewer lianas. Unlike the terraces below, drainage is not by shallow gullies but instead by steep and deep ravines cutting into the flat slopes.

Divisor (07º12'16.4" S, 73º52'58.3" W, 250–600 m; 18–24 August 2005)

Our third camp was 6 km east of the second, in the heart of the Sierra del Divisor mountains, ca. 10 km from the Brazilian border and 150 km northeast of Pucallpa (Fig. 2A). Toward the center of the mountains, the long, flat slopes and steep ravines of the foothills give way to a heterogeneous set of small mountain peaks, horizontal ridges, and broad valleys. The physiography has much in common with the Ojo de Contaya, but is set on a larger vertical scale with more extremes: more substrate heterogeneity and both much drier and wetter habitats. The 18 km of trails included three separate ridges and adjacent steep slopes, sandstone-walled canyons, and broad, sloping valley bottoms. The area shows no signs of human activity, and the presence of several large and valuable *cedro* trees (*Cedrela fissilis*) in the valley bottoms confirms that impression.

Ridge crests

Although our trails did not reach the highest peaks, our views from the ridges revealed that the highest elevations of the small mountains to our east (up to about 800 m) had moderately tall forest (at least 20 m tall), except on cliffs. Several roughly horizontal, flat-topped ridges emerged from these mountains (five ridges were visible near our camp) with distinctly stunted vegetation ranging from 10-m tall "spongy forest" to 2-m tall shrublands, some with open bare patches exposing white sand. These ridges were mixed with other ridges supporting a tall forest 30 m or more in height. The latter forest appeared to be underlain by a red, sandy-clay mixture, although the soil surface had a dense root cover. The ridges topped with shrubland mostly had cliffs on all sides, with an unusually porous sandstone near the ridge tops. This sandstone was honeycombed with holes, giving the appearance of limestone but without the sharp edges, and yet seemed remarkably resistant to erosion. Other bands of the sandstone were seen among the rock walls in some of the canyons below. The porous nature of the sandstone suggests that water drainage may be rapid and excessive from the tops of these strata, leading to severe drought conditions when rainfall is infrequent, and increasing the possibility of occasional, lightning-caused fires. In both the rock walls of the canyons and the exposed strata on the ridge cliffs, this area displays an extraordinary range of substrates. Different kinds of sandstones predominate, but substrates range from layers of soft, loose sand to extremely hard quartzites, and include layers of rock-like clay and other materials.

Valley bottoms

Compared to the other camp areas, the bottoms of the valleys and canyons resembled cloud forest. The moss and leafy liverworts covering most tree trunk surfaces, the high density and diversity of trunk epiphytes, and the abundance of tree ferns added to this impression. Moreover, the depth of these valleys probably contributes to the high humidity. We might be overestimating the humidity gradient because it rained heavily a few times during our stay at this camp after our completely dry conditions up to that point. On the other hand, it seems likely that the Sierra del Divisor generates local rainfall because the mountain range is the first area of higher elevations hit by winds moving west across the entire length of the Amazon Basin.

The walled canyons and broader valleys here both have flat, active floodplains, but these are mostly much narrower (20-50 m) than those of the Contaya and more likely to be strewn with rocks at intervals. The broad valleys are mostly covered with gently sloping sediment from the valley sides, either alluvial fans or lateral slump debris mounds. These areas are not flooded and provide a very uneven landscape, although usually they are not very steep until halfway up the valley slopes.

GEOLOGY AND HYDROLOGY

Author: Robert F. Stallard

Conservation targets: Isolated uplifts of ancient rocks, a geological formation unique to Peru and a small part of neighboring Brazil and unprotected within the Peruvian national system of protected areas (SINANPE); a broad soil and stream fertility gradient represented at small and large spatial scales; a volcanic range in the southeast that is the only such landscape feature on the Amazon Plain

INTRODUCTION

This chapter provides a geological overview of the Sierra del Divisor region based on a literature review, close examinations of satellite imagery, and limited water samples from the inventory. The author has not visited this site, but has broad experience in other parts of South America, especially in the Amazon and Orinoco river basins (Stallard and Edmond 1981, 1983, 1987; Stallard 1985, 1988, 2006; Stallard et al. 1991). In this overview, the goal is to describe the series of faults and uplifts that define this landscape, and to provide an overview of the principal rock formations.

The biological inventory team visited a region that is marked by three significant uplifts: Contamana, Contaya, and Sierra del Divisor. The Contamana and Contaya arches trend east from the Ucayali Valley to the Sierra de Divisor (Sierra de Moa) (Appendix 1). The Sierra de Divisor is an uplift on a system of normal faults that has dropped on the east side relative to the west side, formed by the Tapiche Fault (Dumont 1993, 1996)/Moa-Jaquirana Inverse Fault (Latrubesse and Rancy 2000). The junction of these two faults is an important influence on the landscape, defining the headwaters of both the Río Yavarí and the Río Blanco. Two other faults run in parallel to this one. The first is a low ridge that defines the Bata Cruzeiro Inverse Fault (Latrubesse and Rancy 2000), which appears to connect to the Río Blanco valley to the north (Stallard 2006); the other occurs along the Río Juruá in Brazil (Latrubesse and Rancy 2000). The region may have been uplifted and faulted with the major uplift of the Andes (Dumont 1993; Hoorn et al. 1995; Campbell et al. 2001). The Contamana and Contaya uplift was the site of one of the early oil fields in Peru, the Maquia Oil Field, which was developed in 1957 (Rigo de Righi and Bloomer 1975).

These three uplifts (Sierra del Divisor, Contamana, Contaya) involve mostly Cretaceous and younger rocks shed from several previous uplift cycles of the Andes. The oldest rock exposed at the center of the Contamana and Contaya Arches is the Middle Ordovician Contaya Formation, which consists of weakly metamorphosed black shales with intercalations of fine-grained sandstones and quartzites (SD in IGM 1977; Bellido 1969). The oldest rocks in the Peruvian part of the Sierra de Divisor are the Permian Mitu Group, a molasse formed of red, violet, and brown sandstones and conglomerates, with intercalations of fine-grained sandstones and quartzites (Pms-c in IGM 1977; Bellido 1969). Two major rock formations are missing from the Contamana Arch, Contaya Arch, and the Sierra del Divisor: (1) the carbonate sections found to the west, the Tarma and Copacabana Groups (Penn-Perm), and (2) the Upper Jurassic Sarayaquillo Formation (quartzites and arenites intercalated with siltstone and mudstone, chocolate, red, and pink), found to the west. The present Ucayali Valley flows along what was once the edge of the continent or a marginal sea in the Paleozoic. Presumably the lands on the east side of this margin were more elevated and the marine formations to the west were never deposited or if they were deposited, they were subsequently eroded. Stratigraphically above the Paleozoic cores of these uplifts is a long series of Cretaceous and younger sediments, dominated by continental silicate sediments but with a few marine silicate and marine limestone layers. The marine sediments would tend to form more nutrient-rich soils. Below I discuss each of the Cretaceous formations from oldest to youngest.

The oldest of these formations is the lower Cretaceous Oriente Formation. In the Contamana Region the Oriente Formation is about 1,700 m thick and is broken into six members: (1) Cushabatay (750 m, quartz arenites, with mudstones at the base

that contain plant remains); (2) Aguanuya (155 m, sandstones and black to gray shales that contain plant remains); (3) Esperanza (140 m, shales and marine limestones); (4) Paco (75 m, sandstones intercalated with shales that have plant fossils); (5) Agua Caliente (500-600 m, strongly cross-bedded quartz arenites interbedded with shales that have plant fossils); and (6) Huaya (180 m, fine sandstones with layers of marine shales and mudstones). The quartzites are noted ridge-formers that have a characteristic appearance on the landscape (Ki in IGM 1977; Bellido 1969).

Above the lower Cretaceous Oriente Formation is the middle Cretaceous Chonta Formation, which has a gradational contact with the Oriente Formation. In the Contamana Region, it is 160 m thick and is composed of gray to black mudstones and shales, intercalated with cream-colored limestones (Kms in IGM 1977; Bellido 1969). The upper Cretaceous Azúcar sandstone lies gradationally on top of the Chonta Formation (Ks-c in IGM 1977; Bellido 1969). It is composed of white to yellowish fine- to coarse-grained sandstones with strong cross-bedding. There are intercalated conglomerates and shales. The uppermost layers are gray to black shales with a marine fauna.

The latest Cretaceous was marked by major mountain building to the west and extensive deposition of mostly continental sediments in the foreland basin to the west. First comes the lower Contamana Group, consisting of a thick section of red beds (known as *capas rojas*), which are continental sandstones and shales (KTi-c in IGM 1977; Bellido 1969). There are no marine layers in the Contamana Region. The Cretaceous to Tertiary transition is accompanied by a gradual color change from redder, silty to browner, sandy sediments (Ts-c in IGM 1977; Bellido 1969). The top of the Contamana Group is a regional unconformity (the Ucayali Unconformity). (A regional unconformity is a widespread gap in the sedimentary record marked by the non-deposition of new sediments and often the erosion of previously deposited sediments.) This unconformity is probably associated with a major phase of Andean uplift. To the north of the Contamana Region, the Ucayali Unconformity is preceded by the deposition of the fossiliferous Pevas formation, which includes lacustrine and brackish water sediments and represents areas of richer soils (Hoorn 1994, 1996; Hoorn et al. 1995; Stallard 2006).

Following the Ucayali Unconformity, during the Plio-Pleistocene the more southerly Ucayali Formation and the more northerly Iquitos Formation were deposited. Both are horizontally bedded sand and mud with finer interlayers of conglomerates. These two formations are typically 30-40 m thick (Qpl-c & Q-c in IGM 1977; Bellido 1969). K-Ar isotopic dating of volcanic ashes to the east and south of the Contamana region indicate the Plio-Pleistocene deposition was active between 9 My and 3.1 My ago, probably ending 2.5 My ago with a trans-Amazonian erosion surface that defines the upper terra firme levels (Klammer 1984; Campbell et al. 2001).

To the south of the Contaya Arch are the remnants of several small volcanoes (KT-I in IGM 1977). K-Ar dating indicates an age of between 4.4 to 5.4 My for these volcanoes (Stewart 1971) and the magma chemistry indicates eruption from a subduction zone descending to great depth, about 350 km (James 1978). Uplift of the Ucayali and Iquitos Formations may also have been affected by the subduction of the Nazca Ridge, which reduced the depth of the subduction zone to 100 km, and therefore, presumably passed under the Contaya region after the 4.4 to 5.4 My volcanism (see Stallard 2006). The subducting Nazca Ridge may have lifted the entire region, helping produce the Contamana and Contaya Arches. Presently the subducting Nazca Ridge is beneath the elevated Fitzcarraldo Divide, between the Ucayali Basin and the Madre de Dios Basin.

METHODS

At each site, members of the biological inventory team collected water and soil samples, trying to cover the gradient of soils and streams in the area. I assessed these samples in the laboratory for pH and for conductivity. I measured pH with an ISFET-ORION Model 610 Portable System with a solid-state Orion pHuture

pH/Temperature Systems electrode. Conductivity was quantified with an Amber Science Model 2052 digital conductivity meter with a platinum conductivity dip cell. This conductivity meter has an exceptionally wide dynamic range, which permits the measurement of especially dilute waters. The relationship between these two measures (pH and the logarithm of conductivity) is a useful way to assess the surface geology, and places streams within a regional context (see Stallard 2006).

RESULTS

Water samples taken during the inventory (Table 2) are compared to those from sites in the Matsés region to the north (Stallard 2006) and to sites across the Amazon and Orinoco basins (Appendix 3). Samples from different regions tend to group into associations, which reflects the importance of regional geology in controlling the chemistry of the water (Stallard 1985, 2006). Several features should be noted. Two streams at Ojo de Contaya have blackwater pH-conductivity signatures (indicating abundant organic acids, but not necessarily black water). One stream at the Divisor site has a more dilute organic-acid signature. These three streams likely drain nutrient-depleted soils. Three samples, one from each site, fall on a trend that includes the Río Blanco, from the Matsés inventory to the north (Stallard 2006). This trend indicates a contribution of cations from less depleted soils or from bedrock with easily weathered silicate minerals.

DISCUSSION

All of the study sites are located in Cretaceous sediments. These sediments are quite varied and would be expected to produce a broad range of soils. Quartzites produce especially nutrient-poor, thin, sandy soils. Continental shales and sandstones (especially the red beds) would be expected to produce somewhat nutrient-poor soils, being composed of weathered materials. Marine sandstones and shales often produce richer, more fertile soils. In addition, dark shales, sediments with organic-rich and fossiliferous layers, and limestones and dolomites often are associated with nutrient-rich soils.

Streams ranged from nutrient-poor to intermediate nutrient concentrations at each site. The Ojo de Contaya site is located within the Oriente Formation, probably midway through the stratigraphic section. The water chemistry is consistent with nutrient-poor soils as might be formed on quartzites and weathered shales; however, the largest stream at Ojo de Contaya shows a slight influence of richer soils. In contrast the Río Tapiche appears to drain mostly nutrient-poor soils, presumably from the Sierra del Divisor. At the Divisor site, the largest stream is quite nutrient depleted, while a nearby stream with larger rocks shows an influence of richer soils.

None of these sites, however, shows any influence of widespread nutrient-rich soils such as were encountered in the Actiamë/Yaquerana site in the Matsés inventory. Since borders for protected areas

Table 2. Water samples from Zona Reservada Sierra del Divisor taken during the rapid biological inventory of 6-24 August 2005.

Sample	Locality	Site	pH	Conductivity
AM050001	Ojo de Contaya	Large stream	4.96	18.38
AM050002	Ojo de Contaya	Small stream	3.69	23.4
AM050003	Ojo de Contaya	Stream with hard rock bottom	4.11	8.76
AM050004	Tapiche	Río Tapiche	4.62	21.3
AM050005	Divisor	Stream with large rocks	5.24	20.5
AM050006	Divisor	Large stream	4.79	7.82

proposals recently have been redrawn, this rich-soil site now falls within the northern portion of Zona Reservada. In addition, several other stratigraphic units in the region should be weathering to nutrient-rich soils and solute-rich stream waters. The total area of these nutrient-rich sites may be small, but they should exist based on the underlying geology.

RECOMMENDATIONS

The large geologic variability of the Cretaceous rocks suggests that a wide variety of soils, stream compositions, and therefore habitats should exist in the Sierra del Divisor/Siná Jonibaon Manán Region. Based on the limited number of stream samples collected, the three study sites did not capture the full range of possible environments. Future work should endeavor to document such sites. The remnant volcanoes to the south of this region should have excellent soils with a broad spectrum of nutrients and might be an especially interesting site for future study.

FLORA AND VEGETATION

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Conservation targets: Vegetation on the high hills (up to 650 m), a singular ecological entity within the Amazon basin occurring only in Peru and Brazil and unprotected within SINANPE; a refuge for timber species (e.g., *Cedrela fissilis* and *C. odorata*, Meliaceae; *Cedrelinga cateniformis*, Fabaceae) logged at unsustainable levels in other parts of Loreto, Peru, and Amazonia; stunted forests on poor soils occurring principally on hill crests; a vast stretch of intact forest that forms a corridor between Parque Nacional Cordillera Azul to the west, Parque Nacional da Serra do Divisor in Brazil in the east, and the proposed Reserva Comunal Matsés and the Comunidad Nativa Matsés in the north; a mosaic of soils of poor to intermediate fertility that harbor several poor-soil endemics; ten species potentially new to science

INTRODUCTION

Zona Reservada Sierra del Divisor is large (1,478,311 ha) and spans a wide range of habitat types. The landscape varies broadly from rich floodplain clays in the north to a central area of poor, sandy soils, and includes an area in the south with richer soils that may be volcanic in origin. To the north the area abuts the Comunidad Nativa Matsés and to the east it borders Brazil, forming an intact corridor with the Brazilian national park, Parque Nacional da Serra do Divisor. The western border loosely follows the Serranias de Contamana. The southern limit is dominated by several hill complexes and isolated cone-shaped peaks, and forms part of Reserva Territorial Isconahua, an area set aside for uncontacted indigenous people (Fig. 2A).

At least four expeditions have visited the northern, western, and southern parts of the area, although none had explored the central and eastern areas. Three Peruvian conservation organizations—ProNaturaleza, The Nature Conservancy–Peru, and the Centro de Datos para la Conservación—jointly organized biological inventories in 2000 (in the west, along the Serranias de Contamana); in 2001 (in the south, along the Río Abujao); in 2004 (in the west, from the Serranias de Contamana to the edge of the Ojo de Contaya); and in 2005 (in the southwest, along the Río Callería)(FPCN/CDC 2001, 2005, unpub. data) (Fig. 2A). Biological information for the northern part of the Zona Reservada comes from a 2004 inventory along the Río Yaquerana, directly south of the Comunidad Nativa Matsés (see results for the Actiamë site in Fine et al. 2006).

Our current inventory focused on the central and eastern portions of the Zona Reservada and included two large hill complexes: the Ojo de Contaya and the southernmost of the two series of large ridges that form the border, or *divisor*, with Brazil. Although the western edge of the Ojo de Contaya was explored in 2004, our inventory was the first visit by biologists to its center. Similarly, although there have been previous inventories of scattered visits to the Brazilian side of the Divisor ridge system, prior to our visit the biological communities on the Peruvian side were entirely unknown.

METHODS

During a rapid inventory the botanical team [5x50-m] characterizes the vegetation types and habitat diversity in an area, covering as much ground as possible. We focus on the most common and dominant elements of the flora while keeping an eye out for rare and/or new species. Our catalogue of the plant diversity in the area reflects collections of plant species in fruit or flower, sterile collections of interesting and/or unknown species, and unvouchered observations of widespread species in Amazonia. We made several quantitative measures of plant diversity, including a 5x50-m transect at the first site (Ojo de Contaya), a 100-stem transect at the third site (Divisor), and a survey of adult trees (see Canopy Trees, below).

In the field, R. Foster took approximately 1,400 photographs of plants. These photographs are being organized into a preliminary photographic guide to the plants of the region, and will be freely available at *http://fm2.fieldmuseum.org/plantguides/*.

All of the botanists contributed to the general collections and observations. In addition, two members of the group focused on particular plant families. I. Mesones documented diversity in the Burseraceae and V. Uliana surveyed a handful of herbaceous taxa, including Costaceae, Heliconiaceae, Marantaceae, and Zingiberaceae. At each site N. Dávila recorded the abundance of the largest trees (individuals > 40 cm in diameter at breast height) in different habitats, using a combination of binoculars and fallen leaves to identify individuals to species.

Plant specimens from the inventory are housed in the Herbario Amazonense (AMAZ) of the Universidad Nacional de la Amazonia Peruana in Iquitos, Peru. Duplicate specimens have been sent to the herbarium at the Universidad Nacional Mayor de San Marcos (USM) in Lima, Peru, and triplicate specimens to The Field Museum (F) in Chicago, USA. Several duplicates of herbaceous specimens have been donated to the Herbario da Universidade de São Paulo (ESA).

FLORISTIC RICHNESS AND COMPOSITION

During our 18 days in the field, we recorded ca. 1,000 species at the three inventory sites (Appendix 2). Other rapid inventories in lowland Amazonia have recorded 1,400-1,500 species in similar time frames using similar methods (along the Río Yavarí, Pitman et al. 2003; along the Apayacu, Ampiyacu, and Yaguas rivers, Vriesendorp et al. 2004; between the Yaquerana and Blanco rivers in the Matsés region, Fine et al. 2006). However, these inventories spanned a wider range of soil fertilities and included sites with much richer soils. In the Zona Reservada, the inventory sites were dominated by soils of poor to intermediate fertility, and consequently plant communities were less diverse.

Richer soils are found within other parts of the Zona Reservada, in the gentle hills in the north and in the complex of scattered hills and ridges in the south. We did not survey these areas, although we did fly over them (see Regional Overview and Inventory Sites, above). We estimate a regional flora of 3,000-3,500 species with the inclusion of these areas. Without the richer-soil areas, we estimate the sandier soils of the central and eastern portions support ca. 2,000 plant species.

Because of the generally low soil fertilities, many families had fewer species here than at most Amazonian sites. Some families, however, are most diverse on poorer soils, and we found Nyctaginaceae, Lecythidaceae, Combretaceae, Clusiaceae, and Euphorbiaceae to be surprisingly abundant and rich in species at the three inventory sites. In addition Rubiaceae, Fabaceae, Burseraceae, Meliaceae, and Sapotaceae were among the most abundant and species-rich families during the inventory, not unlike other Amazonian sites. No herbaceous family was especially diverse, although Marantaceae and Araceae were among the most species rich, and certainly the most dominant. Species richness of ferns and Myristicaceae was markedly low, even for poor-soil communities.

At the generic level, *Psychotria* (16 species), *Sloanea* (4), *Ladenbergia* (3), *Guarea* (12), *Tachigali* (10), *Ficus* (15), *Protium* (11), *Pourouma* (8), *Piper* (26), *Inga* (15), and *Neea* (11) were among the most

species-rich genera. With the exception of *Sloanea*, *Tachigali*, and *Ladenbergia*, these genera usually include at least twice as many species in other parts of Amazonia. None of us, however, ever have visited any other site as diverse in *Tachigali* species.

VEGETATION TYPES AND HABITAT DIVERSITY

We surveyed three sites, beginning in the hills at the heart of the Ojo de Contaya and moving progressively eastward to sample a site 73 km distant along the Río Tapiche, and a site 79 km distant in the hills of one of the two Divisor ridges (see Regional Overview and Inventory Sites). Although the Tapiche and Divisor sites are a mere 6 km from one another and only differ in elevation by 30-100 m, we found no habitat overlap between these two sites. In contrast, almost all of the habitats between the Ojo de Contaya and Divisor sites are shared. Below we give a brief overview of each site and we describe the gross habitat types we visited, highlighting site-to-site variation wherever possible.

Ojo de Contaya (250–400 m, 6–12 August 2005)

The Ojo de Contaya is the westernmost site that we visited and lies in the middle of a complex of rounded hills. Below we describe some of the main habitat types at the Ojo de Contaya site in more detail, beginning with valleys and hill slopes, and continuing up to the hill crests. We also discuss one habitat that we have never seen elsewhere in Amazonia, an open area dominated almost exclusively by species of Melastomataceae.

Hill slopes and valleys

The vegetation on hill slopes is difficult to characterize because slopes were sometimes dominated by stunted, low-diversity vegetation, and sometimes supported taller forests with a richer plant community. In general slope vegetation was less species-rich than those in the valleys, and more species-rich than the stunted forests growing on the crests. Because of the overlap between slopes and valleys, we discuss them concurrently below, and highlight some of the taxa that were found only in the valleys.

Both valleys and slopes were overwhelmingly dominated by *Lepidocaryum tenue* (Arecaceae), known locally as *irapay*. This species can form dense stands and effectively reduce plant diversity in the understory. In addition to irapay, common understory plants included a fruiting *Trichilia* (Meliaceae) treelet, the shrub *Siparuna* cf. *guianensis* (Monimiaceae), *Mouriri* sp. (Memecylaceae), *Neoptychocarpus killipii* (Flacourtiaceae), and a *Roucheria* sp. (Hugoniaceae). A single species of *Ischnosiphon* (Marantaceae) formed large patches and dominated the herbaceous community. Trees often had termite nests in their branches or on their main stems. Although we observed few trunk climbers, the majority of trees supported one or two individuals of *Guzmania lingulata* (Bromeliaceae).

In the overstory, the most species-rich genera were *Sloanea* (Elaeocarpaceae), *Pourouma* (Cecropiaceae), *Tachigali* (Fabaceae s.l.), *Protium* (Burseraceae), and *Ladenbergia* (Rubiaceae). In more-disturbed areas we observed *Aparisthmium cordatum* (Euphorbiaceae) and *Jacaranda obtusifolia* (Bignoniaceae) growing together with *Nealchornea japurensis* (Euphorbiaceae). Remarkably, we did not observe any *Cecropia* (Cecropiaceae), a genus typical of disturbed areas on richer soils. Palms, although low in diversity, were abundant at this site, especially *Attalea microcarpa*, *Wettinia augusta*, *Oenocarpus bataua*, and *Iriartella stenocarpa*.

Few species were fruiting while we were in the field, and the understory was especially devoid of fruits. Genera in the Rubiaceae (e.g., *Psychotria*, *Notopleura*, *Palicourea*) and Melastomataceae (e.g., *Miconia*, *Clidemia*, *Tococa*, *Ossaea*) that typically make up the majority of fruiting treelets and shrubs were noticeably absent, species-poor, or uncommon here. One of the few fruiting species, the subcanopy tree *Rhigospira quadrangularis* (Apocynaceae), littered the forest floor with its large fallen fruits, and was a focal species for monkeys (see Mammals).

In wetter areas in the valleys, we found scattered or lone individuals of *Mauritia flexuosa* (Arecaceae), although these never formed the dense

aggregations known as *aguajales* common in other parts of the Peruvian Amazon. Alongside the *Mauritia* we typically found three species of *Heliconia*, including *H. hirsuta* (Heliconiaceae), and a species of *Costus* (Costaceae) that looks like *C. scaber* but has a yellow flower and longer petioles. Along streams, we typically observed scattered Melastomataceae, dense clumps of herbaceous Marantaceae, *Aparisthmium cordatum*, an *Inga* sp. (Fabaceae s.l.), a *Solanum* sp. (Solanaceae), an occasional *Mauritia flexuosa*, and some *Cyathea* tree ferns. The few germinating seedlings we observed were growing principally in wetter areas. The majority of the seedlings had large seeds, including species of *Protium*, *Tachigali*, several Sapotaceae, and the palms *Iriartella stenocarpa* and *Euterpe precatoria*.

