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INSTITUTIONAL PROFILES

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. Environment, Culture, and Conservation (ECCo) is the division of the museum 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.

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Comunidad Nativa Matsés

The Comunidad Nativa (CN) Matsés is an indigenous territory legally registered in Loreto, and includes the majority of Matsés indigenous peoples in Peru. The Matsés territory was legally titled in 1993, and covers 452,735 ha in the Yaquerana district, Requena province, Loreto. The CN Matsés consists of 13 settlements, or *Anexos* situated along the banks of the Río Yaquerana, Río Gálvez, and the Quebrada Chobayacu. The Matsés, hunter-gatherers and farmers by tradition, are in the process of becoming more sedentary. Their organization is based on familial relationships and matrimonial alliances. The *Juntas de Administración* and the *Asamblea General de Delegados* govern formal institutional relationships between the *Anexos*, and the *Junta Directiva* legally represents the CN Matsés. The CN Matsés is autonomous and is not affiliated with any indigenous federation.

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Centro para el Desarrollo del Indígena Amazónico (CEDIA)

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

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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. It houses collections from several countries, but the bulk of the collections showcase representative specimens of the Amazonian flora of Peru, one of the most diverse floras on the planet. The collections serve as a valuable resource for understanding the classification, distribution, phenology, and habitat preferences of plants in the Pteridophyta, Gymnospermae, and Angiospermae. Local and international students, professors, and researchers use the collections to teach, study, identify, and research the flora. Through its research, education, and plant identification the Herbario Amazonense contributes to the conservation of the diverse Amazonian flora.

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INSTITUTIONAL PROFILES

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

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

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Centro de Conservación, Investigación y Manejo de Áreas Naturales (CIMA-Cordillera Azul)

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

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The success of our rapid inventories depends largely—if not entirely—on an enormous network of collaborations on the ground: from the hospitality and ingenuity of local residents, to the excitement and collaborations of our scientist colleagues, to the invaluable support of large government agencies. This inventory was no exception. We sincerely thank each and every individual who helped make this work possible, although we are able to highlight only a small subset below.

We could not have surveyed the spectacular lowland forests surrounding the Comunidad Nativa Matsés without the integral involvement of our Matsés guides and counterparts. They participated in every aspect of the inventory: preparing camps and trails as part of the advance team; surveying plants, fishes, frogs, snakes, birds, and mammals as part of the biological team; identifying traditional assets as part of the social team. We cannot thank the Matsés leaders and our field companions enough for inviting us to inventory the forests neighboring their lands, welcoming us into their communities, and sharing their vision for the future with us.

Guillermo Knell once again handled the logistics masterfully, coordinating the advance preparations for the inventory and putting together a formidable, multi-talented team: José-Ignacio (Pepe) Rojas, Antonio Garate, and Dani Rivera. The advance team led the construction of heliports, campsites, and trails. In addition, Dani formed part of the herpetological team at Itia Tëbu, while Pepe contributed greatly to the bird inventory at Actiamë.

We received excellent support from every settlement within the Comunidad Nativa Matsés. In Choncó, Pepe Rojas was joined by Robinson Reyna from Jorge Chávez; Pepe Rodriguez, Antonio Reyna and Hernan Manuyana from Buen Perú; Pepe Vela, Benito Vela, and Andres Fasabi from San Jose de Añushi; and Jorge Waki, Samuel Coya, and Daniel Teka from San Juan. Dani Rivera and Antonio Garate established