In these forests we found two rare, monocarpic species. *Froesia diffusa* (Quiianaceae) is rarely collected and has medium sized, presumably bird-dispersed fruits (see Pitman et al. 2003). *Froesia* was scattered throughout the landscape, was relatively common in the understory, and occurred at the Divisor inventory site as well. We found three individuals of another monocarpic rarity, *Spathelia* cf. *terminalioides* (Rutaceae), growing alongside the sandstone stream.

Hill crests

The highest hill on the landscape crested at ca. 400 m. On the hill crests we observed two types of forests, loosely correlated with the underlying soil types. Stunted, low-diversity forests (with canopies 5-15 m tall) grew on sandier soils, and taller, higher-diversity forests (with canopies 25-35 m tall) grew on soils with seemingly greater clay content. Generally, plants in the stunted forests tended to be wind dispersed, and plants in the taller forests on the hill crests, as well as in the lower slopes and valleys, were principally animal dispersed. We estimate that an overlap of only 5% exists between the plant communities in the stunted forests and plant communities elsewhere in the landscape.

In the stunted forest we found a community of approximately 40 plant species, typically dominated by a group of small trees including *Macrolobium microcalyx* (Fabaceae s.l.), a potentially new species of *Pseudolmedia* (Moraceae), *Tovomita* aff. *calophyllophylla* (Clusiaceae), and *Matayba* sp. (Sapindaceae). On some crests one of these dominants would be missing, replaced by a *Gnetum* sp. (Gnetaceae) or *Ferdinandusa* sp. (Rubiaceae). Lauraceae was the most diverse family, with five species, and there were three species of *Cybianthus* (Myrsinaceae). Ferns dominated the understory and often formed monodominant patches. The fern *Schizaea elegans*, for example, formed a dense cover as we approached one hill crest, and as we descended along the other side of the hill it was replaced by another fern, *Metaxya rostrata*.

In the tall, crest forest, *Micrandra spruceana* (Euphorbiaceae) was abundant in all size classes. These taller forests had an understory composition similar to that of the plant communities growing on the hill slopes and valleys, although because irapay did not form dense stands and crowd out other species, the understory community here was more diverse. Genera more typical of richer soils, such as *Inga*, *Guarea* (Meliaceae), and *Protium*, were more abundant in this tall forest, and we observed several individuals of *Protium nodulosum*, a clay specialist.

Melastomatal

At Ojo de Contaya we found open areas unlike any we have seen in Amazonia, almost entirely dominated by species in the Melastomataceae (Fig. 3C). In a survey of six of these habitats, the diversity of Melatomataceae ranged from 15-22 species and included *Miconia* spp., *Graffenrieda* sp., *Salpinga* sp., *Maieta guianensis*, *Ossaea boliviana*, *Tococa* sp., and *Miconia bubalina*.

These *melastomatales* superficially resemble the *supay chacras*, or "devil's gardens," that are abundant throughout lowland Amazonia. Supay chacras are open areas dominated by plants with ant mutualisms, almost always including *Cordia nodosa* (Boraginaceae) and *Duroia hirsuta* or *D. saccifera* (Rubiaceae). These typical species were absent from the melastomatales,

although we did find *D. saccifera* and *C. nodosa* nearby in the forest understory, but without their usual ant inhabitants. Moreover, although several of the Melastomataceae (*Tococa*, *Maieta*) had ant associations, we found two melastomatales without any ant plants. These habitats remain a mystery; we do not understand how they are formed, nor how they are maintained.

Tapiche (220–240 m, 12–18 August 2005)

This was our only site along a large river. A typical floodplain flora grows along its banks, although this flora is not as rich as those of floodplain forests elsewhere in Peru (e.g., Madre de Dios) because the soils at this site are nutrient poor. The river is a vulnerable entry point into the area, and we observed evidence of timber extraction at this site (Fig. 9A, see Timber Species below).

Although no habitat overlap exists between the Ojo de Contaya and Tapiche sites, the sites share many plant species. Except for the stunted forest communities on the hill crests, the Ojo de Contaya flora is fully represented here. The Tapiche site is continuous with the slopes of the Divisor ridge (our third inventory site) and these two sites are intimately connected, as the streams that originate in the ridge system flow downhill and feed the aguajal.

Floodplain forest

The Río Tapiche is a dominant force structuring nearby plant communities. Although its influence is most obvious along the riverbanks, the river shapes the vegetation up to 40-50 m inland as well. Plant diversity at Tapiche was higher than at the Ojo de Contaya and Divisor sites, which almost entirely reflects the contribution of the floodplain species.

Closest to the river, we observed typical floodplain species, including *Ficus insipida* (Moraceae; *ojé*), *Acacia loretensis* (Fabaceae s.l.), *Cecropia membranacea* (Cecropiaceae), and *Tachigali* cf. *formicarum* (Fabaceae s.l.). A community of species associated with disturbances, all fast-growing and some heavily defended (with spines, ants, or urticating hairs) inhabits the river edge. This was a low-diversity assemblage, and included abundant populations of *Urera laciniata* (Urticaceae), *Triplaris* sp. (Polygonaceae), *Attalea butyracea* (Arecaceae), *Celtis schippii* (Ulmaceae), and *Jacaranda copaia* (Bignoniaceae). The diversity of Euphorbiaceae, especially in small trees, was remarkably high in these areas and included two species of *Alchornea*, *Acalypha diversifolia*, and a *Sapium* sp.

Farther from the river there were a series of terraces. On the lower terraces *Geonoma macrostachya* and *Chelyocarpus ulei* (Arecaceae) dominated the ground cover, with *Tachigali*, *Wettinia augusta*, and *Astrocaryum chambira* (Arecaceae) common in the overstory. Lianas in the Hippocrataceae were common here, and rich in species. We found an important domestic timber species, *Hura crepitans* (Euphorbiaceae), growing in patches on the lower terraces.

Plant diversity increased with distance from the river. On the higher terraces, the palms that were abundant on the lower terraces disappeared, and species of Marantaceae dominated along with juveniles of *Oenocarpus mapora* (Arecaceae). The high terraces supported a rich overstory that includes *Hevea guianensis* (Euphorbiaceae), *Protium nodulosum* (Burseraceae), *Dipteryx* (Fabaceae), and *Simarouba amara* (Simaroubaceae). In the understory we registered *Siparuna cuspidata*, *Heliconia velutina* (Heliconiaceae), *Geonoma camana* (Arecaceae), *Abarema* sp. (Fabaceae s.l.), *Memora cladotricha* (Bignoniaceae), and several *Pourouma* spp. (Cecropiaceae). We saw some species commonly found on the Manu floodplain, including *Carpotroche longifolia* (Flacourtiaceae), *Virola calophylla* (Myristicaceae), and large trees of *Ficus schultesii* (Moraceae). We often found the lilac flowers of *Petrea* (Verbenaceae) on the ground, highlighting the abundance of this liana in these areas.

There were some differences between the two sides of the river., For example, *Heliconia chartacea* was seen only on one side and not the other. Notably, no irapay (*Lepidocaryum tenue*) grows along the river edges or on the terraces, although once one began ascending the slopes towards the Divisor ridge this species again dominated the understory.

Mauritia *palm swamp, or aguajal*

The palm swamp at this site was expansive and dominated the landscape. Our trail around its borders was about 11 km long and we were able to survey both within and outside the aguajal. In addition to the characteristic *Mauritia flexuosa*, the palm swamp supported a few other species, including *Euterpe precatoria*, *Cespedesia* (Ochnaceae), *Siparuna*, a *Sterculia* (Sterculiaceae) with enormously long leaves, and several large trees, including a *Buchenavia* sp. (Combretaceae) and several *Ficus* spp. (Moraceae).

On the better-drained soils along the border of the aguajal, we documented a plant community with higher diversity. Here we commonly observed a *Trichilia* sp. (Meliaceae), *Naucleopsis ulei* (Moraceae), *Minquartia guianensis* (Olacaceae), at least three species of *Guarea* (Meliaceae), a big-leaved *Pouteria* sp. (Sapotaceae), and a *Parinari* sp. (Chrysobalanaceae). One of the more locally dominant species around the aguajal is *Cassia* cf. *spruceanum* (Fabaceae s.l.), which has white undersides on its leaflets. Additionally we observed two species of *Virola* (Myristicaceae), an *Inga* sp. (with four leaflets, yellow hairs, and a large rachis wing), a *Casearia* sp. (Flacourtiaceae), and a *Talisia* sp. (Sapindaceae). *Miconia tomentosa* (Melastomataceae), common at the Ojo de Contaya, was dominant here as well.

Along the streams that flow into the aguajal we observed two species of *Psychotria* (Rubiaceae), *P. caerulea* and *P.* cf. *deflexa*, as well as *Piper augustum* (Piperaceae), a *Besleria* sp. (Gesneriaceae) with orange axillary flowers, and a shrubby *Alchornea* sp. (Euphorbiaceae). The wet areas along the edge of the aguajal were covered in seedlings, including *Dicranostyles* (Convolvulaceae), *Protium*, *Pourouma*, several species of Menispermaceae, *Aparisthmium cordatum*, *Hymenea* (Fabaceae s.l.), and *Socratea exorrhiza*, *Oenocarpus mapora* and *Iriartea deltoidea* (Arecaceae).

Divisor (250–600 m, 18–24 August, 2005)

The Ojo de Contaya and Divisor sites are separated by only 80 km and they are notably similar in floristic composition and habitat diversity. This is especially remarkable given that these two habitats are separated by a continuous stretch of markedly dissimilar habitat: a lowland forest with gentle topography, and no raised hill formations like the ones in Ojo de Contaya and Divisor. The underlying rocks in the two areas appear to be the same, and there is similar small-scale variation in quartzite and sandstone substrates.

However there are several obvious differences between the two sites. Because of the higher hills in the Divisor ridge (up to ca. 800 m), and the prevailing winds from the Brazilian side, the Divisor ridges are much wetter and more humid than are those of the Ojo de Contaya. Moreover, the hills in this area are not rounded as are ridges of the Ojo de Contaya; the crests of the Divisor are longer and flatter. Also, at Divisor the tallest hill crests do not support stunted forests. Instead, the stunted forest appears to grow only on the tops of smaller hills.

We are unsure of the factors that shape and maintain the stunted forests. Our working hypothesis is that infrequent lightning strikes, perhaps every 500 years, burn the driest areas. Some support exists for this hypothesis because the well-drained hilltops with stunted forests, underlain by a porous sandstone layer, appear to be the driest areas in the landscape. Moreover, we found evidence of lightning strikes and burns on hill crests in both Divisor and Ojo de Contaya.

Below we describe the flora and habitat types of Divisor in more detail. In these descriptions we include a brief mention of the habitat between the Tapiche and Divisor inventory sites, as we explored a 10-km stretch during our walk from one camp to the other.

Hill slopes and valleys
(including slope from Tapiche to Divisor)

The slopes in this region are more steeply inclined than the rounded hills at Ojo de Contaya. At both sites the soils vary over similar, small spatial scales. Sediments are principally sandy, but in some areas soils can be a mixture of sand, red clays, and/or gray clays because of old landslides and lateral slumps. Some species may be responding to these localized soil conditions.

Our survey, however, focused mainly on the most common elements of the flora, as described below.

The understory often was dominated by irapay (*Lepidocaryum tenue*), although we found one area covered in *Ampelozizyphus* cf. *amazonicus* (Rhamnaceae). One of the most common species was *Tachigali vasquezii* (Fabaceae), and often upwards of ten individuals could be counted from a single vantage point. *Tachigali* species richness was higher at Divisor than any other site we have ever visited, principally on slopes and valleys. Other common species in the understory and subcanopy included *Capparis sola* (Capparidaceae), *Aparisthmium cordatum*, and several species of *Neea* (Nyctaginaceae).

Several genera of Rubiaceae were common here, including *Bathysa*, *Ferdinandusa*, and *Rustia*. In the understory, *Dieffenbachia* (Araceae) was among the common herbs, and *Didymocleana trunculata* was the most common fern. Several species formed near monodominant stands in the understory, including the explosively dehiscent *Raputia hirsuta* (Rutaceae) and the treelet *Nealchornea japurensis*.

A lower diversity assemblage grew along streams. It included abundant *Chrysochlamys ulei* (Clusiaceae) along with *Aparisthmium cordatum*, *Froesia diffusa*, juvenile *Micrandra spruceana*, *Pholidostachys synanthera* (Arecaceae), *Marila* sp. (Clusiaceae), *Tovomita weddelliana* (Clusiaceae), and one of the largest *Heliconia* in the world, *H. vellerigera*. Along one of the slopes we found *Podocarpus* cf. *oleifolius* (Podocarpaceae, Fig. 4B). (*Podocarpus* is a rare and "primitive" genus more commonly associated with montane sites.)

Diversity in slopes and valleys was moderate compared to other sites in lowland Amazonia. In a 100-stem transect of individuals 1-10 cm diameter at breast height (dbh) we recorded 65 species, compared to 88 species in areas close to the Colombian border south of the Putumayo river (Vriesendorp et al. 2004) and 80 species in areas north of the Zona Reservada along the Río Yavarí (Pitman et al. 2003). In Divisor, the most common species was represented by a *Rustia* sp. with 5 individuals, followed by *Tachigali* sp. (4), *Guarea* sp. (4), and *Iryanthera* sp. (4; Myristicaceae).

In the flatter, lower elevation areas in Divisor we observed substantial populations of timber species, including more than 20 individuals of *Cedrela fissilis* (Meliaceae) and several *Cedrelinga cateniformis* (Fabaceae; see Timber Species, below).

Hill crests

As in Ojo de Contaya, both tall forests and stunted forests grew on hill crests, with almost no species overlap between the two forest types. The stunted forests were more extensive in Divisor, but this may reflect the longer, bigger hill crests here compared to the smaller, rounder crests in Ojo de Contaya. Stunted forests were yet more stunted in Divisor as well, with 2-m tall canopies in some areas. About 80% of the stunted forest flora appears to be shared between the two sites, although the species unique to Divisor are some of the most exciting records of the inventory.

At least two of these species appear to be new to science, and include a dwarf *Parkia* also recorded at 1,500 m during the Cordillera Azul inventory (Foster et al. 2001) as well as an *Aparisthmium* with small leathery leaves (Fig. 4C). Other species only recorded at Divisor include a *Pagamea* sp. (Rubiaceae) and a *Bonnetia* sp. (Theaceae, Fig. 4I). One species known to be resistant to fire, *Roupala montana* (Proteaceae), was observed only here, and lends support to the notion that these are plant communities shaped by infrequent fires.

In contrast to the unique flora observed in the stunted forests, the taller forest shared species with valley and slope habitats, both here and in the Ojo de Contaya. Some of the more common species in the understory included *Neoptychocarpus killipii*, *Oenocarpus bataua* (Arecaceae), a *Caryocar* sp. (Caryocaraceae), several species of tree ferns, and *Tachigali* spp., as well as *Couepia* and *Licania* (Chrysobalanaceae). As in the tall forest in Ojo de Contaya, *Micrandra spruceana* dominated the overstory. One of the more exciting finds in the tall forests was a *Moronobea* tree (Clusiaceae) that is potentially new to science.

CANOPY TREES (Nállarett Dávila)

Although canopy trees represent only 30% of the flora in tropical forests (Phillips et al. 2003), they are an essential part of the forest structure and provide habitats for numerous other organisms. We sampled large overstory trees at all three inventory sites in our inventory of Zona Reservada Sierra del Divisor.

Depending on the breadth of the habitat, we established either 20 x 500-m or 10 x 1000-m transects and measured trees at least 40 cm in diameter at breast height (dbh). We established as many transects as possible at each site. We recorded 150 species of canopy trees. Fabaceae was the most species-rich family, as is true of most tropical forests (Gentry and Ortiz 1993; Terborgh and Andresen 1998). Below we summarize our results for each site and then briefly discuss the overlap in species composition among sites.

In the Ojo de Contaya we distinguished two main habitat types: hill crests, and hill slopes and valleys. Hill crests principally supported stunted vegetation with stems <40 cm dbh, and therefore we did not conduct any tree surveys. In the taller forest (canopy ca. 30 m tall) growing on the hill slopes and valleys, we registered approximately 90 species. *Cariniana decandra* (Lecythidaceae), *Licania micrantha* (Chrysobalanaceae), and *Qualea* sp. (Vochysiaceae) were the most common species, and all are typical of poor soils (Spichiger et al. 1996). The tall canopies tended to be closed, with few light gaps.

Floristic composition in the overstory changed radically in Tapiche, reflecting the river floodplain and the large palm swamp. Fewer species were recorded here; we registered only about 70 species, dominated by members of the Fabaceae, Euphorbiacae, and Moraceae. The most common species were *Alchornea triplinervia* (Euphorbiaceae), *Acacia loretensis* (Fabaceae s.l.) and *Ficus* sp. (Moraceae). Structurally the canopy was more open in the Tapiche site, favoring rapid tree growth, and we observed several majestic emergents along the river banks, including *Ficus* spp. (Moraceae) and *Hura crepitans* (Euphorbiaceae). In the aguajal we saw few canopy species because of the dominance of *Mauritia flexuosa*. Around its borders, however, we observed *Huberodendron swietenioides* (Bombacaceae), *Cedrelinga cateniformis, Parkia* cf. *multijuga* (Fabaceae), *Brosimum rubescens* (Moraceae) and several species of Lauraceae.

Divisor was similar floristically to the Ojo de Contaya, with sandy and sandy-loam hills. Here we registered ca. 85 canopy tree species. Fabaceae and Euphorbiaceae were the most important families. Some areas, especially lower-lying ones, were dominated by *Huberodendron swietenioides* (Bombacaceae, Fig. 4E). Growing alongside *H. swietenioides* we commonly encountered *Tachigali* sp. (Fabaceae), *Ocotea* cf. *javitensis* (Lauraceae), and *Micrandra spruceana* (Euphorbiaceae), a characteristic species with large tabular buttresses. On higher slopes, *M. spruceana* became even more dominant and grew alongside *Brosimun rubescens* (Moraceae), *Macrolobium acaciifolium* (Fabaceae s.l.), and *Jacaranda copaia* (Bignoniaceae). Similar to the Ojo de Contaya, at this site there were hill crests covered with stunted vegetation that we could not survey for big trees.

We observed more trees flowering and fruiting at Tapiche and Ojo de Contaya than at Divisor. One notable fruiting species at Divisor was *Cedrela fissilis*, an important timber species (see Timber Species, below). A comparison of the three inventory sites reveals that Ojo de Contaya and Divisor are the most similar, sharing 60% of tree species, while Tapiche shares only 20% of its tree species with the two other sites.

BURSERACEAE (Italo Mesones)

Members of the Burseraceae were well represented in this inventory. We observed 29 species in four genera, with the bulk of the richness in the genus *Protium* (with 24 spp.). This represents an intermediate richness for *Protium*, and almost certainly reflects the relatively poor soils of the inventory sites. In comparison, Fine (2004) and Fine et al. (2005) registered 36 species of *Protium* in Allpahuayo-Mishana (near the city of Iquitos) across a greater fertility gradient, from rich soils of the Pevas Formation to poorer white-sand soils. Below we detail

several of the more interesting records of Burseraceae in the Zona Reservada.

Although the area is dominated by poor soils, we found several clay specialists. In the Ojo de Contaya, we found areas where *Protium hebetatum* dominated the subcanopy, especially in the valley bottoms. This species prefers richer soils, but probably responds to the nutrients deposited in the valley bottoms, eroded downslope by rains. Similarly, areas at Tapiche and Divisor were dominated by *Protium nodulosum* in every size class, with some individuals reaching 30 cm dbh and standing 20 m tall. This species typically is found growing in soils with moderate to high fertility levels and substantial clay content. In the Zona Reservada, both *P. hebetatum* and *P. nodulosum* appear to be tolerating sandier conditions than they do normally.

A poor-soil specialist, *Protium heptaphyllum*, dominated several of the crest forests growing on sandy, well-drained soils. This species has been found growing in stunted habitats in other white-sand areas of Peru (Allpahuayo-Mishana, Jeberos, Río Morona, Tamshiyacu, Jenaro Herrera, and Río Blanco). Typically these habitats have high levels of endemism, with upwards of 50% of the species restricted to these poor-soil areas. Three other poor-soil specialists were found during the inventory: *P. calanense*, *P. paniculatum*, and *P. subserratum*.

Sites varied little in their levels of Burseraceae diversity, but a different suite of species was dominant at each site. For example, each of the inventory sites had one species of *Dacryodes* and one species of *Trattinnickia*. However, each site supported their own unique species within these genera, with no species overlap among sites. Similarly, different species of *Protium* dominated at each site, although several species occurred at more than one site, or at all three sites.

We found 15 species of Burseraceae at Ojo de Contaya, including 13 species of *Protium*. *Protium hebetatum* and *P. heptaphyllum* subsp. *ulei* were the most abundant. At Tapiche, we registered 14 species of Burseraceae, including 11 species of *Protium*, and 1 *Crepidospermum*. Here *Protium nodulosum*, *P. trifoliatum*, and *P. amazonicum*, all specialists of moderate to richer soils, were most abundant. At Divisor, we registered the greatest diversity of Burseraceae (17 species), including 15 species of *Protium*. The most abundant species were *Protium nodulosum*, *P. heptaphyllum*, and *P. paniculatum*. These species cover a range of soil preferences from the poorest soils (*heptaphyllum*), to much richer ones (*nodulosum*), and some soils of intermediate richness (*paniculatum*).

HERBACEOUS TAXA (Vera Lis Uliana)

Overall, herbaceous diversity in the Zona Reservada was low. Plants in the order Zingiberales dominated the herbaceous taxa and were concentrated in humid environments close to waterways. Within the Zingiberales, the most species-rich family was Marantaceae (with 26 species), followed by Heliconiaceae (7), Costaceae (3), and Zingiberaceae (1). Below we describe the taxa that dominated the herb community at each inventory site, and discuss several rare and interesting herbaceous plants.

There was substantial overlap in Marantaceae among sites. The understory in Ojo de Contaya and areas outside of the palm swamp at Tapiche were dominated by the same *Ischnosiphon* sp. (Marantaceae). Within the palm swamp at Tapiche we observed two species of *Ischnosiphon*. The most abundant species was *I. arouma* and the other species remains unidentified. At Divisor we also observed *I. arouma* near streams, as well as two species of climbing *Ischnosiphon*, one an unidentified species and the other *I. killipii*. In drier areas at Ojo de Contaya and Divisor we found *Calathea micans* and *Monotagma* sp. closer to the hill crests. Only two species occurred at all three sites, *C. micans* and *C.* aff. *panamensis*.

In the Helicioniaceae, *Heliconia stricta* was rare, while *H. velutina* and *H. lasiorachis* were more common and found close to flooded sites. We found *H. vellegeria*, which is the largest *Heliconia* in the world (standing up to 4 m tall), only in Divisor.

All of the species in the Zingiberales can be cultivated as ornamentals, with *Calathea* and *Heliconia*

the most commonly cultivated species. People living along rivers in Amazonia typically use the petiole and leaves of *I. arouma* for making baskets (Ribeiro et al. 1999), especially as this species grows along *Mauritia* palm swamps, which often are focal sites for hunting and gathering.

TIMBER SPECIES (Italo Mesones)

Although the Sierra del Divisor is a remote area, it suffers the same extractive pressures that threaten timber species throughout the Amazon. For more than 60 years, timber resources in the Peruvian Amazon have not been managed and are exploited in the Peruvian Amazon at an alarming and unmanaged rate. Networks of streams and rivers facilitate access to these timber populations. Because of intense extraction in the past, few timber species currently can be observed along waterways. This is especially true for species that are most important in domestic and international markets, such as *caoba* (*Swietenia macrophylla,* Meliaceae), *cedro* (*Cedrela odorata* and *C. fissilis,* Meliaceae), and *tornillo* (*Cedrelinga cateniformis,* Fabaceae).

As nearby timber sources are exhausted, loggers look for timber in more remote places, placing the long-term survival of timber species in danger. Moreover, people are switching to lesser timber species, such as *cumala* (*Virola* spp. and *Iryanthera* spp., Myristicaceae), *catahua* (*Hura crepitans*, Euphorbiaceae), *lupuna* (*Ceiba* spp., Bombacaceae), *moena* (*Ocotea* spp., *Nectandra* spp. and *Licaria* spp., Lauraceae), and *pashaco* (*Parkia* spp., Fabaceae). The switch to lesser-known timber species is occurring especially in those areas where little timber remains.

In this bleak context, our observations during the inventory were somewhat reassuring. We encountered reproductive populations of cedro, tornillo, *cachimbo caspi* (*Cariniana*, Lecythidaceae), moena, and others, especially in the Divisor headwaters. These areas currently are serving as refuges, where seeds can be produced and dispersed to other areas. Cedro and tornillo were the most abundant species, and are wind- and water-dispersed.

However, other observations during the inventory were more troubling. In the Tapiche area we found stumps of cedro, tornillo, and the medicinal plant *sangre de grado* (*Croton lechlerii*, Euphorbiaceae). These stumps appear to date to as long as 20 years ago. We saw no reproductive trees in Tapiche, only juveniles that may reflect pre-felling reproduction, or seeding into these areas from refuge populations.

Our observations underscore the importance of conserving the headwaters that originate in the Sierra del Divisor ridge complex. This protection would allow populations in heavily affected areas to recuperate, and would be an important step towards the long-term persistence of these timber species.

NEW SPECIES, RARITIES, AND RANGE EXTENSIONS

During the inventory we collected more than 500 fertile specimens. Currently we suspect that about ten species may be new to science. Below we briefly describe some of these, as well as several species that are rare or that represent substantial range extensions.

On the hill crests with stunted vegetation we found at least two species potentially new to science. The first is a fruiting specimen found only in the stunted forests at Divisor, a "bonsai" *Parkia* (Fabaceae s.l., Nállarett Dávila collection number ND1696), which also was seen but not collected at 1,500 m in the Cordillera Azul (Foster et al. 2001). Since our record in Sierra del Divisor is from only ca. 400 m, the two localities currently known for this species span an elevational gradient of more than 1,000 m. Also, only one widespread species of *Aparisthmium* (Euphorbiaceae) is known in the Neotropics, *A. cordatum*. However, we found individuals on the ridge crests in Divisor that appear to be a new species in this genus (ND1882, ND1884), with much smaller and more leathery leaves (Fig. 4C).

Two large trees in the Clusiaceae also appear to be new species. One, a *Moronobea* (ND1924), has a much smaller white flower than the other species known from this genus and was found growing in the

taller crest forest in Divisor. Another, a *Calophyllum* (ND1569) found in the valleys at Ojo de Contaya, has smaller leaves compared to the well-known timber tree, *C. brasiliense*, and has green (not white) sap in its trunk and leaves (Fig. 4J).

Two species of *Calathea*, both found in Ojo de Contaya and Tapiche, probably are new to science. One has leaves that vary from green to a variegated dark- and light-green leaf, with a green inflorescence and white flowers (Vera Lis Uliana collection number VU1396, Fig. 4H). The other species has leaves with a metallic sheen to its undersides and is known from Acre in Brazil, but remains undescribed (VU1397).

At Ojo de Contaya we recorded three individuals of a rare monocarpic species, *Spathelia terminalioides* (Rutaceae, ND1984), growing alongside a stream, in an open area. This species is known from Cusco and Loreto in Peru, and was recorded during an inventory in Federico Roman, in Pando, Bolivia (Alverson et al. 2003). Another rare species was recorded in Divisor when we found an individual of *Podocarpus* cf. *oleifolius* (Fig. 4B, ND1985). Typically this genus is restricted to montane areas; this species does occur in the lowlands in other parts of Peru, however, but almost exclusively on white sands.

In Divisor, we found *Ficus acreana* (Moraceae, Fig. 4G) a species previously known only from Brazil and Ecuador. A species that we initially suspected to be new, a bipinnate legume, is *Stryphnodendron polystachyum* (Fabaceae). After reviewing our collections from previous inventories, it appears that this species is poorly known but widespread.

THREATS, OPPORTUNITIES, AND RECOMMENDATIONS

Currently, the greatest threats to the flora of Zona Reservada Sierra del Divisor are illegal timber extraction, oil exploration, and mining. During our four-day stay along the Río Tapiche, we observed several boats going upriver to scout timber (Fig. 9A). In addition, communities surveyed by the social inventory team report that there are illegal loggers entering the protected area along most, if not all, of the principal waterways. Oil exploration and mining operations overlay the volcanic areas in the south. Overflights and geological maps of the area indicate that this area is one of the highest conservation priorities.

The Zona Reservada, with its high hills rising up from the Amazon basin, is unlike any other place in the world. In only three weeks in the field we found ca. ten plant species potentially new to science and explored habitats that we had never seen previously in Amazonia (e.g., melastomatales and acidic ridge tops with stunted forest). The headwater areas along the Brazilian border serve as a refuge for timber species overexploited in other parts of South America. Because of its biological singularity and its importance as a source area for timber species, we recommend immediate protection of the Zona Reservada.

Our inventory is the fifth in the Sierra del Divisor/Siná Jonibaon Manán Region, yet there is one obvious area that remains unexplored. If possible, and with the permission of local and national indigenous federations, we recommend that biologists visit the southern area that includes the volcanic cones.

FISHES

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Conservation targets: A unique fish community inhabiting aquatic environments in Ojo de Contaya; the upper Río Tapiche, which forms essential headwater areas for migration and reproduction of important commercial and subsistence species; *Hemigrammus, Hemibrycon, Knodu*s, and *Trichomycterus* species (present in remote streams in Ojo de Contaya and in the hills of Divisor) that represent new records for Peru or possibly species new to science; species of Cheirodontinae present in the Río Tapiche and principal tributaries, including *Ancistrus, Cetopsorhamdia, Crossoloricaria,* and *Nannoptopoma* that are also new to science; ornamental species of Cichlidae, Gasteropelecidae, Loricariidae, Anostomidae, and Characidae in the Tapiche; important commercial and subsistence species that are significant sources of protein for native human communities inhabiting the area, such as *Pseudoplatystoma tigrinum, Brycon* spp., *Salminus, Prochilodus nigricans,* and *Leporinus*

INTRODUCTION

Zona Reservada Sierra del Divisor is located in eastern Peru between the east bank of the Río Ucayali and the Brazilian border, in the departments of Loreto and Ucayali. There are several drainage basins located in this area. The principal north-south basins include those of the Yaquerana, Tapiche, Buncuya, Callería, and Abujao rivers. When these and others rivers whose headwaters form in the Sierra del Divisor are taken into account, there are eleven river basins. Most drain towards the right (east) margin of the Río Ucayali. The Río Yaquerana, located in the extreme northeast corner of the Zona Reservada, is an exception; it drains into the Amazon, almost 400 km downriver from Sierra del Divisor, at Peru's easternmost point in Loreto.

Although the ichthyofauna of this vast region is now under study, significant gaps in our knowledge remain, especially for many of the tributaries of the Ucayali (Ortega and Vari 1986), including the majority of those in the Zona Reservada. Fowler (1945) completed one of the first compilations of the fish diversity of Peru, which listed approximately 500 continental species and noted which species are present in the Ucayali basin. Later, Ortega and Vari (1986) published the first annotated list of Peru's freshwater fish, bringing the total to 736 species. One conservative estimate of Peru's continental ichthyofauna diversity suggests that there could be more than 1,100 species (Ortega and Chang 1998), which places Peru among the ten most species-rich countries in the world with respect to ichthyofauna (Thomsen 1999).

Based on these estimates, the ichthyofauna of the Río Ucayali basin easily could surpass 600 species. This estimate is supported by studies conducted in some tributaries in areas adjacent to the Andes, such as the Pisqui and Pachitea basins (de Rham et al. 2001; Ortega et al. 2003), in areas around Pucallpa (Ortega et al. 1977), and the fish collection of the Museo de Historia Natural de la Universidad Nacional Mayor de San Marcos, Lima. Andean tributaries, such as the Pachitea, harbor more than 200 fish species (Ortega et al. 2003), and 171 species have been recorded at Pucallpa.

Within the Zona Reservada, some ichthyological inventories have been conducted in the most accessible regions of the Ucayali. In 2000, an expedition visited Aguas Calientes in Cerros de Contamana (FPCN/CDC 2001); in 2001, the Río Shesha (a tributary of Río Abujao) was studied (FPCN/CDC 2001); and most recently, the western side of Ojo de Contaya at the headwaters of Quebrada Maquía was explored (FPCN/CDC 2005). These studies report low to moderate fish diversity. The ichthyofauna from the following aquatic environments remains unknown: the sub-basins of the Buncuya, Zúngaro, Callería, and Utuquinía rivers, and the upper Abujao.

During this inventory in the Zona Reservada, we evaluated aquatic environments in three previously unexplored areas in the central portion of Ojo de Contaya and the headwaters of the Río Tapiche. Our primary objective was to determine the presence of fish species, populations, or communities that could be considered conservation targets to support the establishment of a protected area in Sierra del Divisor. In the three sites (Ojo de Contaya, Tapiche, and Divisor) we explored diverse aquatic environments, such as rivers, streams, *aguajales* (palm swamps), *tahuampas* (temporary pools in the forest interior), and lagoons. Our results reveal an interesting ichthyofauna of scientific, sociocultural, and economic value.

METHODS

During 15 days of fieldwork, we studied the greatest number and variety of aquatic habitats that we were able to access from our camps. A local guide accompanied us during each fishing excursion and we walked to each site. We sampled 28 stations, 5 to 13 per camp, and we noted the geographic coordinates of each sampling station and recorded basic characteristics of the aquatic environment being sampled. This information is summarized in Appendix 4.

Of the 28 sampled sites, 23 were lotic environments, either rivers or streams, and 5 were lentic, including two aguajales (at Ojo de Contaya and Tapiche), two lagoons (both at Tapiche), and one

temporary flooded pool, or *tahuampa* (Ojo de Contaya). The lentic environments (aguajal and ponds) were largest at Tapiche, and the tahuampa found in Ojo de Contaya was small. Most habitats in the inventory were clearwater lotic environments; the aguajales, one pool and the tahuampa were blackwater. The oxbow lake at Tapiche was the only whitewater habitat.

We conducted mostly diurnal collections (between 08:00 and 15:00 hours), although we made one nocturnal collection in the Río Tapiche to try to trap species active at night. Water levels of the principal tributaries were low because it was the dry, or less rainy, season. This helped us sample all of the identified habitats and microhabitats more effectively. For example, the average depth of the Río Tapiche was 50 cm, allowing us to walk up to 1 km in the main channel to collect from this microhabitat. Back at the camps during the afternoons, we identified collected material.

We collected fish using 10x2.6-m and 5x1.2-m fine-meshed nets (of 5 and 2 mm, respectively). We used these repeatedly to sweep towards the bank or as traps after disturbing areas serving as refuges, such as places with fallen branches and leaves, rapids with rocky bottoms, and areas along the banks with roots. In major streams, lagoons, and the Río Tapiche, we used a 1.8 m cast-net with 12 mm mesh openings. In the aguajales and shallow, small streams we used a hand net (*calcal*) with a diameter of 40 cm, with a 75 cm bag and netting of 2 mm.

We also used hooks and lines in the Río Tapiche to catch larger fish, such as *tigre zúngaro* (Fig. 5D), *piraña*, and *sábalos*, which were identified and photographed. None of these were preserved as speci-mens. In some clearwater environments, we were able to make direct observations to determine the presence of a few, easily identifiable species without having to collect them. We also used a small sound amplifier to detect the electric fields of gymnotiform fish in environments such as aguajales or in streams with submerged vegetation where they seek refuge during the day because their habits are mostly nocturnal. We had success in some of our attempts to collect individual gymnotiformes after determining their presence in this way.

Collected samples were preserved immediately in a 10% formol solution for 24 hours. In each camp, we identified the species and then transferred them to cotton gauze soaked in 70% ethyl alcohol for transport to the Museo de Historia Natural, Lima, where they were added to the scientific collection of the Department of Ichthyology. In the field, we were unable to identify various groups to species level and provisionally sorted them to morphospecies. Further identifications for these morphospecies require additional laboratory study. This methodology has been applied in other rapid inventories, such as Yavarí and Ampiyacu (Ortega et al. 2003; Hidalgo and Olivera 2004).

RESULTS

Description of the aquatic habitats at each camp

Ojo de Contaya

From satellite images we determined that the streams in this site drain northeast towards the headwaters of the Río Buncuya, which eventually flow into the east bank of the Río Ucayali, downriver of Contamana. Aquatic habitats at this campsite correspond almost entirely to first, second, and third order streams and are covered by closed forest canopy, thereby having very little primary productivity. Other aquatic habitats present included one aguajal and a temporary flooded pool. Both were small blackwater habitats (less than 10 m in length) with muddy bottoms covered by organic material and fallen leaves.

We identified only one stream wider than 5 m. The other streams are characterized by clear water, an average width of 4 m wide, an average depth of 30 cm, and a maximum depth of 70 cm (only in the largest stream). Their velocities were slow to moderate, they had narrow banks, and almost all streams had sandy bottoms. Only one stream had a rocky bottom in a 200-m long section, with areas of rapids that reached 3 m in height. There was a large amount of allochthonous plant material, such as logs, branches, and leaves. This material provides both refuge and food for electric fish,

small catfish, smaller characids, and many aquatic invertebrates.

This region is in a hilly area without any significant flooded areas, except for one tahuampa. These drainage systems are far from lowland areas where larger rivers such as the Buncuya and Tapiche are located. We sampled 13 stations at this camp.

Tapiche

This site is part of the headwaters of the Río Tapiche, which flow into the right bank of the Río Ucayali at the latitude of Requena. From this camp, we surveyed the Río Tapiche, two large streams on the right bank of the Tapiche, a large aguajal, one forest pool, and an oxbow lake still in contact with the river.

The most representative habitat in this site is the Río Tapiche, which is a medium-sized river with clear, transparent waters. It is approximately 35 m wide and shallow (50 cm average depth). Its sandy bottom has some piled, fallen, and submerged trunks and the banks vary from narrow, in straight sections, to broad at some bends where sandy beaches are found. The river-edge vegetation varies. Along some parts of the river's course, it barely covers the banks, while in others it stretches out over the river 3 m from the water's edge, creating microhabitats suitable for some fish species, such as *carachamas* and some Characiformes. The course of the Río Tapiche is meandering and forms oxbows that we also evaluated during this inventory.

The streams had clear, completely transparent water with almost no color, or just slightly green. Average stream width was 8 m. As at Tapiche, the streams had sandy bottoms and narrow banks with riparian vegetation covering part of the watercourse. The presence of fallen logs and leaves was more prevalent in these habitats, and only one stream close to the camp had sections of "rapids" close to hilly areas. These rapids had rocky bottoms where the force of the current was considerable, although the depth did not exceed 30 cm.

We also surveyed one aguajal. It was a swampy blackwater, with variable-sized pools 1-10 m wide and a considerable amount of vegetal debris. Its water was dark maroon (black) and transparency varied depending on depth, which did not exceed 40 cm. It did not have banks, or had only very reduced banks, and its muddy bottom contained a large amount of organic material. The ponds were more variable. One whitewater oxbow lake had been formed recently and almost maintained its contact with the river. A more mature forest surrounded the other pool, which was blackwater, older and farther from the river. Both ponds had very muddy bottoms, reached depths of 2 m, and harbored more fish than the aguajal. We sampled ten stations at this site.

Divisor

The site forms part of the Río Tapiche headwaters that originate in the hills above the right banks of the river, close to the border with Brazil. The area is hilly, and all of the creeks and small creeks identified at this site flow into the main stream, which passed by our camp.

The drainage system close to the camp corresponded to this largest (5-m wide) stream. All of the streams were clear water, with mostly sandy bottoms and some rocks, and fallen trunks and branches piled up in various areas. The slope of the watercourses was steepest at this camp, and small rapids formed. In some sections, vertical rocky and clay walls flanked the streams where relatively deeper pools formed (up to 70 cm deep) and we could observe schools of Characiformes. Unlike the camp at Ojo de Contaya, we did not observe any lentic environments, such as temporary pools or aguajales. We sampled five stations from this camp.

Species diversity and community structure

From our collections and observations (3,457 individual fish), we generated a preliminary list of 109 species representing 82 genera, 24 families, and 6 orders (Appendix 5). This diversity is relatively moderate for the Peruvian Amazon, e.g., when compared to other areas further north in Loreto where larger numbers of species have been recorded. However, when considering the types of habitats studied and previous studies conducted in the

Zona Reservada, the number of species is greater than we expected (see Discussion). Of the 109 species, almost 60 (56%) were not identified to the species level and require further study. One individual was only identified to the subfamily level (Cheirodontinae), and also requires more detailed review.

The most species-rich groups are fishes in the order Characiformes (fishes with scales, without fin bones), with 56 species, and the Siluriformes (catfish, fishes with barbels), with 33 species. Together these orders represent 81% of the total diversity registered during the inventory. This dominance is similar to that seen in other inventories, such as Yavarí (Ortega et al. 2003), Ampiyacu (Hidalgo and Olivera 2004), and for the Amazon region in general (Reis et al. 2003). Of the other four orders, the Perciformes (fishes with bones in unpaired fins, like cichlids) and Gymnotiformes (electric fishes) represented 15% (16 species) of the total ichthyofauna recorded in the Zona Reservada, and the orders Cyprinodontiformes *(rivúlidos*) and Synbranchiformes (*anguilas de pantano* or *atingas*) were represented by 4 species (4%).

The families Characidae and Loricariidae have the highest number of species in the neotropical region (Reis et al. 2003), and we observed their dominance during our inventory as well. Several of the probable new records for Peru or species new to science in the inventory area belong to these families (Appendix 5). At the family level, Characidae had the greatest number of species (40 species, or 37% of the total number of species), followed by the Loricariidae, with 14 (13%). Together, these two families represent half of the ichthyofauna recorded in the Zona Reservada during this inventory. Other families with significant presence included Cichlidae (8 species), Heptapteridae (6), and Crenuchidae and Gymnotidae (4 each). Acestrorhynchidae, Aspredinidae, Curimatidae, Gasteropelecidae, Parodontidae, Prochilodontidae, Pseudopimelodidae, Sternopygidae, and Synbranchidae were represented by one species each.

Community structure shows a large number of small to medium-sized species (adults measured between 5 and 15 cm long), represented by 68 species (64% of the ichthyofauna recorded during the inventory). Primarily, these species are members of the Characidae (*Hemigrammus,* Cheirodontinae), Lebiasinidae (*Pyrrhulina*), and Crenuchidae (*Melanocharacidium, Microcharacidium*) within the Characiformes, and of the Heptapteridae (*Pariolius, Imparfinis,* and *Cetopsorhamdia*; Figs. 5C, 5F), Loricariidae (*Otocinclus, Ancistrus, Nannoptopoma, Peckoltia*), and Trichomycteridae (*Stegophilus, Trichomycterus*) within the Siluriformes (catfish). Small species of other groups, like Rivulidae and Cichlidae (*Apistogramma, Bujurquina*), also were present. Some adult Characidae species, like *Tyttocharax* and *Xenurobrycon,* were smaller than 2 cm and are an example of miniaturization that occurs in some species in Amazonia (Weitzman and Vari 1988).

Close to 25 species (22% of the total) correspond to groups whose adults can exceed 20 cm in length. In the Río Tapiche, we observed individuals of this size, such as *sábalos* (*Brycon* spp. and *Salminus*), *lisa* (*Leporinus friderici*), *boquichico* (*Prochilodus nigricans*), *huasaco* (*Hoplias malabaricus*), catfish-like *bocón* (*Ageneiosus*) and *cunchis* (*Pimelodus* spp.), and *añashua* (*Crenicichla*), a cichlid. The largest species we observed during the inventory was the *tigre zúngaro* (*Pseudoplatystoma tigrinum*), which can reach up to 1 m in length (Fig. 5D). Human communities use all of these species, which inhabit large rivers, such as the Río Tapiche and its major tributaries. Of these larger species only *Hoplias malabaricus* was recorded at Ojo de Contaya, and at Divisor we observed *Crenicichla*.

Site and habitat diversity

Ojo de Contaya

At this camp, we recorded 20 species belonging to 12 families and 6 orders. The richest orders were the Characiformes (9 species), Gymnotiformes (4), and Siluriformes (3). Two *Rivulus* species represented the Cyprinodontiformes, and Perciformes and Synbranchiformes each had one species. The fish community is poor in species, highly variable at the order level, and is notably distinct compared to communities in previous studies in the Zona Reservada.

Most (ca. 16) species were present in all streams at this camp, which demonstrates high community homogeneity. Other common species in this site were *Chrysobrycon, Ancistrus*, *Rivulus*, and *Pariolius*. The latter is a heptaperid catfish described from the Río Ampiyacu (north of the Amazon) and recorded in the Ampiyacu and Matsés inventories at low abundance and capture frequency. At Ojo de Contaya *Pariolius armillatus* was present in almost all streams and was found to be more abundant here than in previous inventories. It was the fourth-most abundant species for this site.

We found greater species diversity and abundance in the streams than in the lentic environments (tahuampa and agujal): we registered 19 species for the first and 8 species for the second habitat type. *Pyrrhulina* was found only in lentic environments, and was the second-most abundant species at this camp (129 individuals, 13% of the total number of individuals). A recent study of aguajales in Madre de Dios found a species of this genus to be the most frequently encountered fish in this habitat (Hidalgo, pers. obs.).

From this site, it is likely that three species from the genera *Hemibrycon, Hemigrammus*, and *Rivulus* are new records for Peru or are species new to science. Of these, *Hemigrammus* was the most common and abundant species for this site because it was present in every habitat (including the aguajal and tahuampa) and represented 50% of the total abundance of fish at this site (Appendix 5). This species has not been recorded during previous inventories conducted in the Zona Reservada, not even in the western area of Ojo de Contaya (FPCN/CDC 2005).

Tapiche

We recorded 94 species corresponding to 24 families and 6 orders at this site. Species richness was the greatest for the Characiformes, with 56 species (60%), followed by the Siluriformes, with 32 species (34%). Eight species were Gymnotiformes (9%), 7 were Perciformes (7%), and Cyprinodontiformes and Synbranchiformes had 1 species each. This site was the most diverse of all three camps surveyed in the inventory.

Diversity was highest in this site because we evaluated a greater variety of aquatic habitats and aquatic environments were larger in size when compared to similar habitat types at Ojo de Contaya and Divisor. The Río Tapiche is the most important habitat at this site, with 58 species, which is almost two thirds of the site's diversity. In addition, all of the commercially important species were registered here (ca. 8 species). The principal streams also harbored a moderate number of species (ca. 35), mostly small fishes and several commercially important ones, such as *sábalos de cola negra* (*Brycon melanopterus*) and *lisas*.

We identified 35 species in the ponds at Tapiche. The most abundant were *Serrapinnus piaba* and *Cichlasoma amazonarum*. In the whitewater oxbow in front of the camp, we recorded several species fished for human consumption, such as boquichicos, huasacos, and lisas, all living in healthy populations. We found relatively few species (9) in the blackwater pool, where small *Serrapinnus piaba* were dominant. The most abundant species in the aguajal were *Hemigrammus* sp. 3 and *Pyrrhulina* sp. 2, which were unique for this habitat.

We found eight species important to Amazonian fisheries, principally scaly fish, such as sábalos, boquichicos, and lisas, and large catfish like the tigre zúngaro (Appendix 5). We collected or observed these species in the Río Tapiche, in the oxbow in front of the camp, and in the lower portions of the major streams. Of these species, the sábalo cola negra was the most common; it was seen in the river and major streams in schools of ten or more individuals.

We expect that seven species registered in this site will be new to science, or at least new records for Peru. They belong to the genera *Hemibrycon, Ancistrus, Crossoloricaria, Cetopsorhamdia* (Fig. 5C), *Nannoptopoma, Hypoptopoma*, and *Otocinclus*. The small catfish *Cetopsorhamdia* and *Crossoloricaria* were found among submerged leaves in the streams and in the sandy bottom of the Río Tapiche, respectively.

Divisor

We recorded 24 species at this site corresponding to 9 families and 5 orders. The Characiformes were the most diverse, with 10 species, followed by the Siluriformes, with 7. We also recorded 3 rivulids, 2 electric fish, and 2 cichlids.

Only clearwater streams were observed at this site. The most frequently captured and most common species were *Hemibrycon*, *Knodus* sp. 2, *Melanocharacidium*, *Creagrutus*, and *Ancistrus*, all small-sized. Six species were unique to this site, including *Trichomycterus, Knodus* sp. 2*, Rhamdia quelen*, and a *Rhamdia* sp.

Fish diversity at Divisor is greater than that of Ojo de Contaya but shared more species in common with Tapiche (16 species, or 67% of this site's total). The most common species was *Knodus* sp. 2*,* present in all sampled sites, followed by *Melanocharacidium, Gymnotus*, and *Ancistrus* sp. 2, which were present in all but one of the sampled sites. At least three species registered at Divisor probably are new records for Peru or species new to science, including *Trichomycterus* sp. (Fig. 5E), *Knodus* sp. 2*,* and *Rhamdia* sp. (species that were not recorded at the other inventory sites).

Site comparisons

We found very few species shared among all three sites. There were only five, including *Chrysobrycon, Hemibrycon, Characidium* sp. 1, *Pariolius armillatus*, and *Rivulus* sp. 1. Their abundance varied greatly at each site. *Rivulus* sp. 1 was the only one of these common species also found in the aguajales; the other four species only were found in streams.

We noticed the greatest similarities between Tapiche and Divisor, which share the same drainage. We found that only 25% (6 of 24) of Divisor's species were not recorded downstream at Tapiche despite their proximity (ca. 5 km between the two). Likewise, we found that 35% (7 of 20) of the species registered at Ojo de Contaya were not encountered elsewhere, and this site was more similar to Tapiche (55%) than to Divisor (35%).

At the outset, we thought that the ichthyofauna of Ojo de Contaya and Divisor could be similar because the sites share similar water characteristics (Appendix 4) and hilly topographies. However, it appears that small, geographically separated hydrographic systems can contain different fish communities, reinforcing the hypothesis that each medium or small sub-basin could harbor a distinct fish fauna (Ortega and Vari 1986; Vari and Harold 1998; de Rham et al. 2001).

At the trophic level, the communities of the hilly areas of Ojo de Contaya and Divisor appear similar, both containing species adapted to live in unproductive waters that rely on allochthonous plant material originating from the nearby forest.

Interesting records

The fish community of Ojo de Contaya is unique and very different from what was registered in nearby areas. Even though a small number of species were present, we recorded all orders of fishes present in the inventory, which demonstrates outstanding diversity. We expected to find few species in these ecosystems but we registered six orders, as many as were recorded at Tapiche and even one more than at Divisor. Only two orders, Characiformes and Siluriformes, were recorded in the Serrania de Contamana, and only four on the western side of Ojo de Contaya (FPCN/CDC 2001 and 2005, respectively).

We estimate that at least 14 species (12% of the ichthyofauna) are potential new records for Peru or are species new to science (Appendix 5). Already, four have been confirmed as new to science according to the specialists consulted, including *Nannoptopoma*, *Otocinclus, Hypoptopoma*, and *Cetopsorhamdia* (Fig. 5C). The genus *Crossoloricaria* has two species in Peru, one in Madre de Dios and the other in central Ucayali, specifically from the Aguaytía and Pachitea drainages. Our specimen most resembles the species described from Madre de Dios. However, it appears that both known *Crossoloricaria* species are restricted to the original type locality and nearby areas. The species we recorded at Tapiche may represent a third (as yet

undescribed) species, which could be the same suspected new species recorded in the Cordillera Azul (de Rham et al. 2001).

Another interesting find was the abundance of locally and regionally important fish, such as sábalos, boquichicos, and lisas, with relatively abundant populations for a medium-sized river and a headwater river. In addition, we recorded large catfish, such as tigre zúngaro, which is highly valued for its flavor. These species migrate towards the headwaters to spawn, especially the Characiformes, which form large schools known as *mijanos* in the Peruvian Amazon. During these mijanos, large quantities of fish can be caught and represent a source of essential protein for riparian inhabitants in the zone. We also observed species of ornamental value, such as glass fish (*Leptagoniates steindachneri,* Fig. 5B), lisas (*Abramites hypselonotus*), colored carachamas (such as *Peckoltia,* Fig. 5A), among other species that should be protected because of their uniqueness. According to fishery statistics in Loreto, various such species are extracted from Río Tapiche.

Pariolius armillatus was relatively abundant in Ojo de Contaya and rare in other inventories of lower areas, such as Ampiyacu (Hidalgo and Olivera 2004) and Matsés (Hidalgo and Velasquez 2006). According to Bockmann and Guazzelli (2003) the presence and abundance of catfish like *Pariolius* is an indicator of good water quality, and could be used as an efficient environmental indicator. In the three camps, we observed species of Heptapteridae primarily inhabiting the streams.

DISCUSSION

Fish diversity in Zona Reservada Sierra del Divisor is moderate (109 species). The number of species is relatively low compared with the diversity encountered in other regions recently inventoried north of the Zona Reservada, e.g., Yavarí (240 species) and Ampiyacu (207 species), and is much less diverse than estimates for the entire Ucayali Basin (more than 600 species). Nonetheless, we must consider that there are a large number of regional habitats that are not found in the area inventoried in the Zona Reservada. Many such habitats correspond to lower and flooded areas, such as in Yavarí, that favor greater species richness and fish abundance, and a greater number of lentic habitats, such as pools, and an increased number of blackwater habitats.

In the Cordillera Azul, probably the area most comparable to Sierra del Divisor, 93 fish species were recorded by de Rham et al. (2001) from 200 to 700 m altitude. Our results for Sierra del Divisor, during a similar amount of time as the survey in Cordillera Azul, surpass this value. Analyzing species composition, we find that there is a similarity in the presence of sábalos, tigre zúngaro, and several Characidae, but in the Zona Reservada several unique species that could be new to science stand out.

One aspect that caught our attention was that there are very few similarities between our results and those reported in previous inventories of the ichthyofauna within the Zona Reservada, which suggests apparent isolation of fish communities. The FPCN/CDC survey (2001) recorded 19 fish species from two orders (Characiformes and Siluriformes) in the aquatic environments of the Serrania de Contamana. In the sites most similar to the Serrania de Contamana, the Ojo de Contaya and Divisor, we found six and five orders, respectively.

The only genus found at both Ojo de Contaya and the Serrania de Contamana was a carachama (*Ancistrus*), and it is possible that there are different species at each site. Notably 60% of the species we recorded at Ojo de Contaya had not been recorded during the 2004 evaluations of the headwaters of the Pacaya and Maquía streams that emerge on the western slope of this geological formation.

We believe that species composition in small hydrographic systems, such as first order streams, could vary greatly even among streams that are geographically proximate if these streams belong to different watersheds. This concurs with hypotheses previously put forward (Vari 1998; Vari and Harold 1998). Mountainous areas, such as the Serrania de Contamana and Ojo de Contaya, can act as dispersal barriers for aquatic organisms that

belong to different watersheds. This has been observed for species of *Astroblepus* and *Trichomycterus* in Andean regions, such as Megantoni (Hidalgo and Quispe 2005). Similarly Barthem et al. (2003) have shown that the ichthyofauna of major rivers and flooded areas can be similar, while the ichthyofauna of nearby streams can be substantially different.

Considering that the Zona Reservada includes the headwaters of approximately 11 rivers (the Yaquerana, Blanco, Tapiche, Buncuya, Zúngaro, Callería, Utuquinía, and Abujao, among others), it is likely that the drainage systems in the hills that contain first order streams harbor unknown ichthyofaunas specialized to these habitats, as we observed in the relatively low mountains of Ojo de Contaya. During an overflight of the southern part of the Zona Reservada, we observed higher hills (ca. 900 m), suggesting this area is an interesting one for future study. We estimate that between 250 and 300 species of fishes could exist within the Zona Reservada.

THREATS, OPPORTUNITIES, AND RECOMMENDATIONS

Threats

Deforestation by illegal timber extraction is a threat to aquatic communities. In headwater regions, such as the Ojo de Contaya and Tapiche basins, tierra firme forest and fish species are directly related. Here, primary production is much reduced in comparison with flooded areas located in the lowland portions of drainage basins. In aquatic systems with low primary production, the forests provide substantial food resources for fish species in diverse ways (for example, terrestrial invertebrates, fruits, seeds, trunks, and pollen). Species inhabiting these streams, such as the catfish (*Ancistrus*) or characids (*Hemibrycon, Creagrutus, Characidium, Apareiodon*), use these resources and have adapted to these conditions.

Removing bank vegetation causes erosion, sedimentation, and habitat (refuge) loss, and decreases the availability of food. Effects on habitat include changes in the hydrological regime, which could result in the drying up of bodies of water, especially in small streams that are used as routes to extract timber. These habitat changes lead to a loss of diversity and potentially even species extinctions, especially in species adapted to aquatic environments that rely almost exclusively on the forest for their food sources. According to Sabino and Castro (1990), in Mata Atlántica streams where riparian vegetation was reduced, the average number of native species went from about 20 to less than 9.

In addition to these effects from timber extraction, the riverbeds and major streambeds can be degraded if dams are built to facilitate timber removal. This creates a barrier for species movement, traps fish (making them more vulnerable to massive fishing), and also affects reproduction and recruitment.

Another threat is the use of non-selective fishing methods, e.g., poisons, dynamite, and drag nets with small mesh size, which indiscriminately kill all fishes in a population. Over the short term, this drastically reduces available stock, and over the medium and long term the fish resources—critical for local human communities—are depleted. According to the local people interviewed during the social inventory, the use of toxic substances, such as Tiodan, for fishing considerably has reduced populations of *arahuana* (*Osteoglossum bicirrhosum*). This species was not recorded during our inventory, but is present in the Zona Reservada in the Río Callería and the lower part of the Río Tapiche.

Large-scale commercial fishing during fish reproductive periods is another threat, especially for migrating species that become more vulnerable to fishing because they migrate before the rains, when water levels in many tributaries are at their lowest levels.

Recommendations

Protection and Management

The aquatic environments of the Zona Reservada provide fish resources for the communities living in these river basins, as evidenced by strong fishing pressure in the lower reaches closer to major rivers, such as the

Ucayali and Amazon. Except for the Parque Nacional Cordillera Azul, there is no other protected area similar to the Zona Reservada in Loreto.

Ojo de Contaya is a unique area with fish species that have little or no commercial value for consumption or as ornamentals, but have great scientific value. The protection granted to this area could be stricter than the rest of the hilly areas.

Protecting the headwaters has two main advantages. First, it helps avoid the disturbances caused by deforestation that alter waterways, thereby protecting the biological and hydrological conditions for those species that depend on forest resources. Second, conserving these habitats favors any migratory species that are present or that could be present, such as other large catfish (*zúngaro*, *dorado*) that may use these areas to spawn.

Local communities in the region should safeguard the Zona Reservada from unauthorized, non-local fishermen, who enter oxbow lakes and rivers and employ harmful and non-selective fishing methods. In addition, there should be controlled fishing during the times of year when the resources are most vulnerable (e.g., during migration). Local residents should participate in the final process of determining land-use classifications for the area because they are the principal stakeholders caring for the natural resources.

Research

More inventories are needed in the headwaters of other rivers with sources in Divisor, including the Blanco, Zúngaro, Bunyuca, Callería, and Utuquinía. The mountainous, southern portions of the area that reach higher altitudes should be studied as well.

Ecological research is need in the headwater areas to understand the migration dynamics and reproduction of fish species. Recent studies in Peru have begun to investigate where large catfish, such as dorado (*Brachyplatystoma rousseauxii*), spawn. Determining the presence of larva in these areas could provide indications about these processes (Goulding, pers. comm.).

We need to determine which species are most often captured in the area by fishing, which areas are the most important fishing zones, which fishing methods are used, and the relative abundance and use of the species (i.e., an evaluation of aquatic resources). This research would help to elucidate the area's fishing capacity and help guide environmental education programs about the negative medium- and long-term impacts of toxic substances used in fishing.

In areas with larger human populations, aquaculture activities could be encouraged (after feasibility studies were completed). These could serve as a source of animal protein during the rainy season and provide economic income from selling surplus fish. We must emphasize that these activities should be undertaken only using native, preferably fast-growing species that have low production costs, such as boquichicos, sábalos, and cichlids, among others. Species that are rare in the region, such as arahuana (*Osteoglossum bicirrhosum*), also could be raised and used to replenish wild populations.

AMPHIBIANS AND REPTILES

Authors / Participants: Moisés Barbosa de Souza and Carlos Fernando Rivera Gonzales

Conservation targets: Amphibian communities that reproduce and develop in forest and stream environments (*Centrolene, Cochranella, Hyalinobatrachium, Colostethus, Dendrobates,* and *Eleutherodactylus*); rare species that represent new records for Peru (*Osteocephalus subtilis, Micrurus albicinctus*); species of economic value threatened in other parts of their distributions (turtles, tortoises, and caiman)

INTRODUCTION

Herpetological studies have been conducted in the Peruvian Amazon over the past three decades. There are few sites, however, with comprehensive information about the composition of the amphibian and reptile communities (Crump 1974; Duellman 1978, 1990; Dixon and Soini 1986; Rodríguez and Cadle 1990;

Duellman and Salas 1991; Rodríguez 1992; Rodríguez and Duellman 1994; Duellman and Mendelson 1995; Lamar 1998).

There have been few long-term herpetological studies in the region. Our inventory was situated south of the Amazon and east of the Río Ucayali, within Zona Reservada Sierra del Divisor, which is part of a massif of low mountains that forms the Peru-Brazil border. Previous short-term inventories were conducted in the Serrania de Contamana in November 2000 (FPCN/CDC 2001); in the southwestern portions of the Ojo de Contaya in October 2004 (Rivera 2005); in the northern portion of the Zona Reservada in November 2004 (Gordo et al. 2006); along the upper Río Shesha, in the southeastern portion of the Zona Reservada in January 2001 (FPCN/CDC 2001); and in the southwestern portion of the Zona Reservada in July 2005 (Rivera, unpublished data). Additionally some herpetological surveys were conducted between 1990 and 2002 in the Parque Nacional da Serra do Divisor and the Alto Jurua Extractive Reserve area, in adjacent Acre, Brazil (Souza 1997, 2003).

METHODS

We sampled three sites in the Zona Reservada over 16 days. At each site we surveyed transects that covered as much heterogeneous habitat as possible (creeks, plains, ridge crests, etc.). Within these habitats we sampled as many microhabitats as possible, including the litter layer, decayed wood, foliage and branches of shrubs, tree buttresses, and bromeliads. Local guides assisted us throughout the inventory.

Our sampling effort varied between the three sites: six days at Ojo de Contaya, and five days each at Tapiche and Divisor. To search for reptiles and amphibians we hiked slowly, mainly at night, and continued the following day in the morning along the same transect. The distance we covered depended on the abundance of the species encountered, topography, and the type of vegetation. Each survey varied between 8 and 10 hours, totalling 280 observation hours. We relied on opportunistic observations and collections. Frog vocalizations helped us to locate individuals and many of these were tape-recorded.

We used identification keys, field guides, and pictures to identify species. Most species were identified in the field, photographed and released. When field identification was not possible we collected a voucher specimen for further study. Collections were deposited in the Museo de Historia Natural de la Universidad Nacional Mayor de San Marcos, Lima.

RESULTS

We registered 109 species: 68 amphibians and 41 reptiles (Appendix 6). Two species, a frog and a snake, appear to be new records for Peru. We need to confirm identifications for 15 species of frogs: *Centrolene* (1 species), *Cochranella* (1), *Hyalinobatrachium* (2), *Colostethus* (3), *Epipedobates* (1), *Osteocephalus* (2), *Adenomera* (1), and *Eleutherodactylus* (4). Some of these, especially *Eleutherodactylus* sp. 4 (Fig. 6C), might be species new to science. Within the amphibians we recorded 67 species in the order Anura, represented by 6 families (Bufonidae, 4 species; Centrolenidae, 4; Dendrobatidae, 9; Hylidae, 25; Leptodactylidae, 23; and Microhylidae, 2), and one species in the order Caudata in the family Plethedontidae. Of the 41 reptile species, 21 belong to the suborder Squamata, representing five families of snakes: Aniliidae (1 species), Boidae (3), Colubridae (14), Elapidae (1), and Viperidae (2). Within the suborder Lacertilia we recorded 17 species belonging to six families: Gekkonidae (3), Gymnophthalidae (7), Polychrotidae (3), Scincidae (1), Teiidae (2), and Tropiduridae (1). We recorded one species in the order Crocodylia (family Crocodylidae), and two families in the order Chelonia: Testudinidae (1) y Podocnemidae (1).

Ojo de Contaya

This site was located in the center of the geological massif known as the Ojo de Contaya, 53 km east of Contamana. The topography is hilly, with variable slopes and creeks draining in many directions. The lower parts of the valleys apparently flood seasonally.

At this site we recorded 43 species: 29 amphibians and 14 reptiles. Eleven species were encountered during the inventory only at Ojo de Contaya. Among these was *Bolitoglossa altamazonica*, the only salamander species we found during the inventory. Our record of the frog *Osteocephalus subtilis* (Hylidae) represents a western extension of its distribution. This species previously was known only in Brazil.

Tapiche

The second site we sampled was located on the upper Río Tapiche, 73 km east of Ojo de Contaya, near the base of the Sierra del Divisor. This area seems to represent the largest flooded area within the Zona Reservada. Sampled transects were situated on both banks of the Río Tapiche in various habitats, including river edges, creeks, old terraces, a palm swamp, and an oxbow lake. The diversity of these habitats was reflected in the number of species that we found. Of the 66 species we recorded at this site, 40 were amphibians and 26 reptiles. More than half of the species (36) registered in Tapiche were found only here.

One of our most remarkable findings was an individual of the venomous snake *Micrurus albicinctus* (Fig. 6E), which represents the first record for Peru and a significant extension of its known range to the west. This species previously was known only from the Brazilian states of Acre, Mato Grosso, Rondonia and Amazonas. *Dendrobates quinquevittatus,* a poorly known species in Peru, was found at this site in low densities and always associated with the presence of a species of bamboo, locally known as *marona*.

We recorded several species of economic importance at Tapiche. *Podocnemis unifilis* (known locally as *taricaya*) is one of the two species of turtles that we found here. It is considered a vulnerable species. Both its eggs and meat are highly prized by the region's inhabitants for subsistence and commercial uses. At Tapiche we found healthy populations of these species, which use the sandy beaches to lay their eggs. *Geochelone denticulata* (known locally as *motelo*), the other turtle species that we found at this site, also is of economic importance in the area, and its eggs and meat are important for local people. We also recorded *Paleosuchus trigonatus* (dwarf caiman), another species of economic importance in the region.

Divisor

Our third camp was located 6 km east of Tapiche in the core of the Sierra del Divisor, close to Brazil. Physiographically, this site was similar to Ojo de Contaya, however there were some habitats here that were either drier or wetter habitats than at Ojo de Contaya, including the drier ridgetops and the more humid valleys along streams. The trail system connected the majority of the habitats at this site from the ridge crests to the valley bottoms, as well as the transitional zones in between.

Here we recorded 52 species: 32 amphibians and 20 reptiles. As at Tapiche, we found many of these species (22 out of 52, or 42%) only at this site during the inventory. We recorded *Osteocephalus subtilis* (a species also recorded in Ojo de Contaya), and a species of *Eleutherodactylus* potentially new to science (on the slopes near the ridge crests where there was an abundance of a terrestrial bromeliad, Fig. 6C). A species of *Bachia*, a lizard with reduced limbs and considered rare with few records in Peru, also was present here. *Dendrobates quinquevittatus*, another poorly known species, was abundant here and was found inside a bromeliad (*Guzmania lingulata*). At Tapiche we found the same species living in the stem internodes of a bamboo, suggesting that this frog may be responding to similar structural features in these different plant species.

DISCUSSION

We recorded 109 species of amphibians and reptiles during the inventory. We expect that with additional surveys, especially during the wet season and in the southern portions of Zona Reservada Sierra del Divisor, the regional herpetofauna will surpass 200 species. This reflects species recorded in previous inventories in the Zona Reservada, as well as inventories in neighboring

Acre, Brazil that have recorded 190 species: 125 amphibians, and 65 reptiles (Souza 1997, 2003).

Comparison among the inventory sites

We recorded the highest species richness of reptiles and amphibians at Tapiche (66 species), followed by Divisor (53) and Ojo de Contaya (43). The high diversity at Tapiche might be related to the greater habitat heterogeneity (palm swamps, várzea, tree fall gaps, oxbow lakes, river, primary and secondary forest) and its lower elevation compared to the other sites. At Tapiche we recorded amphibian species typical of open areas and lowlands in the Amazon, with a predominance of Hylidae, many species of which depend entirely on bodies of water for their reproduction. Ojo de Contaya and Divisor differ only slightly in the number of species, with a predominance of the Leptodactylidae.

Although Ojo de Contaya and Divisor share similar topographic and vegetation characteristics, only 13% of the species occurred at both sites. The difference may be attributed to the rainfall during the days we sampled at Divisor, causing some amphibians, especially among the Leptodactylidae, to enter a reproductive phase.

Differences in amphibian species richness among sites are related in part to reproductive behavior, which is considered an important factor in determining community structure. All of the most abundant species rely on the rainy season for their reproduction. For example, *Hyla boans* and a species of the *Bufo margaritifer* group breed at the edges of creeks and rivers; *Osteocephalus deridens*, *Dendrobates ventrimaculatus*, and *D. quinquevittatus* breed in water stored in bracts in the axils of plants, hollow bamboo internodes (*Chusquea* sp.), and in trees; *Colostethus* spp. breed in the humid ground litter; *Adenomera* spp. breed in small burrows built in the ground; and Centrolenidae lay their eggs on the leaves of vegetation overhanging edges of streams and rivers.

The most abundant lizard species were *Anolis fuscoauratus* at Ojo de Contaya and *Anolis trachyderma* at Tapiche.

OPPORTUNITIES, THREATS AND RECOMMENDATIONS

Logging, mining, and fishing with poisons present threats to the amphibian community within the Zona Reservada. We did not observe evidence of hunting of turtles and caimans, but the presence of loggers in the Río Tapiche headwaters could increase the hunting pressure on these species and decrease their population sizes through egg collection and hunting of adults.

Some amphibian species are eaten by local inhabitants, such as the *hualo* (*Leptodactylus pentadactylus*) and the *sapo regaton* (*Hyla boans*). Other species, such as dendrobatids and some hylids (e.g., *Phyllomedusa* spp.) have ornamental and biomedical value because of the biologically active components in their skin, including alkaloids, peptides, and proteins. Therefore populations of these species potentially are vulnerable to over-exploitation.

The Zona Reservada contains a unique assemblage of amphibians and reptiles and is a high conservation priority. We recommend additional inventories, especially during the wet season and in the southern portions of the Zona Reservada, as well as workshops with local communities to develop participatory management and sustainable harvesting practices for subsistence species.

BIRDS

Participants/Authors: Thomas S. Schulenberg, Christian Albujar, and José I. Rojas

Conservation targets: Acre Antshrike (*Thamnophilus divisorius*), a recently described species that is endemic to the Sierra del Divisor and the Contaya ridges; other bird species that are restricted to low-stature, ridge-crest forests, especially Zimmer's Tody-Tyrant (*Hemitriccus minimus*) and the white-sands population of Fuscous Flycatcher (*Cnemotriccus fuscatus duidae*); macaws, especially the Blue-headed Macaw (*Primolius couloni*), which has only a small global population and is nearly endemic to Peru; rare or poorly-known species in Peru, such as Rufous Potoo (*Nyctibius bracteatus*) and Fiery Topaz (*Topaza pyra*); game birds (tinamous, cracids) that typically suffer from hunting pressure in other parts of Amazonia

INTRODUCTION

The Sierra del Divisor is the commanding physical feature of the vast regions of central Peru that lie south of the Amazon and east of the lower and central Río Ucayali. Nonetheless the Divisor has remained almost unknown to biologists. This situation is surprising, both in light of the Divisor's prominence and because of its proximity to Pucallpa, a site well known for ornithological collections in the mid-twentieth century (Traylor 1958; O'Neill and Pearson 1974).

Zona Reservada Sierra del Divisor encompasses the Sierra del Divisor itself, which lies along the Peru/Brazil border; other uplifted areas closer to the Río Ucayali (the Serranias de Contamana and Contaya); the headwaters of the Río Yavarí to the north of the Divisor, which abuts the Comunidad Nativa Matsés; and another cluster of rounded hills south of the Divisor (Fig. 2A). Lane et al. (2003) and Stotz and Pequeño (2006) provide most of our current knowledge of the avifauna of the Río Yavarí. Actiamë, the southernmost site visited during the inventory of the Reserva Comunal Matsés, also lies within the northern limits of the Zona Reservada (see Stotz and Pequeño 2006). Small collections (at the Field Museum [FMNH]) were made at Cerro Azul, near Contamana, by J. Schunke in 1947, and in the Serranias de Contamana by Peter Hocking and associates in 1985 and 1986 (at FMNH and the Museo de Historia Natural de la Universidad Nacional Mayor de San Marcos [MUSM]). More recently ProNaturaleza (FPCN), The Nature Conservancy-Peru (TNC), and the Centro de Datos para la Conservación (CDC) sponsored a series of inventories in the Contamana region. The first of these (November 2000) visited Aguas Calientes and Cerro Chanchahuaya, east of Contamana, with Christian Albujar as the participating ornithologist (FPCN/CDC 2001; also MUSM). A second inventory, with José Álvarez A. as the ornithologist, penetrated deeper into the area, reaching the western margins of the Contaya ridges during October 2004 (Álvarez 2005). A third such inventory visited sites close to the Río Ucayali in the southwestern portion of the Zona Reservada during July 2005.

Farther to the south, John P. O'Neill led a joint expedition (Louisiana State University Museum of Natural Science [LSUMZ] and MUSM) up the Río Shesha, east of Pucallpa in northern Ucayali, in 1987. This was the first attempt to survey a site (Cerro Tahuayo) in the complex of rounded hills south of the Divisor. A brief additional visit to this region was made in January 2001, sponsored by ProNaturaleza, TNC, and CDC, again with the participation of C. Albujar (FPCN/CDC 2001, Fig. 2A).

The avifauna of the state of Acre, in western Brazil immediately adjacent to this part of Peru, also remained largely unknown until recent years. A series of rapid ecological evaluations were made in the Parque Nacional da Serra do Divisor during July 1996 (northern sectors of the park) and March 1997 (southern sectors), under the sponsorship of The Nature Conservancy, S.O.S. Amazônia, and the Instituto Brasileiro do Meio Ambiente e de Recursos Naturais Renováveis. Bret M. Whitney, David C. Oren, and Dionísio C. Pimentel Neto made up the ornithology team during these evaluations (Whitney et al. 1996, 1997).

The present inventory visited three sites during August 2005. The first of these was in the center of the Contaya uplift. The second and third sites visited were farther east, along the upper Río Tapiche and nearby in the ridges of the Sierra del Divisor (Figs. 3A, 3B).

METHODS

We conducted bird surveys along trail systems established at each camp. We left camp before or at dawn every day, and often did not return to the camp until mid- or late afternoon. When we returned to camp in early or mid-afternoon, we usually headed back to the field for a few hours in late afternoon. We rarely walked trails at night, and did so only at Tapiche. Each member of the team walked trails separately, to increase the number of independent observations. Each observer walked all trails at each camp, typically at least twice but less commonly a trail would be visited only once by each member of the team. The number of kilometers walked per day by each observer varied by camp. The total lengths of the trails at

each camp were 14.6 km (Ojo de Contaya), ca. 25 km (Tapiche), and ca. 18 km (Divisor). Other members of the expedition, especially D. Moskovits, routinely reported their bird observations to us.

All observers carried portable sound recorders and directional microphones, to tape-record species and to use sound playback as a tool to visually confirm identifications. Most recordings will be deposited at the Macaulay Library, Cornell Laboratory of Ornithology, Ithaca, NY, USA.

Appendix 7 presents the relative abundance of each species by site. Our assessments of relative abundance are subjective but are based on the combined observations of all members of the team who were present at a site. We use four rankings to designate relative abundance. "Fairly common" signifies species that were encountered daily by one or more observers (when in proper habitat for that species). "Uncommon" species were noted several times at each site, but not daily. "Rare" denotes species that were found only twice. An "X" is used to note species that were detected only once per site.

RESULTS

Avifaunas at the sites surveyed

During the inventory we recorded 365 bird species (Appendix 7), a relatively low species richness for sites in the Peruvian Amazon. The number of species per site ranged from 149 (Ojo de Contaya) to 283 (Tapiche, although an additional 44 species were noted at Tapiche by Rojas in the 27 days before the arrival of the rest of the team). The moderate number of bird species likely reflects the relatively sandy, nutrient-poor soils at the study sites. Although species richness was not as high as at some other sites in Amazonia, we made a number of important discoveries of rare or poorly known species, most of which are associated with sandy or nutrient-poor soils.

Ojo de Contaya

The Ojo de Contaya camp is dominated by sandy soils and hilly topography. This was the site with the lowest species richness (149 species) of any locality visited during the inventory. In particular, we were impressed at the number of widespread and typically common forest birds of Amazonian Peru that were very scarce (aracaris, *Pteroglossus* sp.; Chestnut-tailed Antbird, *Myrmeciza hemimelaena*) or apparently absent (e.g., Ruddy Pigeon, *Patagioenas subvinacea*; Lemon-throated Barbet, *Eubucco richardsoni*; Buff-throated Woodcreeper, *Xiphorhynchus guttatus*; White-flanked Antwren, *Myrmotherula axillaris*; and Gray Antbird, *Cercomacra cinerascens*). Mixed-species flocks, especially of canopy species, were infrequent and usually were very simple in structure. For example, the basic understory antbird flock consisted of Saturnine Antshrike (*Thamnomanes saturninus*), Stipple-throated Antwren (*Myrmotherula haematonota*), and Long-winged Antwren (*Myrmotherula longipennis*) as regular members, and a small number of additional species as occasional members. Also particularly striking was a relative low diversity of ovenbird (Furnariidae) species. Other groups that were notably scarce or absent were parrots (other than Rose-fronted Parakeet, *Pyrrhura roseifrons*) and icterids (oropendolas, *Psarocolius* sp.; caciques, *Cacicus* sp.).

We believe that the low number of species at this site is attributable to the relatively poor soils. A number of forest bird species, previously unknown or rarely reported from Peru, recently have been demonstrated to be associated with such soils (Álvarez and Whitney 2003). We recorded one of these species, Yellow-throated Flycatcher (*Conopias parvus*), several times in the taller forests that are dominant at this site. *C. parvus* also was reported from the adjacent Contaya site in October 2004 (Álvarez 2005), from sites in both the upper (Stotz and Pequeño 2006) and lower (Lane et al. 2003) Río Yavarí, and from the northern sector of the Parque Nacional da Serra do Divisor in Acre (Whitney et al. 1996).

The most interesting bird species were found in small areas of low-stature forest on the crests of the three ridges accessible by the Ojo de Contaya trail system. At all three sites we found Zimmer's Tody-Tyrant, *Hemitriccus minimus*. This small flycatcher only

recently was reported from Peru (Álvarez and Whitney 2003), although it appears to be widely, if patchily, distributed in forests on sandy soil.

The most exciting discovery at Ojo de Contaya—one of our greatest surprises of the entire inventory—was the presence of Acre Antshrike, *Thamnophilus divisorius* (Figs. 7C, 7D). This recently described species was discovered in 1996 on a single ridge in the northern sector of the Parque Nacional da Serra do Divisor (Whitney et al. 2004). We anticipated that we would encounter it during the inventory but thought that it might be restricted to the ridges on the border, on the Peruvian side of Sierra del Divisor contiguous with the Brazilian locality. It was an electrifying experience to locate this antshrike so far from the type locality and to extend the distribution of this rare and poorly known species nearly 100 km to the west. Its presence at the Contaya site is particularly important because this locality is separated from the Divisor site by a wide expanse of lowland forest, within which the antshrike does not occur. We found *T. divisorius* on two of the three ridge crests that we visited at Contaya that were dominated by low-stature forest, the specialized habitat of this species (Whitney et al. 2004; see also Flora and Vegetation, p. 161 and Figs. 3H, 3I). We do not know why we were unable to locate this species on the third ridge with what looked to be suitable habitat. However, the extent of low-stature forest on this ridge was less than at the two other sites and may not have been sufficiently extensive to support even a single antshrike pair. It also is interesting that terrestrial bromeliads were not an element of the sites where we found *T. divisorius* at Contaya, although bromeliads dominate in the understory at the type locality (Whitney et al. 2004).

Despite the relatively low species richness of birds at Ojo de Contaya, we encountered several swarms of army ants, which were attended by many of the species that would be expected in this part of Peru. The most notable exceptions were the absence, or scarcity, of larger ant-following birds (bare-eyes, *Phlegopsis* spp.). We also observed Yellow-shouldered Grosbeak (*Parkerthraustes humeralis*) in one of the infrequently seen large canopy flocks. *P. humeralis* is a species that is widely distributed in Amazonia but typically is found only at low densities and may be absent from many sites. Our sighting from Ojo de Contaya is the only record in the immense area in Peru between the immediate south bank of the Amazon (Robbins et al. 1991), to the north, and the upper Río Shesha (J. P. O'Neill, pers. comm.), to the south. The expanse of this gap may reflect not only the relative scarcity of this species, but also the crude nature of our knowledge of bird distribution east of the Ucayali.

Spix's Guans (*Penelope jacquacu*) were seen regularly during our visit and we also had several records of Razor-billed Curassow (*Mitu tuberosum*).

Tapiche

This site, on the banks of the upper Río Tapiche, was the most species-rich of the three sites visited during the inventory. During the period that the full team was present at the site we recorded 283 species. An additional 44 species were noted by Rojas during the 27 days that he was present at this site as part of the advance team, for a combined total of 327 species.

Most of the common, widespread species of Amazonian forest that we did not find at Ojo de Contaya were present at Tapiche. Nonetheless, many expected species seemed to be lacking or to occur only at low densities, such as amazon parrots (*Amazona* spp.), aracaris (*Pteroglossus* spp.), and ovenbirds (Furnariidae). On the other hand, we were impressed by the large numbers of tinamous present at Tapiche, especially around the margins of the large *Mauritia* palm swamp (*aguajal*). We also regularly recorded *Penelope jacquacu* and Blue-throated Piping-Guans (*Pipile cumanensis*), and had several sightings of *Mitu tuberosum*.

The most outstanding observations from the Tapiche camp are records of two bird species that are very poorly known in Peru and that are primarily known from sites north of the Amazon. One of these is the Rufous Potoo (*Nyctibius bracteatus,* Fig. 7A), a nocturnal species with few records from Peru (Álvarez and Whitney 2003). Most of the Peruvian localities of

N. bracteatus are from sites with sandy or nutrient-poor soil (although there also are records from a few sites where the known avifauna demonstrates few or no affinities with other species known to be restricted to sandy soils). Although this species is known from sites south of the Amazon in Brazil, our record, as well as a record by Álvarez (2005) from the margins of the Contaya ridges in October 2004, are the first reports from Peru from anywhere south of the Amazon. This species may prove to be widespread (if uncommon or patchily distributed) throughout most of Amazonian Peru.

The other such species is Fiery Topaz (*Topaza pyra*), a spectacularly showy hummingbird that is widespread but uncommon in northern Peru and whose distribution largely is restricted to forests on sandy soils, particularly with associated black-water streams (Hu et al. 2000). In the early morning we periodically observed this species flycatching over the Río Tapiche or flying (also flycatching?) over forest streams. Until recently the only record from Peru south of the Amazon and east of the Río Ucayali was from the Reserva Comunal Tamshiyacu-Tahuayo (A. Begazo, pers. comm.). In addition to our records from Tapiche, this species was found 80 km to the west in the southwestern region of the Contaya ridges in October 2004 (Álvarez 2005), and also has been reported from the northern sectors of the Parque Nacional da Serra do Divisor (Whitney et al. 1996).

Other interesting range extensions were recorded at Tapiche. We heard Brazilian Tinamou (*Crypturellus strigulosus*) singing at dusk several times. Ours is the first record for this species in Peru between Jenaro Herrera (Álvarez 2002), on the lower Ucayali, and Lagarto (Zimmer 1938), on the upper Ucayali near the mouth of the Río Urubamba. This species also was found in the northern sector of the Parque Nacional da Serra do Divisor (Whitney et al. 1996). Our record, and the records from adjacent Acre, suggest that the birds at Jenaro Herrera do not represent an isolated population but rather that *C. strigulosus* will prove to be widely distributed in eastern Peru south of the Amazon, at least on well-drained upland (terra firme) terraces.

Another interesting record was of Black Bushbird (*Neoctantes niger*). This understory antbird, which usually is found only in low densities, previously was not reported from Peru between the lower Río Yavarí (Lane et al. 2003) and the Río Manu/upper Río Madre de Dios in southern Peru (Terborgh et al. 1984; FMNH). Thus our Tapiche record falls in the center of what had been a huge "hole" in the known Peruvian distribution of this species. There are records from a few sites in adjacent southern Acre (Whittaker and Oren 1999), however, suggesting that *Neoctantes* is more widespread in easternmost Peru than previously was realized. It may be that the Madre de Dios records, seemingly so isolated from other Peruvian localities, represent only the southern terminus of a chain of populations that extends south along the Peruvian/Brazilian border.

At Tapiche, we observed Point-tailed Palmcreeper (*Berlepschia rikeri*), an ovenbird that is restricted to aguajales. We regularly encountered this species in the large aguajal at Tapiche and also at least once along the Río Tapiche. Although we expected the presence of this species in the study area, this is the first record for Peru in the vast region between the lower Río Yavarí (Lane et al. 2003) and Madre de Dios (Karr et al. 1990). This is yet another indication of the extent to which our knowledge of bird distribution in central Amazonian Peru remains incomplete and fragmentary.

We also have a sighting from Tapiche of Bar-bellied Woodcreeper (*Hylexetastes stresemanni*). This site is within the known distribution of this species, but it generally is rare and has been reported from few localities in Peru. *H. stresemanni* also is known from nearby localities, such as Cerro Chanchahuaya (FPCN/CDC 2001) and the margins of the Contaya ridges (Álvarez 2005). Plain Softtail (*Thripophaga fusciceps*) was fairly common along edges of rivers and oxbow lakes. This uncommon ovenbird was almost unknown from northern Amazonian Peru until recently, but now has been found at several sites in this region of Peru and in adjacent Acre, and apparently is relatively widespread in this area (Whitney et al. 1996; Lane et al.

2003; Stotz and Pequeño 2006; A. Begazo pers. comm.; R. Ridgely pers. comm).

We saw Emerald Toucanet (*Aulacorhynchus prasinus*) several times at this site. The status of this species in Amazonian Peru is not clear, but our records fill a small gap between records from the Río Shesha in northern Ucayali (J.P. O'Neill pers. comm.; LSUMZ, MUSM) and the upper Río Yavarí (Stotz and Pequeño 2006), suggesting that is it more widespread, if uncommon, in this part of Peru. As suggested by Stotz and Pequeño (2006), the same is probably true of adjacent Acre, although this species only recently was reported from Brazil for the first time (Whittaker and Oren 1999). Finally, we regularly saw Amazonian Parrotlet (*Nannopsittaca dachilleae*) in small numbers in disturbed forest at the edge of a cocha near the Río Tapiche. This species was expected in the region because it first was collected not far to the south along the Río Shesha (O'Neill et al. 1991). However, it is known from surprisingly few localities in Amazonian Peru, with most records from southeastern Peru. We expect that it will be found to be relatively widespread in east-central and southeastern Peru.

Prior to the arrival of the inventory team, Rojas had observations of two rare species of macaws. The most important of these was a small flock of Blue-headed Macaws (*Primolius couloni*) that regularly was seen along the Río Tapiche over a period of ten days. This species currently is regarded as endangered by BirdLife International. We believe that this ranking almost surely exaggerates the threat faced by this species. Nonetheless *P. couloni* is an uncommon species, never found in large numbers at any site, and is restricted mostly to central and southern Peru. Other sites where it has been reported include the Serranias de Contamana (P. Hocking, MUSM), the upper Río Shesha (J.P. O'Neill pers. comm.), and the northern sector of the Parque Nacional da Serra do Divisor in Acre (Whitney et al. 1996), suggesting that *P. couloni* is widely distributed within the Zona Reservada and the adjacent park in Brazil. Rojas also noted Scarlet Macaw (*Ara macao*) on a single occasion. *A. macao* has a wide distribution in neotropical rain forests, but in Peru it is the least common of the large macaws and is uncommon to rare outside of its current stronghold in southeastern Peru.

Divisor

Soils at this site were relatively sandy and the topography was very hilly. In many ways the avifauna at this site was intermediate in species abundance and composition between the first two sites visited. During the inventory we detected 180 bird species. Most of these were shared with the forest species of the Tapiche site, although there were some interesting differences. For example, the dominant forest pigeon at Tapiche was Ruddy Pigeon (*Patagioenas subvinacea*), with only small numbers of Plumbeous Pigeon (*P. plumbea*) noted daily. At Divisor, however, these relative abundances were reversed (note that *P. plumbea* was the only pigeon species recorded at Ojo de Contaya). Similarly, at Tapiche the Bluish-slate Antshrike (*Thamnomanes schistogynus*) was the most frequent "leader" species of understory mixed-species antbird flocks, whereas at both Ojo de Contaya and Divisor this species was missing entirely and was replaced by other species of *Thamnomanes*.

The most important and interesting bird communities at Divisor were, as expected, those of stunted or low-stature forests on ridge crests. Many (although not all) ridge crests at this site were covered, largely or entirely, with a very stunted forest (see the Flora and Vegetation chapter). A small set of species was restricted entirely, or almost so, to this habitat: Blackish Nightjar (*Caprimulgus nigrescens,* Fig. 7B), *Hemitriccus minimus*, and Fuscous Flycatcher (*Cnemotriccus fuscatus duidae*). *Caprimulgus nigrescens* in Peru primarily is found locally in the foothills of the Andes, but also is found patchily in Amazonian Peru (including Aguas Calientes near Contamana: MUSM), especially at sites that are on sandy soils. Although locally distributed in Amazonian Peru, *Hemitriccus minimus* was expected here after being found in similar (but taller) forest at Ojo de Contaya. This *Cnemotriccus* also is restricted to sandy soils and patchily distributed across Amazonia. Originally described as a subspecies

of the widespread *Cnemotriccus fuscatus*, *C. f. duidae* overlaps geographically with other subspecies of *fuscatus* and differs in voice and in habitat preferences; no doubt it eventually will be recognized as a separate species (Hilty 2003; B. Whitney pers. comm.).

Thamnophilus divisorius (Figs. 7C, 7D) also was present at the margins of the most stunted forest, but had a clear preference for an adjacent, taller, ridge-top forest with a prominent bromeliad understory. This habitat apparently is similar to the type locality of this species in Acre, Brazil (Whitney et al. 2004). The antshrike was common on both ridges with this forest type that were accessible by trail, and we also heard it singing from adjacent ridges.

As at Tapiche, *Topaza pyra* was seen several times flying over streams in the forest in the early morning. One of the most remarkable records of the inventory was of an Oilbird (*Steatornis caripensis*) that flew over the stream at our field camp for two successive evenings, shortly after nightfall. *Steatornis* is patchily distributed in the Andes of Peru, where it roosts and breeds communally in relatively large caves. Records in Amazonia are very few (Whittaker et al. 2004). It has been supposed that such records are of individuals that wander far from Andean roost sites, given that the species is known to travel long distances (up to at least 150 km) when feeding (Roca 1994). We found no caves that we thought would be large enough to support an oilbird colony during our short visit, but we also could easily imagine, from the numerous rock walls perforated regularly with small cavities, that such caves might exist within the larger expanse of the Sierra del Divisor. J. P. O'Neill (pers. comm.) heard local guides on the Río Shesha mention that the hills there (in northern Ucayali) contained a "*cueva de lechuzas,*" which might have referred to an oilbird cave. Our field assistants also mentioned caves with oilbirds a day's travel from Orellana, presumably somewhere in the northern portions of the Cordillera Azul, on the west bank of the Río Ucayali (and much closer to the Andes).

Another surprising record was of a single Red-rumped Cacique (*Cacicus haemorrhous*). We are aware of no records of this species from Peru south of the Amazon and east of the Río Ucayali, between the lower Río Yavarí and the upper Río Purús, nor is it known from Acre in adjacent Brazil.

Several times we noted but could not identify swifts flying over the Divisor area. These clearly were some species of relatively long, square-tailed species, larger than *Chaetura* spp. They may have been any one of several species of *Cypseloides*, or Chestnut-collared Swift (*Streptoprocne rutila*). We suspect that they were the latter species, but were unable to confirm this. *Streptoprocne rutila* is not known from Amazonia, and rarely is seen far from mountainous terrain where nesting sites, on shaded vertical rock faces near water, are located (Marín and Stiles 1992). We did not locate any active nesting sites of swifts in the Sierra del Divisor, but we can imagine that the still largely unexplored expanses of these ridges would harbor suitable nesting sites for *Cypseloides* and *Streptoprocne*.

Numbers of large cracids were relatively low at this site, but both *Penelope jacquacu* and *Mitu tuberosum* were present.

Migration

August, which falls during the austral winter, is a period of little migratory activity. We noted a few individual shorebirds (Solitary Sandpiper, *Tringa solitaria*; Spotted Sandpiper, *Actitis macularius*) that represent recently arrived migrants from North America. The majority of austral migrants to Amazonian Peru winter farther south, reaching no farther north than southern Ucayali or Madre de Dios, but at least eight species (Dark-billed Cuckoo, *Coccyzus melacoryphus*; Large Elaenia, *Elaenia spectabilis*; Small-billed Elaenia, *Elaenia parvirostris*; Vermilion Flycatcher, *Pyrocephalus rubinus*; Streaked Flycatcher, *Myiodynastes maculatus*; Swainson's Flycatcher, *Myiarchus swainsoni*; and Red-eyed Vireo, *Vireo olivaceus*) winter widely throughout Amazonian Peru. Most austral migrant species occupy open situations, such as river margins, which were restricted during our inventory at the Tapiche site. No austral migrants were noted in the stunted ridge-

crest forests at Ojo de Contaya and Divisor, habitats that were much more open than the adjacent taller forests. We recorded only two austral migrant species (*Myiodynastes maculatus* and *Vireo olivaceus*). The one forest-based austral migrant noted during our survey, *Vireo olivaceus*, was notably scarce and was encountered only at Tapiche.

Reproduction

Rainfall in east-central Peru (where the Sierra del Divisor is located) is seasonal, with a noticeable dry period that peaks in June, July, and August. It might be expected that avian reproductive behavior would be similarly seasonal in this part of Peru, but seasonality of avian reproduction in Amazonian Peru has not been investigated in depth. The volume of bird song during the inventory was low (surprisingly low, in our experience, especially at Ojo de Contaya) and so we suspect that levels of breeding activity also were low. Nonetheless during the inventory we encountered active nests of several species: Yellow-browed Antbird (*Hypocnemis hypoxantha*) at Ojo de Contaya; Common Pauraque (*Nyctidromus albicollis*), Ocellated Poorwill (*Nyctiphrynus ocellatus*), Amazon Kingfisher (*Chloroceryle amazona*), Black-fronted Nunbird (*Monasa nigrifrons*), Swallow-wing (*Chelidoptera tenebrosa*), Scarlet-hooded Barbet (*Eubucco tucinkae*), Masked Tityra (*Tityra semifasciata*), White-banded Swallow (*Atticora fasciata*), Olive Oropendola (*Psarocolius bifasciatus*), and Yellow-rumped Cacique (*Cacicus cela*) at Tapiche; and *Caprimulgus nigrescens,* Black-throated Trogon (*Trogon rufus*), and *Myrmotherula haematonota* at Divisor. We saw dependent young of several species, including Banded Antbird (*Dichrozona cincta*; Tapiche), *Hypocnemis hypoxantha* (Ojo de Contaya), and Ringed Antpipit (*Corythopis torquatus*; Tapiche), as well as independent juveniles of White-necked Thrush (*Turdus albicollis*; Ojo de Contaya).

Additionally, at Tapiche we observed several species of parrots (Blue-and-yellow Macaw, *Ara ararauna*; White-bellied Parrot, *Pionites leucogaster*) investigating holes in trees and saw a pair of *Pyrrhura roseifrons* copulating.

DISCUSSION

As mentioned above, species richness at the three sites visited was lower than we had anticipated for a site in Amazonia but perhaps not unusually so when the sandy soils are taken into account. Many more species would be expected at sites with richer soils, and indeed our most species-rich site (Tapiche) was on a river floodplain. We also know that the soils and associated avifauna are much richer in other portions of the Zona Reservada, such as in the northeastern quadrant in the upper Río Yavarí drainage (Stotz and Pequeño 2006) and in the southeastern quadrant in the upper Río Shesha drainage (J.P. O'Neill pers. comm.). Taking into account those two areas, the avifauna of the Serrania de Contamana, and the results of our inventory, approximately 465 bird species currently are reported from Zona Reservada Sierra del Divisor. We estimate that 570 bird species regularly occur in the area, indicating that bird species richess in the entire area is relatively high.

Comparison among sites

The Tapiche site, with 327 bird species observed during the inventory, clearly was much richer than were the two other sites. We assume that this difference primarily reflects the floodplain of the Río Tapiche and the 45 species associated with oxbow lakes and river-edge forests and beaches, habitats that were lacking at the two other sites. A more comparable basis for comparison to the Ojo de Contaya and Divisor sites would be 234 species, the number of forest birds observed at Tapiche during the period of the inventory (which still exceeds the number of species recorded at either of the two other sites).

Species richness at Ojo de Contaya (149) and at Divisor (180) was much more comparable. Seventeen species were shared between Tapiche and Divisor but were lacking at Ojo de Contaya (although some of these were relatively scarce at Divisor as well). Overall, Divisor was intermediate between the two other sites, both in species richness and in species composition.

Birds of white-sand forests

The presence of white-sand areas scattered across Amazonia has been known for many years but ornithologists have been slow to appreciate the importance of this habitat. In particular the presence of extensive areas of white-sand forests as far west as Peru only recently has been noticed. These forests support a suite of species previously unreported from Peru or considered to be rare there (Álvarez and Whitney 2003), as well as several species new to science (Whitney and Álvarez 1998, 2005; Álvarez and Whitney 2001; Isler et al. 2001). The majority of these birds, especially the recently described species, are restricted to unusual forest formations found on sites with soils that are even sandier than those at our study sites. "Classic" white-sand forests include *varillales* (forest of very short stature and low species-richness of plants, growing on almost pure sand) and *irapayales* (closed-canopy forest, often over weathered clays, with an understory dominated by *irapay* palms, *Lepidocaryum tenue*). True varillales were not present at the sites that we visited. The closest approximation to varillales was on the crests of many ridges at Ojo de Contaya and Divisor. Here we found a bird community that, while very small, was entirely restricted to a particular, patchily distributed habitat (*Caprimulgus nigrescens, Thamnophilus divisorius, Hemitriccus minimus,* and *Cnemotriccus fuscatus duidae*) (Figs. 7B, 7C, 7D) .

Another set of species is less restricted to pure white-sand forests, but nonetheless usually is associated with nutrient-poor, sandy, or well-drained soils. Several such species were encountered during the inventory (*Crypturellus strigulosus, Nyctibius bracteatus, Topaza pyra*, and *Conopias parvus*). Most of these (all but the *Crypturellus*) also were found in at locations southwest of our Ojo de Contaya site in October 2004 (Álvarez 2005), suggesting that these species are relatively widespread in sandy-soil forests in the Zona Reservada. Several other such species associated with sandy soils were not encountered during the rapid biological inventory. At least two of these (Brown-banded Puffbird, *Notharchus ordii*; Cinnamon Tyrant, *Neopipo cinnamomea*) were found, however, in earlier surveys of the Divisor closer to Contamana (FPCN/CDC 2001; Álvarez 2005). Taken together, the results of all of the bird inventories in the Zona Reservada suggest that species that are associated with sandy or nutrient-poor soils are widespread in this area. That some of these species were not encountered in all parts of the region may reflect the fact that most such species are rare or uncommon, even where present, and easily can be missed during a short visit. We expect that further work in the Divisor would show that most if not all of these species are broadly distributed across the region.

Other interesting records from the Zona Reservada

Here we wish to call attention to some other unusual records of bird species known from Zona Reservada Sierra del Divisor, but that we did not encounter during our inventory. Red-winged Wood-Rail (*Aramides calopterus*) is a poorly known and apparently rare species reported from only a few scattered sites in Peru, many of which are located in foothills or hilly areas of Amazonia. One of these localities is Cerro Azul (Traylor 1958), east of Contamana, and so probably within the Zona Reservada. This species should be looked for elsewhere in the region.

Rufous-winged Antwren (*Herpsilochmus rufimarginatus*) is known locally from Amazonian Brazil, but in Andean countries largely is restricted to foothills. The presence of this species near Cerro Tahuayo on the Río Shesha (J.P. O'Neill pers. comm.) was unexpected and is the only record of this bird from Peru away from the Andes.

Elusive Antpitta (*Grallaria eludens*) is known at sites both to the north of the Zona Reservada, in the Río Yavarí drainage (Lane et al. 2003), and in the southeastern portion, in the Río Shesha drainage (Isler and Whitney 2002; J.P. O'Neill pers. comm.). This is a very poorly known, rare species whose entire distribution lies in easternmost Amazonian Peru and westernmost Brazil.

Black Phoebe (*Sayornis nigricans*) occurs near Aguas Calientes in the range of hills closest to Contamana (P. Hocking, specimen at MUSM; FPCN/CDC 2001). This species otherwise is restricted to the slopes of the Andes and to the higher outlying ridges, such as the Cordillera Azul and the Cerros del Sira. Aguas Calientes is the only Amazonian locality where *Sayornis nigricans* has been reported. We looked for this species along rocky streams in the Zona Reservada, but did not observe it.

Biogeographic considerations

It long has been known that there is turnover between related species across Amazonia, and that this faunal turnover often occurs across the opposite banks of major rivers (Wallace 1852). The Río Ucayali, especially the central and upper sections, separates the distributions of a number of sister species of birds. At the same time, a different pattern of faunal turnover occurs in central Peru in which sister species replace one another in a roughly north-south fashion, with no river acting as a barrier between them. This pattern is particularly pronounced east of the Río Ucayali (see Lane et al. 2003; Stotz and Pequeño 2006) but is part of a broader pattern of faunal replacement that for some species pairs also extends to the west bank of the Ucayali (see Haffer 1997). Surprisingly little is known about the details of faunal turnover in this region, especially east of the Río Ucayali. Our results are consistent with earlier observations and suggest that there does not seem to be any single area east of the Ucayali within which the majority of the species-pairs turnovers take place (in contrast to, say, the marked faunal turnover in small nonvolant mammals between the upper and lower Río Juruá in western Brazil; Patton et al. 2000). Furthermore, in at least some cases species-pair turnover is not abrupt (parapatric or narrowly sympatric distributions), as is the case with truly allopatric opposite-bank replacement, but instead occurs with some relatively broad level of sympatry between the two species. Further study will be required to determine the extent to which (or if) faunal turnover is mediated at the local level by subtle shifts in soil type and forest structure.

Straight-billed Hermit (Phaethornis bourcieri)/ Needle-billed Hermit (P. philippii)

P. bourcieri is widespread north of the Amazon and also occurs south of the Marañón. *P. philippii* occurs on the immediate south bank of the Amazon (Zimmer 1950; Robbins et al. 1991), in the Río Yavarí drainage (Lane et al. 2003; Stotz and Pequeño 2006) and is widespread in southeastern Peru. Thus it was a great surprise when *bourcieri* was found to be the only *Phaethornis* species present near Contamana (P. Hocking specimens, MUSM, FMNH) and in the upper Río Shesha (J.P. O'Neill pers. comm; LSUMZ, MUSM). Similarly, we found *bourcieri* to be common at all three of our sites, but did not observe *philippii* at all. Farther to the north, both species were reported near the mouth of the Río Ucayali at Jenaro Herrera (Wust et al. 1990). The two species apparently approach one another in the upper Ucayali drainage, with records of *philippii* from the east bank of the upper Ucayali (Zimmer 1950) and *bourcieri* present not far away on the lower Río Urubamba (M.J. Miller pers. comm., MUSM). We do not know whether the two species are broadly sympatric, but rarely syntopic, in east central Peru; or whether *bourcieri* occupies most of this region (at least in areas that drain into the Río Ucayali) with only limited contact with *philippii* along the lowermost and uppermost reaches of the Ucayali.

Rusty-breasted Nunlet (Nonnula rubecula)/ Fulvous-chinned Nunlet (N. sclateri)

N. rubecula occurs in eastern Peru on both banks of the Amazon (east of the Napo and Ucayali rivers), whereas *N. sclateri* is widespread but uncommon in southeastern Peru. We encountered *Nonnula* only at the Tapiche site, where all records were of *rubecula*. *N. sclateri* was reported by Álvarez (2005) ca. 30 km to the southwest of our Ojo de Contaya site, and earlier was found along the lower Río Ucayali at Jenaro Herrera (Álvarez pers. comm.); it also was found in the upper Río Shesha (J.P. O'Neill pers. comm.). These two species have not yet been found at the same site, but it is clear that the turnover from one species to the other is complicated

and perhaps is affected at the local level by soil type or other factors.

Saturnine Antshrike (*Thamnomanes saturninus*)/ *Dusky-throated Antshrike* (*T. ardesiacus*)

T. ardesiacus is widespread in Amazonian Peru but is replaced in east-central Peru, south of the Amazon, by *T. saturninus*. *T. saturninus* has been collected near Contamana (P. Hocking specimens, MUSM, FMNH; FPCN/CDC 2001), was observed east of Contamana (Álvarez 2005), and also was the only species reported in the northern sector of the Parque Nacional da Serra do Divisor in Acre (Whitney et al. 1996). As expected from the records at this latitude to the east and the west of our sites, *T. saturninus* was fairly common at Ojo de Contaya. Members of this species pair were uncommon at Tapiche, and we did not carefully examine the few individuals that we encountered. We were greatly surprised to discover that *T. ardesiacus* was the common species at Divisor (although one of us, C. Albujar, also observed at least a few individuals that we believe were *saturninus*). The nearest specimen locality for *ardesiacus* is in the upper Río Shesha, in the southeast quadrant of the Zona Reservada (J.P. O'Neill pers. comm; LSUMZ, MUSM). The northward "intrusion" of *ardesiacus* to the Sierra del Divisor, into an area that lies between Contamana/Ojo de Contaya and the records in Acre, was completely unexpected. As with the case of the two species of *Nonnula*, this example demonstrates that the geography of turnover of sister species within this region can be complicated and is not simply a function of latitude.

In other instances, we typically encountered the more southerly member of a pair (e.g., Purus Jacamar, *Galbalcyrhynchus purusianus*, rather than White-eared Jacamar, *G. leucotis*; Semicollared Puffbird, *Malacoptila semicincta*, rather than Rufous-necked Puffbird, *M. rufa*; Scaly-backed Antbird, *Hylophylax poecilinota griseiventris*, not subspecies *gutturalis*). But in one instance, we found the more northerly representative of a species pair (Red-billed Ground-Cuckoo, *Neomorphus pucheranii*, not Rufous-vented Ground-Cuckoo, *N. geoffroyi*).

RECOMMENDATIONS

Threats and opportunities

Zona Reservada Sierra del Divisor represents an unparalled opportunity to protect the region's unique habitats and the rare species associated with them. The combined presence of (1) a bird species (Acre Antshrike, *Thamnophilus divisorius*) whose distribution is completely restricted to the Sierra del Divisor and the Ojo de Contaya, (2) a suite of rare species associated with specialized, stunted, ridge-crest forests, (3) a large complement of rare white-sand bird species, and (4) significant large-scale habitat heterogeneity and high species richness of birds, make the Zona Reservada a high priority for conservation. Because of the position of the Zona Reservada, which lies between Parque Nacional Cordillera de Azul (west of the Río Ucayali in Peru) and Parque Nacional da Serra do Divisor in Brazil, preservation of the Zona Reservada will enhance the value of both of these formally protected areas. Indeed, the majority of the highland areas of the Sierra del Divisor are found on the Peruvian side of the border, and so preservation of the Peruvian portion may be critical to the protection and management of the unique habitats and species found there.

At present, the human population density in the Zona Reservada is extremely low. The primary threat to birds is habitat destruction associated with extractive activities, such as logging, oil exploration or development, and mining, all of which already threaten the region. During the inventory we saw direct evidence of illegal logging (stumps, people traveling upriver to log; Fig. 9A) on the upper Río Tapiche, and this activity may be occurring elsewhere in the Zona Reservada as well. Logging is a direct threat to all forest species but has the greatest effects on species with specialized habitat requirements and/or patchy distributions. Perhaps most vulnerable is the Acre Antshrike (*Thamnophilus divisorius*), which is known only from the Sierra del Divisor and the Ojo de Contaya (i.e., nowhere else in the world) (Figs. 7C, 7D). Moreover, even within the Zona Reservada, the Acre Antshrike is restricted to a specialized, stunted forest found on the crests of some ridges. Other

rare or poorly known species associated with these soils are found in the Zona Reservada, both on ridge crests (overlapping with the *Thamnophilus*), or in the taller forests in valley floors.

The destructive effects of large-scale resource extraction are compounded for some species by the hunting pressure that typically accompanies logging or mining camps. Cracids, tinamous, and other game birds were present throughout the area, and all are vulnerable to hunting.

Research

To our great surprise we encountered *Thamnophilus divisorius* not only in the Sierra del Divisor on the Peru/Brazil border, but also as far west as Ojo de Contaya, where previous inventories did not encounter it. Although we assume that it will prove to be widespread on ridge crests throughout the area, it should be searched for at additional sites (especially in the Contaya uplift). Additional effort also should be made to corroborate our suspicions that rare white-sand species (such as *Nyctibius bracteatus, Topaza pyra, Conopias parvus,* and others) are widespread in the region, and that species that we did not encounter (such as *Notharchus ordii* and *Neopipo cinnamomea*) also occur.

The bird life of the crests of round-topped, volcanic hills south of the Sierra del Divisor remains almost entirely unknown. Our impression from the air is that the tops of these hills are covered almost entirely in tall forest and that there is little or no sign of the stunted forest formations of the Sierra del Divisor and the Serranias de Contamana and Contaya farther north. Nonetheless these hills warrant further investigation.

Attempts also should be made, at any hilly site within the Zona Reservada, to search out suitable nesting or roosting sites for "Andean" cave- or waterfall-dwelling species, such as *Steatornis caripensis* and *Streptoprocne rutila*, which we suspect may have isolated populations there.

We repeatedly were surprised, when evaluating some of our observational records, at how little was known about the details of bird distribution in east-central Peru (the large area south of the Amazon and east of the Río Ucayali). Many additional inventories are needed in this region to give us a better understanding of distributional patterns. A series of north-south transects across the region could generate much useful information, not only on the general pattern of species distributions, but on the extent to which white-sand species are patchily (vs. uniformly) distributed in the Zona Reservada; on the geographic limits of white sands and nutrient-poor soils (and associated avifaunas) vs. richer soils (and more species rich avifaunas); on the patterns of replacement between sister species; and on the extent to which such replacement may be associated with subtle shifts in soil and forest composition.

MAMMALS

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Conservation targets: One of the most diverse primate communities in the Neotropics, with 15 species; red uakari monkey (*Cacajao calvus*) and Goeldi's monkey (*Callimico goeldii*), both of which have patchy distributions and are considered Near Threatened by the World Conservation Union (IUCN); common woolly monkey (*Lagothrix poeppigii*), black spider monkey (*Ateles chamek*), and South American tapir (*Tapirus terrestris*), abundant in the region but under serious hunting pressure elsewhere; species with large home ranges, such as jaguar (*Panthera onca*) and puma (*Puma concolor*), that are highly vulnerable to overhunting, and also listed as Near Threatened by the IUCN

INTRODUCTION

The Sierra del Divisor is a complex and unique geomorphologic formation situated in one of the most diverse Neotropical regions for mammals, the Western Amazon Basin (Voss and Emmons 1996). The area is expected to harbor mammal species with highly restricted geographical distributions, such as red uakari monkey (*Cacajao calvus,* Fig. 8A), Goeldi's monkey (*Callimico goeldii,* Fig. 8D), and pacarana (*Dinomys branickii*).

This mountain range forms a border between Peru and Brazil. On the Brazilian side, The Nature Conservancy and S.O.S. Amazônia conducted biological

inventories in the northern and southern sectors of the Parque Nacional da Serra do Divisor and registered 32 species of medium to large mammals (Whitney et al. 1996, 1997; see Appendix 9). The list includes the three species mentioned above, confirming their presence in the region (and the importance of preserving them). The Peruvian side of the Sierra del Divisor is listed as a priority area for conservation by the Peruvian government (Rodríguez 1996), but is not yet protected. Four previous inventories were conducted within Zona Reservada Sierra del Divisor (Appendix 9): two in the Sierras de Contamana and Contaya, in the western portions of the Zona Reservada (FPCN/CDC 2001, 2005), one in the southeast, at Rio Abujao-Shesha (FPCN/CDC 2001), and one in the Reserva Comunal Matsés (Amanzo 2006), in the northern part of the Zona Reservada.

During the inventory, we evaluated the diversity of bats and medium-to-large mammals at three sites within the central portion of the Zona Reservada. In this chapter we present our results, discuss differences in diversity among the three sites, compare our results with those other inventories in the region, highlight the important species for conservation, and discuss research, management, and conservation opportunities.

METHODS

The inventory was conducted in the dry season, 6–24 August 2005 at three sites between 200 and 450 m. Information on globally threatened species was taken from IUCN (2004), and from CITES (2005). Information on the categorization by INRENA of threatened species was taken from INRENA (2004). We used rankings from the IUCN/SSC Chiroptera specialist group (Hutson et al. 2001) for bats.

Non-volant mammals

We registered medium and large mammals along established trails in all three sites (Ojo de Contaya, Tapiche, and Divisor). We used a combination of direct observation and indirect evidence, such as tracks and other signs of mammal activity (vocalizations, feeding remains, dens, scratches on trees), to sample along trails varying in length from 0.6 to 15 km. These trails crossed the majority of habitats in each site. We conducted both diurnal and nocturnal surveys. Our diurnal surveys typically began at 06:00. The time to complete a survey varied according to the length of the trail. Nocturnal surveys were usually from 19:00 to 21:00 hours. We walked slowly (ca. 1 km/hour), on separate trails, scanning the vegetation from the canopy down to the ground and recording the presence of terrestrial and arboreal mammals. When needed, we followed animals to confirm their identity and estimate group size. For each observation, we noted the species, time of day, number of individuals, type of activity at that moment (resting, foraging, walking, etc.), and vegetation type.

To detect the presence of mammal species that are more difficult to observe, we installed automatic cameras with infrared sensors along animal trails, on beaches along streams or rivers, and at clay licks. Three were Leaf River Scouting Cameras, Model C-1, and two were DC-200 Deer Cams. The camera traps were placed 50-70 cm above the ground and programmed to wait five minutes between shots.

We also included all observations made by other members of the inventory team and the advance trail-cutting team.

Using Emmons' (1997) mammal identification field guide, we interviewed Fernando Valera from the community of Canaan, our guide in the Tapiche camp, to obtain the Shipibo names for the mammals expected to occur in the area of the three camps.

Volant mammals (bats)

We evaluated the bat community during two days at each camp using five mist nets, each 12 by 2.6 m. Mist nets were placed in various habitats (e.g., primary forest, secondary forest, riverine forest, over streams and other bodies of water) and potentially preferred microsites (e.g., below fruiting trees, forest clearings, across trails, or near roosts). We also looked for roosting bats in fallen and hollow trees, armadillo

burrows, and under leaves, as suggested by Simmons and Voss (1998) as an effective complementary method to record bat species.

We opened mist nets at dusk (about 18:30), checked them every 30 minutes, and closed the nets at 23:00 hours. Each time a bat was caught, we noted the time of day and habitat, identified the bat to species, and determined the sex and reproductive status. We released each bat after all data were recorded. For each site, we calculated capture effort and success using the number of nights and net hours.

RESULTS

Non-volant mammals

We walked 237 km during the inventory and recorded 38 species of medium to large mammals, which is 60% of the 64 species expected for the region (Appendix 8). Among those, 4 were marsupials, 3 xenarthrans, 13 primates, 7 carnivores, 5 ungulates, and 6 rodents.

Ojo de Contaya

We covered 61 km in five days (6-11 August 2005) and recorded 23 species of medium to large mammals, including 2 marsupials, 2 xenarthrans, 6 primates, 5 carnivores, 4 ungulates, and 4 rodents (Appendix 8).

Black spider monkeys (*Ateles chamek*) and brown capuchin monkeys (*Cebus apella*) were the most frequently detected species in the area, seen or heard by several people every day along independent trails. Encounters with monk saki monkey (*Pithecia monachus*) were also fairly common (5 of the 6 days of inventory in two different valleys). Common woolly monkeys (*Lagothrix poeppigii*) were seen only on two different days at nearby places, and therefore seemed to be less common than the species mentioned above. White-fronted capuchin monkeys (*Cebus albifrons*) were rare, with only a single observation made by the advance trail-cutting team. No small primates were recorded at this site.

Most unexpectedly, we observed a group of *Cacajao calvus* (approximately 15 individuals) on the top of a ridge. Previous studies associate the presence of *Cacajao* with permanently or seasonally flooded forest, especially palm swamps (known as *aguajales*; Barnett and Brandon-Jones 1997). Based on satellite images of the region, we estimate that the nearest aguajal was approximately 15 km away from the site of our record. *C. calvus* may migrate seasonally between flooded and high forest following patterns of fruit production (Mark Bowler, pers. comm.), and perhaps our observation reflects this type of local migration.

This record also may suggest that *Cacajao calvus* exploits resources from ridgetops more than other primates observed in the area. All encounters of *Ateles chamek*, *Lagothrix poeppigii*, and *Pithecia monachus* were near the valleys. *Cebus apella* was the only other primate that we observed both in valleys and on hilltops.

Other common mammals at the Ojo de Contaya were South American tapir (*Tapirus terrestris*), paca (*Cuniculus paca*, Fig. 8C), red brocket deer (*Mazama americana*, Fig. 8B), nine-banded long-nosed armadillo (*Dasypus novemcinctus*), southern Amazon red squirrel (*Sciurus spadiceus*), and Amazon dwarf squirrel (*Microsciurus flaviventer*), all of which we detected several times, but only in the valleys.

All other species reported for this site were recorded only once each. Such a pattern of rarity is expected and does not necessarily translate to truly low abundances. Some species are rarely observed due to their cryptic behavior (e.g., sloths) or nocturnal activity (e.g., marsupials).

Nevertheless, three species stand out as unusually rare or absent. Collared peccary (*Pecari tajacu*) was recorded only once, by a member of the advance team. And we did not encounter black agouti (*Dasyprocta fuliginosa*) and red howler monkey (*Alouatta seniculus*). These results reflect their absence or extreme rarity in the area because these animals are detected easily when present and are widespread and locally common where they occur (M.L.S.P. Jorge pers. obs.). For peccaries and agoutis, two factors could explain such patterns: a paucity of hard nuts, and difficulty of terrestrial mobility within the area, due to

the hilly topography. For *Alouatta*, the best explanation might be the scarcity of soft leaves in plants that grow on nutrient-poor soils.

Tapiche

We covered 111 km in five days (12-17 August 2005) and recorded 31 species of medium to large mammals, including 1 marsupial, 3 xenarthrans, 12 primates, 5 carnivores, 5 ungulates, and 5 rodents (Appendix 8).

The most remarkable result for this site was the detection of 12 species of primates, an extremely high number of species for a single site in Amazonia (Voss and Emmons 1996; Peres 1999). The most frequently seen species were *Cebus apella*, *Lagothrix poeppigii*, and *Pithecia monachus*. Interestingly, *Ateles chamek*, which was the most commonly primate observed at Ojo de Contaya, was recorded only once at Tapiche.

A large group of *Cacajao calvus* (approximately 30 individuals) was seen near the camp on the first day in a large *Mauritia flexuosa* aguajal, which is a poorly drained, swampy habitat preferred by this species (Barnett and Brandon-Jones 1997).

Our team encountered the poorly known *Callimico goeldii* (Fig. 8D) several times in a dense riverine forest with some bamboo. Here the marmoset was seen in groups of approximately four, sometimes in association with black-chested moustached tamarin (*Saguinus mystax*) and saddleback tamarin (*S. fuscicollis*). In those occasions, individuals of *Callimico* occupied the understory, whereas *Saguinus* occurred in the understory and middle canopy, as described previously by Christen (1999) and Porter (2004).

We observed and heard the coppery titi monkey (*Callicebus cupreus*) several times in mature forest, secondary forest (*Cecropia* sp.), and in riverine forest. We also saw a group of a four to six individuals of booted titi monkey (*C. caligatus*) in riverine forest close to the camp. The sympatry of two species this genus is expected (Hershkovitz 1988) and is reported for other sites of western Amazonia (Peres 1999).

We did not record either the white-fronted capuchin monkey (*Cebus albifrons*) or the common squirrel monkey (*Saimiri sciureus*) at this site. In fact, *Saimiri* was not recorded at all during the inventory.

Tapirus terrestris, *Pecari tajacu*, and white-lipped peccary (*Tayassu pecari*) were the most abundant terrestrial mammals in the site, with several sightings by almost all members of the inventory, and numerous signs of their presence in all the habitat types. *Cuniculus paca* and *Mazama americana* also were recorded in several occasions by direct observation, scats, tracks, and photographs (Figs. 8B, 8C). Finally, we observed numerous dens of *Dasypus novemcinctus* along all the trails, in mature and secondary forest.

As at the Ojo de Contaya site, at Tapiche we also had only single encounters with each of the other species reported in the Appendix 8. Among those, we observed an individual of Neotropical river otter (*Lontra longicaudis*) near the Río Tapiche and additional tracks of this species at another stream that may correspond to a different individual.

Divisor

We covered 65 km in five days (19-23 August 2005). We recorded 18 species of medium to large mammals, including 1 marsupial, 2 xenarthrans, 5 primates, 3 carnivores, 3 ungulates, and 4 rodents (Appendix 8).

Lagothrix poeppigii (6-15 individuals), *Cebus apella, Tapirus terrestris*, and *Cuniculus paca* were the most common mammals in this site, with several signs of their presence in almost all habitats.

One unexpected record of this site was that of a small group of *Saguinus fuscicollis* (two adults and one juvenile), which was the only species of small monkey recorded. The absence of *Pithecia monachus* and rarity of *Ateles chamek* also was unusual.

Other remarkable species that were recorded only once each are the puma (*Puma concolor*), of which we found a set of tracks, one jaguar (*Panthera onca*) that was seen near the camp by the advance team, and a juvenile male of southern tamandua (*Tamandua tetradactyla*) that we saw 2.5 m above the ground in mature forest. This individual was completely brown with a black collar.

Volant mammals (bats)

We captured 80 bats belonging to 4 families, 18 genera, and 26 species (Appendix 10). Sixteen species were recorded at Ojo de Contaya, 12 at Tapiche, and 10 at Divisor. Bat species recorded during this inventory represent 16.4% of the 158 bat species known from Peru (Hice et al. 2004). The success rate was 0.43 individuals per net-night at the three camps. Ojo de Contaya (35 captures) had a success rate of 0.7 individuals per net-night, versus Tapiche and Divisor each with 0.3 individuals per net-night (15 captures). Such low success rates probably reflect a decrease in bat captures because of the full moon at Tapiche and Divisor.

Phyllostomidae was the most diverse family, with 23 species within 15 genera, and the subfamilies Carolliinae (genus *Carollia*) and Stenodermatinae (genus *Artibeus*) were the most abundant groups.

Abundance among genera differed slightly among the sites. *Carollia* and *Artibeus* accounted for 60% of the captures at Ojo de Contaya, whereas the same genera accounted for 40% at Tapiche and 60% at Divisor. These values may reflect a habitat similarity between Ojo de Contaya and Divisor. Both were very hilly and at higher altitudes, in contrast with Tapiche, which had flatter topography and was closer to a larger river. Nonetheless, caution is needed for such correlation due to the small number of days sampled and the effect of the full moon, especially at Tapiche.

Finally, at Divisor a colony of approximately 15 individuals of *Saccopteryx bilineata* was found in a cave near a stream. This species was not record by mist netting at any of the three sites.

DISCUSSION

Sixty percent of the 64 expected species of medium to large mammals were recorded during our inventory. Our sampling methods were especially efficient in detecting diurnal animals, those that live in groups, and animals that leave some indirect evidence of their presence. Therefore, we are confident of the abundance estimates for primates, ungulates, armadillos, and large or diurnal rodents (paca, agouti, acouchy, and squirrels).

For primates, we registered 80% of the expected species (13 of 16), although not all species were recorded in all sampled sites. Furthermore, we not only observed large primates in large groups (more than 15 individuals), but also at high frequency, highlighting the importance of the Zona Reservada in conserving the Amazonian primate community.

Pygmy marmoset (*Callithrix pygmaea*), *Saimiri sciureus*, and Emperor tamarin (*Saguinus imperator*) were three primate species that we did not encounter during our inventory. The first two species were recorded in previous inventories in the Zona Reservada (Appendix 9). *Callithrix pygmaea* inhabits alluvial forests and dense secondary vegetation with abundant lianas and vines (Aquino and Encarnacion 1994). The reasons for our failure to record this species are not clear. The Tapiche site had riverine vegetation that seemed to be a good habitat for *C. pygmaea,* but this species is known to have a patchy distribution (Emmons and Feer 1997). *Saimiri sciureus* inhabits most types of tropical forest, including wet and dry forest, continuous and secondary forest, mangrove swamps, riparian habitat, and forest fragments (Baldwin and Baldwin 1971), and its apparent absence is also difficult to explain. It may reflect seasonal migration (Trolle 2003).

For *Saguinus imperator*, the most probable explanation is that our sites are north of its geographic range. In Peru, this species occurs in Madre de Díos, which is south of our inventoried areas. In the Brazilian portion of the Divisor, *S. imperator* was only recorded in the southern part of the national park, which is also south of our sites.

All five expected ungulates (*Tapirus terrestris*, *Tayassu pecari*, *Pecari tajacu*, *Mazama americana* and *M. gouazoubira*) and the two ungulate-like rodents (*Cuniculus paca*, *Dasyprocta fuliginosa*) were recorded during the inventory, although in different abundances within and among sites. We did not record *Dinomys branickii*, probably due to the absence of bamboo forest, its preferred habitat (C. Peres pers. comm.).

Among the recorded primates, *Cebus apella*, *Ateles chamek*, and *Lagothrix poeppigii* were abundant

in all three sites. Among other groups, *Dasypus novemcinctus*, *Eira barbara*, *Pecari tajacu*, *Mazama americana*, *Tapirus terrestris*, and *Cuniculus paca* also were common in the three sites.

The least represented group in our inventory was the Carnivora, of which we recorded only 40% of the expected species (7 of 18). Most carnivores are solitary, with cryptic behavior and low population densities, and therefore are difficult to detect. Our results most likely underestimate the number of carnivore species for the region.

Comparisons among the three inventory sites

Tapiche was the site with the highest species richness. There, we encountered 31 species of medium to large mammals, of which 11 were not found at the other sites (Appendix 8). Such a pattern was expected because Tapiche had the greatest diversity of habitats, with riverine forest, a large palm swamp, and mature forest. Therefore, distinct habitat specialists were recorded at this site. For example, most small primates (*Callimico goeldii*, *Saguinus mystax*, *Aotus* sp., *Callicebus caligatus*, and *C. cupreus*) are associated with riverine forest, and were only recorded at Tapiche. *Tayassu pecari* is highly dependent on the presence of ample water resources (Mayer and Wetzel 1987), as are capybara (*Hydrochaeris hydrochaeris*; Mones and Ojasti 1986), and they were only found at Tapiche. The giant armadillo (*Priodontes maximus*), *Alouatta seniculus*, and the South American coati (*Nasua nasua*) also were only recorded at Tapiche, perhaps due to their preference for disturbed habitats. Finally, there was a higher abundance at this site of large terrestrial herbivores, including *Tapirus terrestris*, *Pecari tajacu*, *Mazama americana*, and *Cuniculus paca*, which almost certainly reflects the presence of the large *Mauritia* swamp in the area.

Ojo de Contaya and Divisor had considerably lower species richness compared to Tapiche (23 and 18, respectively). This may reflect that within the Zona Reservada, habitat type was more important than proximity in defining similarities in species number and composition.

Both Ojo de Contaya and Divisor had hilly topography and a dominance of sandy soils. We encountered very few mammals on the top of the hills, except *Cebus apella* (a few times at Ojo de Contaya), *Cacajao calvus* (once at Ojo de Contaya), and *Saguinus fuscicollis* (once at Divisor). Valleys at both sites harbored populations of large arboreal and terrestrial herbivores and frugivores, but no small primates.

We registered four species only at Ojo de Contaya: water opossum (*Chironectes minimus*), southern two-toed sloth (*Choloepus didactylus*), ocelot (*Leopardus pardalis*), and Bolivian squirrel (*Sciurus ignitus*); and one at Divisor (*Puma concolor*). Nevertheless, all these species are difficult to observe, so their apparent absence at the other sites may simply be a sampling artifact.

Comparisons with other inventories in the Zona Reservada

We compared species richness and composition from this inventory with inventories of three other sites within the Zona Reservada: reports from the Sierra de Contamana and Río Abujao-Shesha (FPCN/CDC 2001, 2005), and the Actiamë site from the rapid biological inventory of the Reserva Comunal Matsés (Amanzo 2006). We also compared our study with inventories reported from the Parque Nacional da Serra do Divisor, Brazil (Whitney et al. 1996, 1997; see Appendix 9 here).

Four different sites were evaluated in the Sierra de Contamana and Río Abujao-Shesha inventory. Thirty-five species were recorded, 24 of which were shared with our sites (including 10 species of primates). Nine species were recorded only at our sites, including *Choloepus didactylus*, *Callimico goeldii*, *Callicebus cupreus, C. caligatus*, *Nasua nasua*, and *Puma concolor*. Species that were recorded only at the Sierra de Contamana sites were the giant anteater (*Myrmecophaga tridactyla*), *Callithrix pygmaea*, *Saimiri sciureus*, the neotropical pygmy squirrel (*Sciurillus pusillus*), the northern Amazon red squirrel (*Sciurus igniventris*), and the green acouchy (*Myoprocta pratti*).

The most diverse areas for primate species in Peru are the Río Gálvez drainage basin (Fleck and Harder 2000) and the Reserva Comunal Tamshiyacu-Tahuayo (Puertas and Bodmer 1993), both with 14 species. In this inventory we recorded 13 primate species. If we add *Callithrix pygmaea* and *Saimiri sciureus*, both of which were recorded in the Serrania de Contamana, we would reach 15 species and the Zona Reservada would become the region in Peru with the greatest diversity of primates.

An impressively high number (35 mammal species) was recorded in four days at Actiamë (Amanzo 2006). Such high species richness likely reflects the great availability of edible fruits, combined with the presence of different habitats at this site. This number is very similar to the 31 species that we recorded at Tapiche, which was our site that probably was most similar to Actiamë. Particularly outstanding at Actiamë was the higher diversity of xenarthran species (eight species vs. four at our sites). For the other mammal groups, richness was fairly similar in Actiamë and our sites.

Finally, two mammal species were recorded at the Parque Nacional da Serra do Divisor in Brazil, but not during any of the surveys in the Zona Reservada: *Dinomys branickii* and *Saguinus imperator*. As mentioned previously in this report, we suspect that *Dinomys* was not recorded at our sites due to the absence of its most suitable habitat, bamboo forests (C. Peres pers. comm.). And the presence of *Saguinus imperator* at Parque Nacional da Serra do Divisor is probably due to the location of the Brazilian park, which is consistent with the more southerly locations of records of *S. imperator* from Peru.

THREATS, OPPORTUNITIES AND RECOMMENDATIONS

Principal threats

Within Zona Reservada Sierra del Divisor there are distinct threats for medium to large mammals. Large mammals (terrestrial herbivores, primates, and top predators) are heavily threatened by hunting. We did not find any evidence of hunting pressure at our three inventory sites, probably because of their location far from any human settlement. Nevertheless, the inventories at Serranía de Contamana and Río Abujao-Shesha, closer to the borders of the Zona Reservada, showed clear evidence of hunting pressure (e.g., absence of *Ateles chamek*). These results highlight the importance of preserving a vast, continuous region so as to preserve substantial populations of game species, which are threatened closer to human settlements.

For smaller mammal species, the principal threat is habitat loss. Four of the 13 species of primates reported in our inventory (*Callimico goeldii, Saguinus mystax, Callicebus caligatus*, and *C. cupreus*) were found only in the riverine forest near the Río Tapiche. Therefore, the loss of such habitat probably would cause the local extinction of those species. Due to their proximity to larger rivers, riverine forests will probably be the first habitats to be removed or degraded if the region is not protected from human occupation, emphasizing the importance of strictly protecting a mosaic of habitat types.

For *Callimico goeldii* the threat is even more serious because this species has a very restricted geographic distribution. *Cacajao calvus* also has a very restricted geographic distribution, and is primarily associated with palm swamps near larger rivers. The removal or degradation of these habitats would be extremely detrimental for the survival of both of these rare habitat specialists.

Conservation opportunities

Medium and large mammals

We recorded a large number of species considered threatened at national and international levels (Appendix 8). Of the 64 expected species, 20 are categorized as threatened on IUCN's Red List (2004), 30 are protected by the Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES 2005), and 12 are categorized as threatened on the national list for Peru (INRENA 2004).

The poorly known *Callimico goeldii* and *Cacajao calvus* are listed as Near Threatened (IUCN 2004), Vulnerable according to INRENA (2004),

and are in the Appendix I of CITES (CITES 2005). *Callimico goeldii* is one of the least studied South American primates because its cryptic nature and low density make it difficult to observe (Porter et al. 2001).

Cacajao calvus ucayalii (the subspecies endemic to Peru and western Brazil) is limited to the right banks of the Amazon and Ucayali rivers in northeastern Peru and western Brazil (Hershkovitz 1987; Barnett and Brandon-Jones 1997). *Cacajao calvus* is threatened across its range but to date none of the areas where its presence has been reported is under government protection in Peru.

Large monkeys, such as *Ateles chamek* and *Lagothrix poeppigii*, are considered as Vulnerable and Near Threatened, respectively, by INRENA (2004) and are part of the Appendix II of CITES (2005).

Priodontes maximus is widely distributed throughout the Amazon (Emmons and Feer 1997), but listed as Endangered by IUCN (2004) and is very threatened by hunting.

Tapirus terrestris is considered Vulnerable by both the IUCN (2004) and INRENA (2004), and is listed in Appendix II of CITES (2005) because its populations have been seriously reduced by overhunting (and in some places already have suffered local extinction). Tapir populations, rare elsewhere in Peru, were very common at the three inventory sites.

Large carnivores, such as jaguars (*Panthera onca)* and pumas (*Puma concolor*), are listed as Near Threatened by IUCN (2004) and INRENA (2004), and in the Appendix I and II, respectively, by CITES (2005). Both species were recorded during the inventory, and because of their large home ranges, they are seriously threatened by habitat loss and hunting in other parts of Amazonia.

Bats

Four of the bat species recorded during the inventory (*Artibeus obscurus*, *Platyrrhinus infuscus*, *Sturnira magna*, and *Vampyressa bidens*; Appendix 10) are listed as at Lower Risk (Near Threatened) by the IUCN/SSC Chiroptera specialist group (Hutson et al. 2001).

Recommendations

Protection and management

We recommend that Zona Reservada Sierra del Divisor receive strict protection, especially the areas containing well-preserved riverine forests, palm swamps, and mature lowland forests. This would sustain large populations of most of the medium to large mammals and the preferred habitats for small primates and the threatened species *Callimico goeldii* and *Cacajao calvus*. Hilly areas also should be fully protected because they almost certainly sustain populations of large mammals in valleys. Hilltops, although not so important for large mammal species richness, may harbor small specialist mammals.

We also recommend the creation of a plan to properly manage the populations of preferred game species, such as *Ateles chamek*, *Lagothrix poeppigii*, and *Tapirus terrestris*. Such a plan should be developed in agreement with the local native and local colonist communities. Strictly protected areas, where hunting is prohibited, should be established adjacent to buffer areas where light hunting could be allowed.

Research

We need to map the areas of high abundances of game species and manage their populations. We still know almost nothing about the communities of bats and small terrestrial mammals in the region. In particular we recommend small-mammal surveys in the ridge crests of the region, where there are specific microhabitats that are known to be associated with range-restricted species of other vertebrate groups (e.g., the Acre Antshrike, *Thamnophilus divisorius*). Other interesting observations that invite further research are (1) the presence of two variations of *Ateles chamek* at Ojo de Contaya, one with a red face and the other with a white to blackish face. (We recommend additional research to determine whether these represent are natural variations within the same species or two sympatric congeneric species.); and (2) the presence of *Cacajao calvus* in hilltops, away from any lowland forest. Such an observation may represent an extension of the habitats used by the species,

underscoring our limited knowledge about its habitat use and movements. Accurately determining the factors underlying their presence in such an unexpected place would help to structure guidelines for proper conservation and management.

SOCIOCULTURAL ASSETS FOR CONSERVATION

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Conservation targets: The Isconahua Territorial Reserve; diversified farm plots to develop subsistence-based economies; secondary-forest cover for rotating agricultural crops; water sources for fishing for family consumption; forests with commercial timber species appropriate for sustainable management

Assets for conservation: Traditional practices and local knowledge that are compatible with biological and cultural conservation; strong organizational capacity and interest in managing a protected area and natural resources; strong commitment to the area and awareness of the value of natural resources; positive attitudes and willingness to consider the future of the region

INTRODUCTION

Prior to the rapid biological inventory, both Reserva Territorial Isconahua* and a proposal to establish Reserva Territorial Yavarí-Tapiche existed within Zona Reservada Sierra del Divisor (Fig. 10B). Various biological and socio-economic studies conducted in this region contributed to the proposal for a protected area. These studies also facilitated anthropological reconnaissance of the Iskonawa* reserve and the Yavarí-Tapiche reserve (Mayuruna ethnic group). The most recent of these (2004) is the "Socio-economic Study of the Area of Influence of the Proposed Zona Reservada Sierra del Divisor," developed by ProNaturaleza (northern portion) and Center for Amazonian Research-Ucayali National University (southern portion).

Around Zona Reservada Sierra del Divisor there are approximately 20 communities and settlements in which diverse ethnic groups live along the Ucayali, Abujao, Callería, Utiquinía, and Tapiche rivers (Fig. 2A).

METHODS

Our principal objective was to identify the sociocultural assets of local communities and settlements in Zona Reservada Sierra del Divisor. From 2 to 22 August 2005, we visited 9 of 20 communities and settlements around the Zona Reservada (Appendix 11). We could not visit the remaining populations because of limited river access.

In these communities and settlements, we conducted informal and formal meetings with the full participation of community residents and local leaders. In the formal meetings, we explained the purpose of the rapid inventory to residents and recorded local opinions about the creation, management, and control of the protected area. The formal meetings also gave us a preliminary understanding of sociocultural assets and use and care of biodiversity. We collected data in the communities and settlements using participatory techniques, in addition to workshops and semi-structured interviews.

We systematically observed everyday life of the population; held informal conversations with community leaders and key figures; led focus groups; participated in community meetings; developed resource use maps; observed forest integrity in areas of hunting, timber, and non-timber forest product extraction; informally visited homes and agricultural plots; and participated in *faenas* (collectively organized, community projects). All of this information helped us gain a more complete understanding of the socio-cultural assets in the communities and settlements closest to the Zona Reservada.

RESULTS

We identified a set of local patterns of natural resource use, organizational capacities, positive attitudes toward the care and protection of the area, cultural values (supported by leadership and consensus in the social organization), and strong attachment to place and the

* Spelling of the official name of the reserve differs from that used by the Iskonawa themselves.

environment. These local sociocultural assets and practices provide an opportunity to overcome threats and contribute to biodiversity conservation.

Assets

Sustainable use of the natural resources

Knowledge of and techniques for resource use, based on management and low levels of extraction, exist in all of the communities and settlements near the Zona Reservada (Appendix 12). These aspects of the regional population represent significant assets because they challenge quality-of-life definitions that typically are aligned with "development" and "economic growth" and destructive to natural resources (Daly and Cobb 1989; Daly 1996).

In general, the inhabitants along the Zona Reservada use natural resources in a manner compatible with conservation. The extraction of forest products is implemented at the level of the household because these activities are conducted principally for household consumption and basic necessities. The low-impact extraction of forest resources uses manual techniques and small-scale technologies, permitting the regeneration of natural resources (Fig. 11A).

We identified several assets in the Comunidad Nativa (C.N.) Callería, an exemplary indigenous community belonging to the Shipibo-Conibo ethnic group. During conversations with residents, an important topic was the use and management of natural resources. Although located near the confluence with the Río Callería, a tributary of the Río Ucayali close to regional markets, the residents of this community rely primarily on subsistence-based production and extraction and sell their products only to purchase necessary items for healthcare and their children's education. Agricultural production is practiced at the household level, and crops include many varieties of banana, manioc, corn, legumes, fruit trees, and medicinal plants.

Because they are located in a floodplain, residents periodically hunt northwest from the Chachibai indigenous settlement (which consists of Iskonawa populations) and in forests within the El Roble forestry concession. There, hunters find deer (*Mazama* spp.), collared peccary (*Pecari tajacu*), paca (*Cuniculus paca*), saki monkey (*Pithecia monachus*), woolly monkey (*Lagothrix poeppigii*), and game birds.

Fishing for household consumption represents a key activity that is practiced daily in the Río Callería and oxbow lakes (Fig. 11D). The most harvested species include *palometa* (*Mylossoma duriventre*), *sardina* (*Triportheus* sp.), and *lisa* (*Leporinis friderici*) during the low water levels, and *carachama* (Loricariidae), *acarahuazú* (*Astronotus ocellatus*), *cahuara*, *sardina*, and *paña* (piranha, Characidae) during the rest of the year. To ensure the sustainability of this activity, members of the community have created a "Fishing Committee" (Comité de Pesca), formed in 2000 with the support of the Asociación para la Investigación y el Desarrollo Integral (AIDER) and the Fondo de Desarrollo Indígena, which manages a *paiche* (*Arapaima gigas*) farm to repopulate the lakes. The long-term objective of the Fishing Committee is to obtain a concession for the management of this species. Lago Chashuya, which is sufficiently large to support a management plan for the farming of paiche, has been selected. Residents have plans to perform joint management with the Pantoja community (originally from the Cocama ethnic group). They also plan to eventually repopulate other species, such as *gamitana* (*Colossoma macropomum*), *arawana* (*Osteoglossum bicirrhosum*), *doncella* (*Pseudoplatystoma fasciatum*), and *paco* (*Piaractus brachypomus*).

The C.N. Callería has been developing a timber project on 2,528 ha of forest managed by the Comité de Manejo Forestal. This committee includes 24 people and is administered by a president, vice president, treasurer, chief of operations, supervisor of silvicultural treatments, and various others. Timber extraction will occur over a 20-year cutting cycle, and cutting will occur annually in areas that range from 120 to 140 ha. At the same time, the members of the committee feel it is important to give added value to the lumber they produce, e.g., constructing furniture. They also plan to produce

charcoal from the branches of the harvested trees, so as to more efficiently use woody biomass. The presence of outsiders who extract forest products affects the natural resources of the area and has led to various forms of community vigilance. Residents repeatedly express the need to care for the area for the future, given the presence of this strong and persistent threat in the area. The goals of residents in the C.N. Callería—to take care of and manage natural resources—have been backed by specific actions to protect the area from outsiders who practice unsustainable extractive activities. For example, the Comité de Pesca contains a sub-committee focused on vigilance that controls and monitors local access to the area being fished. It has built a control post on the Río Callería to monitor access and use of resources in the area, particularly commercial fishing activities (Fig. 11C). Unfortunately, this system is not always respected by outsiders who pass through the area, probably because the community members do not have government backing.

There exists a great deal of human capacity in the C.N. Callería to collaborate in the protection and care of the Zona Reservada. Residents have demonstrated their interest in conducting, through their own initiative, sustainable use and care of the resources of the area. They also demonstrate the organizational capacity to participate in efforts to control resources. Interestingly, during one conversation with a women's group that forms part of the Comité de Artesanias in the C.N. Callería, they supported the creation of a protected area, and they also recognized the need to maintain a gender balance in the care of natural resources. Two women commented that, "Women also can be park guards," and that, "In the Sira there is a woman park guard, and we can do it, too."

We identified similar assets, particularly relating to resource use, in the other communities and settlements we visited. For example, diversified agriculture is implemented according to labor availability in the community and is used primarily for family consumption. In more densely settled areas, crop diversification is prevalent. Such is the case in the C.N. Patria Nueva, where residents plant manioc, corn, beans, rice, banana, fruits, and a variety of vegetables in their farm plots. In Bellavista, subsistence agriculture is one of the primary activities of the residents, who cultivate manioc, banana, corn, beans, and other fruits, such as mango, lemon, pineapple, and watermelon, for household consumption.

In Guacamayo, which is less densely settled, agricultural production for household consumption is more limited. They cultivate corn, rice, banana, and manioc, as does the C.N. San Mateo, where residents plant manioc, banana, corn, beans, avocado, and a small nursery of cotton.

The majority of the settlements around the Zona Reservada carry out a wide range of extractive activities, including hunting, fishing, and the extraction of timber and non-timber forest products. In some cases, the techniques used are sustainable and low impact because they support household consumption. In other instances, the extraction can be considered sustainable because of the low-impact technologies utilized. A notable example of an extractive activity founded on sustainable management of non-timber resources is practiced in Guacamayo, where residents dedicate the majority of their time to the extraction and refinement of woven thatch known locally as *crisnejas*, which is made from a palm (*Lepidocaryum tenue*) called *irapay* (Fig. 11A). The thatch is sold in Pucallpa and represents the principal income-generating activity in this community. The technique used to manage the irapay palm consists of harvesting mature leaves and leaving the *cogollo* (terminal apex) intact with at least two or three fronds, permitting a rotation cycle every five years per plant.

In Bellavista, residents practice extractive activities in the majority of the tributaries of the Río Tapiche. Residents have extensive knowledge of the forest and the location of diverse species. They harvest low-density timber of high economic value in the local market, such as *cedro* (*Cedrela* sp.), *caoba* (*Swietenia macrophylla*), *cumala* (*Virola, Iryanthera*), *lupuna* (*Ceiba*), *catahua* (*Hura crepitans*), and *copaiba* (*Copaifera reticulata*). Chainsaws are used to fell and buck the logs, which then are manually skidded to the

river for transport. This use of forest products is considered low impact, with minimal disturbance and with natural regeneration of forest products. Harvesting is practiced only among trees with acceptable diameters by commercial standards. Small-diameter trees are left standing, guaranteeing the natural regeneration of trees and seed dispersal. Heavy machinery is not permitted in timber extraction.

In Canelos, residents hunt forest game very infrequently, primarily to celebrate the Christmas holiday, weddings, and the community's anniversary. In these cases, the majority of species harvested include *majás* (*Cuniculus paca*), deer, collared peccary, and various monkeys.

Strong desire to care for natural resources

Threats to the Zona Reservada affect not only biodiversity but also local residents and isolated indigenous groups. During conversations with members of the communities and settlements the majority expressed a great desire to protect their natural resources and control the access of outsiders who seek to extract forest products.

Fish are fundamental in local diets. In all of the communities and settlements we visited, fishing was primarily for household consumption. However, commercial fishing by outsiders is forcing local communities to organize, manage, and protect their fish and water resources.

Residents of the C.N. San Mateo, for example, indicated that resources abundant during their parents' generation have become scarce. They reflected that it is important to maintain species diversity, as well as diversify crops in their agricultural plots and gardens. This desire led them to introduce some plants, such as *sangre de grado* (*Croton lechleri*) and the *aguaje* palm (*Mauritia flexuosa*), into the community.

Currently, forestry concessions exist. These are managed by loggers and border the territory of the C.N. San Mateo. In addition, illegal loggers toil inside and around the community. Faced with these threats, the community is vulnerable because it has few members to help monitor and protect its territory, and also is too isolated to solicit support and file complaints to government authorities. For these reasons, residents expressed a willingness to collaborate in the care and protection of their natural resources. Current residents of San Mateo, despite threats they have received from loggers and the continual penetration of miners and other outsiders into their territory, feel compelled to stay in the area because it is integral to their livelihoods: the forest provides them with sufficient goods for household consumption and guarantees a good quality of life.

Residents of Vista Alegre, Guacamayo, C.N. Patria Nueva, and C.N. Callería possess positive attitudes with regard to the creation of a protected area in the region and want to take better care of their aquatic resources. They are concerned about the use of a pesticide (known as Tiodan) for commercial fishing, and about the opening of forest from the headwaters of the Río Callería to the headwaters of the Río Tapiche for the extraction of high-value timber (caoba and cedro), as this would bisect the Zona Reservada and part of Reserva Territorial Isconahua. For these reasons, residents consider the creation of a protected area a legal instrument that will reduce territorial encroachment by loggers and commercial fishing with pesticides.

On the Río Tapiche, residents belonging to the C.N. Limón Cocha expressed fear that their children will not have natural resources in the future because remaining resources are substantially depleted. For this reason, safeguarding the remaining forest is extremely important. When informed about the proposal for the Zona Reservada, they agreed with the idea of creating a protected area and expressed their desire to participate in its monitoring and management.

These local perspectives for conservation of natural resources in the Zona Reservada reflect an asset that was found in all areas visited by our team. Initiatives derived from these conservation-friendly perspectives should be incorporated into strategies and mechanisms for the protection of biodiversity in the area.

Effective community organization

Local social organizations that effectively carry out activities for the well-being of the community and the family are a great asset for the implementation of a system to protect biological and cultural diversity. Various examples of organizational assets were apparent during our fieldwork. In general, these confirm that the communal use of natural resources can contribute in important ways to the conservation and sustainable management of natural resources. Kinship, in the majority of the cases, forms an important base upon which to consolidate these collective practices.

Collective community labor, known as *minga*, is the principal form in which community members in the region organize and carry out agricultural and communal activities. Mingas engage in community work (such as cleaning and maintaining the soccer field), and also are organized for the benefit of multiple families (tending agricultural plots and crops, building homes, etc). The mingas generally last an entire day and include 15 to 25 people. Men and women of various ages participate, and it is the responsibility of the minga organizers to provide food and drink for all participants. These group efforts strength-en social and kin-based networks within the community.

In various communities, there exist mechanisms that guarantee the democratic participation of residents. For those who do not contribute to communal activities, local authorities enforce informal sanctions, which encourage greater participation and the acceptance of duties. When an authority figure is consistently absent, or results are not evident during the period during which an authority is in charge, the community changes the authority or proceeds to restructure community jurisdiction.

One example of collective, organized work is the harvesting of natural resources in Guacamayo, where men, women, and children work together to weave irapay palm leaves into thatch. During the morning, the men harvest the fronds while the children are at school; and in the afternoon, all family members weave the fronds into thatch (Fig. 11A). The thatch is sold by way of an intermediary (generally a relative) in exchange for basic household items from Pucallpa (kerosene, salt, oil, soap).

In the C.N. Callería, different committees were formed with the intention of carrying out sustainable forest management of natural resources. These committees are dedicated to the management of forest and fisheries, and the creation of handicrafts.

To make handicrafts, women primarily rely on raw forest goods. However, additional resources are required to make ceramics, such as lacquer and white and black soils that are imported from neighboring native communities, including Tupac Amaru (from the upper Río Ucayali) and Nuevo Edén (from the Río Pisqui). These intercommunity relations, based on kinship and collective organization, constitute an important asset because they demonstrate great capacity for communication and coordination despite geographic distance.

Other kinship ties strengthen the conduct of community organizations. Diverse forms of local organization exist, including those of citizens, community authorities, and key groups (committees, clubs, work commissions, etc.) created to carry out specific tasks (management of forest, fish, irapay, etc.).

The majority of communities and settlements we visited are organized politically and officially, implementing decision-making by way of community assemblies and applying sanctions to those who do not participate adequately. Less formal, but effective, means of consolidating community efforts also are employed, e.g., in Guacamayo where few residents (only 12 families) are able to make decisions without the need of holding a formal meeting.

On the other hand, the C.N. Callería is consolidated by means of a formal system. The population is particularly organized because of a strong political organization that has community support. The authorities set priorities for the interests of the community and coordinate important issues such as cleaning the streets and *linderos* (paths that community members clear in the forest to delineate the limits of a given territory), organizing mingas (for home construction, tending to the soccer field and schools), among other activities. Every

Saturday approximately 90 residents dedicate part of their time to community work. This group contains able-bodied people (young people and adults with physical strength and skills), and "retirees" (older adults and elderly people for whom participation is optional).

We observed another interesting example of a group created by women to respond to a specific necessity in the C.N. Limón Cocha, where the mothers' club (Club de Madres) was recently reconstituted to teach the Kapanawa native language to the children in coordination with the primary school.

All of these effective methods of communal organization represent the diversity of local capacity that could contribute to the protection of the area. Not only do the official authorities work toward the well-being of the community and of the family, but informal organizations and groups have been created specifically to protect natural resources and to develop activities for the well-being of the community. Throughout these various organizations, kinship bonds play important roles.

Many of the indigenous communities and settlements have a presence in the area that traces back for up to five generations. An important sense of identity and attachment to place has been transmitted to younger generations, who in turn express interest in caring for forest resources so that future generations may use them. Also, some recent settlers express a desire to remain where they have settled and live from forest resources. In conclusion, small settlements and communities use natural resources, primarily for local consumption, commerce, and subsistence. In some cases, efforts are in place to repopulate fish, manage different forest resources, and develop strategies to control access to natural resources.

THREATS AND RECOMMENDATIONS

Extractive interests motivated by regional, national, and international markets threaten Zona Reservada Sierra del Divisor, particularly the region's biological diversity and the voluntarily isolated indigenous communities living within its boundaries. To counter these threats, we offer the following recommendations:

Develop participatory mechanisms for the protection and management of the area.

Social and cultural assets we identified during the rapid social inventory should form the basis for local participation in the protection of the Zona Reservada. Mechanisms for protecting the area should be incorporated into the numerous social organizations that already exist in the local communities and settlements. These organizations include local authorities and other organized groups that carry out management and oversee the use of fish, forest, and agricultural resources. All of these local capacities should be enlisted for the care of the protected area.

Involve the Comunidad Nativa Matsés.

The C.N. Matsés lies to the north of Zona Reservada Sierra del Divisor, and the Matsés traditionally use the areas within the northern reaches of the Zona Reservada, along the Brazilian border. We recommend that the Matsés be explicitly incorporated into the management and care of the northern part of the Zona Reservada.

Develop a shared vision among diverse parties involved in the protection of the area.

There exists local interest in developing the sustainable use of natural resources for the well-being of local communities. We recommend a series of meetings among actors who share the same vision of protecting the area, so as to outline a plan to define and implement a management plan for the area. We can accomplish this by linking conservation interests, sustainable use of natural resources, and guarantees of the rights of indigenous people.

To achieve this shared vision, we recommend an open dialogue among all local organizations and residents to share their ideas and integrate them into the implementation of a protected area. A process of consultation and dialogue should continue with the local residents who were eager to share their interest in caring for the region over the long term. Our inventory was rapid and there are still additional communities and residents that should be visited and included.

Correct boundaries of overlapping protected areas and indigenous territories.

In the cases where overlaps exist between protected areas and indigenous territories, we recommend reviewing and modifying boundaries, as in the following cases (Figs. 2A, 10C, 10D):

- Reserva Territorial Isconahua overlap with the C.N. San Mateo
- Zona Reservada Sierra del Divisor overlap with settlements along the Río Callería
- The proposed Reserva Territorial Yavarí-Tapiche overlap with the proposed extension of the C.N. Matsés
- Zona Reservada Sierra del Divisor overlap with the proposed extension of the C.N. Matsés

Recognize important sociocultural assets.

Local residents have a long-term vision of commitment to protect the area and secure the well-being of future generations. Transmission of knowledge, local technologies, and cultural values to younger generations in the Sierra del Divisor region should be recognized explicitly as an asset, and fostered in the future.

LEGAL STATUS OF TERRITORIAL RESERVES FOR THE PROTECTION OF ISOLATED INDIGENOUS PEOPLES IN PERU

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Introduction

Legal protection of the rights of voluntarily isolated indigenous peoples has been disorganized and incomplete in Peru. Throughout its history as a republic, Peru has shown little interest in these Amazonian peoples. Yet with the development of economic activities, including the extraction of natural resources from the Peruvian Amazon in the second half of the twentieth century, the government enacted legislation creating areas known as *Reservas Territoriales* (Territorial Reserves). These reserves were meant to protect the isolated indigenous populations from threats or aggression by incoming settlers, oil and mining companies, legal and illegal loggers, coca growers, and drug traffickers. The legislation has several flaws, however. In this chapter, we present a general overview of the current legal status of the Reservas Territoriales.

International protection of voluntarily isolated indigenous peoples

For two decades, efforts to enact special protections for indigenous peoples worldwide, and in Latin America in particular, have failed. Currently, draft declarations recognizing the rights of indigenous groups are being reviewed by the United Nations as well as by the Organization of American States (OAS). Meanwhile, Convention 169—the Convention on Indigenous and Tribal Peoples in Independent Countries—adopted by the International Labour Organization (ILO), serves as the only law that protects the rights of "isolated" indigenous peoples, as peoples in voluntary isolation or in first contact are known to the outside world.

A meeting in Belém, Brazil, in November 2005, the Primer Encuentro Internacional sobre Pueblos Indígenas Aislados de la Amazonía y del Gran Chaco—with indigenous organizations, social service organizations, conservation agencies, and other experts—focused on the protection and defense of the rights of isolated indigenous peoples. Participating Peruvian organizations included the Asociación Interétnica de Desarrollo de la Selva Peruana (AIDESEP, Peru's indian affairs agency, the only indigenous organization at the event), Defensoría del Pueblo, Instituto del Bien Común (IBC), Asociación Peruana para la Conservación de la Naturaleza (APECO), WWF-Peru, and Derecho, Ambiente y Recursos Naturales (DAR).

This event, organized by the Coordinación General de Indios Aislados de la FUNAI (A Fundação Nacional do Índio) and the NGO Centro de Trabajo Indigenista (CTI), produced a general analysis of the critically vulnerable status of voluntarily isolated indigenous peoples throughout the Peruvian Amazon and the Chaco (Table 3).

Table 3. Analysis of the legal status of isolated indigenous groups (Gamboa 2006).

Country	Legal status	Actual status	Legal Proposals
Bolivia	None	Vulnerable	None
Brazil	Protected Areas	Vulnerable (state governments and illegal loggers)	Statute of 1973
Colombia	Protected Zones in national parks	Vulnerable (political violence)	Protected Zones in national parks
Ecuador	Executive Decree	Vulnerable (oil politics)	Protected Zones in national parks
Peru	Territorial Reserves	Vulnerable (economic politics in Amazonia)	Proposal for Special Regulations from the Comisión Especial (D.S. 024-2005-PCM)
Paraguay	Properties bought by NGOs	Culturally vulnerable	None except the Chaco Biosphere Reserve

Participating organizations recognized the need to form an international information and monitoring network to protect voluntarily isolated peoples. The Alianza Internacional para la Protección de los Pueblos Indígenas Aislados was created, with its administrative office assigned to the Brazilian ILO. In the Declaración de Belém sobre Pueblos Indígenas Aislados (11 November 2005), countries of the Amazon and Chaco regions were urged to take steps to protect voluntarily isolated peoples. In Peru, the Alianza coordinated a letter-writing campaign to the Peruvian congress to encourage adoption of the proposed bill containing the "Regulations for Special Protection of Voluntary Isolated and First-contact Indigenous Peoples" (draft bill submitted by Prime Minister Carlos Ferrero, through the letter of April 26, 2005, to the Comisión de Amazonía del Congreso).

Current protective regulations

The laws that regulate the collective rights of voluntarily isolated peoples in the Peruvian Amazon—defined in Peru's national legislation as indigenous peoples, ethnolinguistic groups, indigenous populations, and others—are the following:

- Article 89 of the Constitución Política de 1993
- Article 14—Clauses 1, 2, and 3—of the Convention N° 169 on Indigenous and Tribal Peoples in Independent Countries, adopted in Geneva on 27 June 1989 by the International Labour Organization (ILO)
- The Second Transitory Phase of Law N° 22175, Ley de Comunidades Nativas y de Desarrollo Agrario en las Regiones de Selva y Ceja de Selva ("Native Communities and Agrarian Development of Forest Regions and their Borders")
- Articles 4, 5, 6, 9, and 10 of the Supreme Decree N° 003-79-AA, Reglamento de la Ley de Comunidades Nativas y de Desarrollo Agrario de las Regiones de Selva y Ceja de Selva, through which the Direcciones Regionales Agrarias (Regional Agrarian Directorates) oversee the delineation of Native Communities' territories.

Along with these main regulations are international mechanisms in (1) the Universal Human Rights Declaration; (2) the 1996 "International Pacts on Civil and Political Rights and Economic, Social, and Cultural Rights" (Pactos Internacionales de Derechos Civiles y Políticos y Derechos Económicos, Sociales y Culturales); (3) the International Convention on the Elimination of All Forms of Racial Discrimination; and (4) the American Convention on Human Rights. Together with the laws in the political constitution of Peru, these regulations offer legal support for the *pro juris hominun* interpretation in favor of the rights of isolated indigenous peoples.

According to Article 10 of Law 22175 (Decreto Ley N° 22175), the government guarantees the territorial integrity of native communities (*Comunidades Nativas*) and will register property values and grant land titles, taking into account the communities' sedentary or nomadic natures. Articles 4, 5, and 6 of the Reglamento de la Ley de Comunidades Nativas y de Desarrollo Agrario de las Regiones de Selva y Ceja de Selva establish complementary protective regulations for isolated and first-contact cultural groups, thereby creating national Reservas Territoriales for the protection of these indigenous groups.

Current "indigenous" territorial reserves

Working together in interpreting the regulations that grant authority for demarcating territories, Peru's Ministry of Agriculture and the Regional Agrarian Directorates have set up lands and corresponding rights for voluntarily isolated indigenous peoples through Reservas Territoriales that were created by various regulations since 1990. The resulting "mixed" system combines protection of natural resources and the collective rights of isolated indigenous peoples. The need for a coherent, strong system to protect human rights is fully evident today. And that need for a coherent legal system is urgent to coordinate state and national policies, institutions, regulations, and

Table 4. Currently established "indigenous" Reservas Territoriales in Peru (Gamboa 2006).

Protected cultural group	Enacting regulation	Level of regulation	Modification of the enacting regulation
Kugapakori, Nahua, Nanti, and others	Decreto Supremo 028-2003-AG, of 7/25/2003	Supreme Decree	(1) Proposal to protection of the property rights of the indigenous peoples (with traditional occupations) to use the natural resources in the reserve (2) Rights of use of the area's natural resources for subsistence (3) Prohibition of colonist settlements (4) Prohibition of economic activities
Murunahua (ethnic group)	Resolución Directoral Regional 453-99-CTAR-UCAYALI-DRSA, of 9/24/1999	Resolution of the Regional Agrarian Directorate	(1) Proposal to protect the property rights of the indigenous people (with traditional occupations) to use the natural resources in the reserve (1997) (2) Exclusion of forestry concessions (1999)
Mashco-Piro (ethnolinguistic group)	Resolución Directoral Regional 190-97-CTARU/DRA, of 4/1/1997	Resolution of the Regional Agrarian Directorate	Proposal to protect the property rights of the indigenous people (with traditional occupations) to use the natural resources in the reserve
Iskonawa (Isconahua) (ethnic group)	Resolución Directoral Regional 201-98-CTARU/DGRA-OAJ-T, of 6/11/1998	Resolution of the Regional Agrarian Directorate	Proposal to protect the property rights of the indigenous people (with traditional occupations) to use the natural resources in the reserve
Groups not specified in Madre de Dios	Resolución Ministerial 427-2002-AG, of 4/22/2002	Ministry Resolution	Proposal to protect the property rights of the indigenous people (with traditional occupations) to use the natural resources in the reserve

procedures that protect and enforce the interests and collective rights of isolated indigenous peoples. Five "indigenous" territorial reserves exist in Peru, under various laws (Table 4).

With the exception of the Reserva Territorial for the "Kugapakori, Nahua, Nanti, and others"—which was elevated to the level of "Supreme Decree" because of political motives related to the Camisea Gas energy project—there has been no fundamental protection specifically for the benefit of isolated indigenous peoples created anywhere in Peru. The only measure regulating the need to establish legislative and administrative procedures to protect the rights of isolated indigenous peoples was Supreme Decree 013-2001-PROMUDEH. This decree charged the Secretaria Técnica de Asuntos Indígenas (SETAI, "Technical Office of Indigenous Affairs"), of the then-Ministerio de la Mujer y del Desarrollo Humano ("Ministry of Women and Human Development"), with overseeing and ensuring respect toward, and rights of, voluntarily isolated and first-contact indigenous peoples in all actions undertaken by the Departments of (1) agriculture; (2) industry, tourism, and international commercial negotiations; (3) energy and mines; (4) health; (5) education; (6) defense; and (7) fisheries. SETAI was also responsible for outlining a policy of intervention to guarantee the rights of these indigenous peoples.

With the creation of the Comisión Nacional de los Pueblos Andinos, Amazónicos y Afroperuanos (CONAPA)—assigned to the Presidencia del Consejo de Ministros—SETAI, which initially oversaw CONAPA, was dissolved and its functions were assumed by the Executive Secretary of CONAPA. Subsequently CONAPA was deactivated and now the Instituto Nacional de Desarrollo de los Pueblos Indígenas, Amazónicos y Afroperuano (INDEPA) assumes the job of creating a system of protection for the isolated indigenous peoples (Art. 13, Law 28495 of 6 April 2005).

Official state recognition of the vulnerability of voluntarily isolated indigenous peoples

The Defensoría ("Defense Council") del Pueblo del Perú published Report 101 (Resolución Defensorial N° 032-2005-DP), entitled Pueblos Indígenas en Situación de Aislamiento Voluntario y Contacto Inicial. The reports mentions an estimated 14 ethnic groups in vulnerable situations (with regard to life, health, property, and use of natural resources). Principal threats come from mining and oil operations, legal and illegal logging, tourism, drug trafficking, and others. The report also identified economic activities—in particular oil exploitation—that will have a serious negative impact on these isolated indigenous peoples (Table 5).

Report 101 determined that, despite the establishment of Reservas Territoriales, economic activities continued unimpeded, having a negative effect on the life, health, and physical integrity of the indigenous peoples, as well as destroying their territorial

Table 5. Impact of oil exploitation activities (Gamboa 2006).

Cultural group	Lot/Principal operator/Status
Kugapakori, Nahua, and Kirineri	Lot 88/Pluspetrol, TGP, and Hunt Oil, Cusco/Exploitation license active; and Lot 57/Repsol, Cusco Ucayali/Exploitation license active
Arabela, Auca (Huaorani)	Lot 39/Repsol, Loreto/Exploitation license active; and Lot 67/Barret, Loreto/Exploitation license active
Murunahua	Lot 110/Petrobrás, Ucayali/Exploitation license
Isolated indigenous peoples of Madre de Dios	Lot 113/Sapet/Exploitation license active

Table 6. Territorial Reserves Created to Date (Gamboa 2006).

Cultural group	Activities harming isolated indigenous groups
Kugapakori, Nahua, Nanti, and others	Lot 88 of Gas de Camisea's Proyecto Energético
Murunahua (ethnic group)	Logging concessions and illegal logging (exclusion of the area by INRENA)
Mashco-Piro (ethnolinguistic group)	Logging concessions and illegal logging
Iskonawa (Isconahua) (ethnic group)	Logging concessions and illegal logging
Groups not identified in Madre de Dios	Logging concessions and illegal logging (exclusion of the area by INRENA)

rights, cultural identities, and natural resources. The report proposed the creation of special regulation to give genuine and full protection for voluntarily isolated indigenous peoples (Table 6).

"Special Protection" regulations

As of 2005, the vulnerable status of voluntarily isolated and first-contact indigenous peoples, brought to public attention through the Camisea Gas project and the social and economic problems of the Peruvian Amazon, resulted in the confirmation of a special commission formed by representatives of the Ministries of agriculture, health, defense, foreign relations, energy and mines, transportation, and communication, as well as "The Defense Council of the People" (la Defensoría del Pueblo), with INDEPA as president of the commission. Also participating were representatives of the farm-labor and Amazon associations, AIDESEP and the Confederación de Nacionalidades Amazónicas del Perú (CONAP). The commission was created by Supreme Decree 024-2005-PCM, which formulated a "Draft Bill for the Protection of Voluntarily Isolated or First-Contact Indigenous Peoples."

Subsequently, the presidency of the Council of Ministers (Consejo de Ministros), through communication 078-2005-PCM, presented the proposal developed by the "Comisión Especial del Consejo de Ministros to the Comisión de Amazonía, Asuntos Indígenas y Afroperuanos" of the Peruvian Congress.

The Congressional Commission (through the Decision of Bill 13057) proposed the "Law for the Protection of Voluntarily Isolated and First-Contact Indigenous Peoples," which modifies and limits the special-protection regulations for these groups presented by the Special Commission. The two proposals for laws were radically different: a "Draft Bill on Special Regulations for the Protection of Voluntarily Isolated and First-Contact Indigenous Peoples" developed by the Comisión Especial del Poder Ejecutivo (Supreme Decree 024-2005-PCM), and Decision 13057, the "Law for the Protection of Voluntarily Isolated and First-Contact Indigenous Peoples." The second proposal weakens the first because it eliminates (1) the transectorial obligations of the government; (2) the institutionality of the regulations (through the lack of a named director); (3) the "Procedures of Protection," and (4) the "Proposal of Transectorial Protection."

In 2005, the new Comisión de Pueblos Andinoamazónicos, Afroperuanos, Ecología y Ambiente del Congreso de la República petitioned the Consejo Directivo ("Managing Council") to withdraw Decision 13057 for further study by that Commission.
A communication on October 4 and 5 of 2005 from indigenous organizations (AIDESEP and CONAP) and NGOs (WWF, DAR, IBC, Shinai, Racimos), requesting that the legislative process of Decision 13057 be detained, was successful. Unfortunately, the Comisión de Pueblos Andinoamazónicos, Afroperuanos, Ecología y

Ambiente del Congreso de la República did not discuss this decision until the end of November, making approval of any regulation or law benefiting these groups in the year 2005 impossible. Not until 30 November 2005 did Commission advisors present the by-then merged Comisión de Pueblos Andinoamazónicos, Afroperuanos, Ecología y Ambiente with a pre-decision on these special regulations. The new text eliminated the initially proposed Special Regulations by the Comisión del Poder Ejecutivo (created by Supreme Decree 024-2005-PCM); however, it retains the inviolable character of the Reservas Territoriales (e.g., prohibiting settlements other than those of the isolated groups and explicitly prohibiting "the granting of rights that would imply the surrendering of natural resources"). The shortcomings of this proposal include (1) the lack of clarity on the issue of special regulations of protection, which are made transitory until these isolated peoples enter into voluntary contact with mainstream society; (2) the establishment of two complex procedures to protect these peoples (one to prove their existence and another to create a territorial reserve); and (3) the setting of time limits for the Reservas Territoriales, to be stated in the Supreme Decrees that create the Reserves. With arbitrary limits of five, ten, or fifteen years for strict protection, the intrusion of activities harmful to the rights of these isolated peoples becomes possible in the near future.

AIDESEP and other organizations (WWF, IBC, DAR, Racimos, Shinai) developed diverse strategies to speak with and educate members of the Peruvian Congress, both in the Commission and in the full Congress. The goal is to regulate economic activities—from extractive economies to the sustainable exploitation of natural resources—that would infringe on the human rights of the isolated indigenous peoples. International legislation that protects these indigenous peoples could impose international sanctions on Peru, such as those indicated in the ruling of the Interamerican Court in Awas Tigni vs. Nicaragua, which prohibits Nicaragua from granting natural resource concessions without recognizing the ancestral and historic property rights of indigenous communities.

Current legislative status

On 13 December 2005, the Comisión de Pueblos Andinoamazónicos, Afroperuanos, Ecología y Ambiente finally approved Decision 13057, which substantially kept intact the "Special Regulations for the Protection of Voluntarily Isolated and First-Contact Indigenous Peoples." However, we make two observations below:

- Some elements of the legislation are from the original proposed draft bill of the Comisión Especial del Poder Ejecutivo (created by Supreme Decree 024-2005-PCM), in which national institutions (the ministries of energy and mines, health, external relations, and agriculture—MINEN, MINSA, MRE, MINAG, INRENA) and indigenous organizations (AIDESEP and CONAP) participated. This version is certainly better than the previous one (of 24 June 2005). Among the recovered elements are (1) the transectorial nature of the regulations; (2) the clear obligation of the government toward the isolated indigenous peoples; and (3) the inviolable character of the territorial reserves (with prohibition against the establishment of colonist settlements and economic activities).
- Among the problems in the text is (1) the elimination of the injunction to penalize unauthorized incursions into the territorial reserves. This elimination weakens the preventive and protective measures of the original regulations. (2) Time limits have been established for the indigenous territorial reserves, "renewable indefinitely as often as necessary." However, the intercultural criterion that the reserves be maintained until the isolated groups decide to initiate contact has not been retained, (3) nor has the regulatory decree indicating "that rights acquired by third parties or economic activities in progress at the time a territorial reserve is established must conform to the objectives and resolutions of the Régimen Especial de Protección, to this law, and to its rules."

Other elements in this version are dangerous, for example, the intention to reduce Reservas Territoriales because of their overlap with the rights of third parties, logging grants, or other exploitation rights; even in cases

of overlap with "permanent production forests" that represent a type of "economic-ecologic zoning" but not an exploitation right. We must prevent the reduction of areas of protection for these cultural groups.

The Decision 13057 was approved by the full Congress in March 2006. It was promulgated as Law 28736, which entered into force on 19 May 2006. This law created the "special transectorial regulations to protect voluntary isolated and first-contact indigenous peoples." However, it still needs to be modified, or, through regulations, made to be stronger to provide strict protection for isolated indigenous peoples. The group led by AIDESEP and composed by WWF, Shinai, Racimos, DAR, and IBC continue to work on a proposal of modification of the law while simultaneously working on regulations that would strengthen the current law.

Final comments

The objective of these special regulations is to clarify the duality of the legal discourse: (1) to recognize the full rights of isolated indigenous peoples and (2) to protect them effectively from any social, economic, cultural, or political interference that would harm them, as has occurred multiple times in the past, with the rubber-tappers, Shining Path (Sendero Luminoso), Armed Forces, settlers, or even other native communities. We should emphasize that constitutional and legal protection of the rights of indigenous peoples, and the exercising of these rights, must be in accordance with respect for human rights, as dictated by the Constitution and, where appropriate, by law. While it is important to create special regulations for the protection of voluntarily isolated indigenous peoples and to work out a clause of constitutional agreement that contains a "legal, constitutional benefit" that respects our legal system, it is just as critical that this framework of protection seek to establish an utterly fair and straightforward intercultural dialogue between the socially dominant culture and the Andean or Amazonian one, which has been dominated for centuries. Perhaps these regulations will give a new start to identities based on the notion that Mariategui designated "Peruvianness" (*peruanidad*).

This is an opportunity that history has granted us as a national society to value and celebrate the diverse cultures that enrich Peru.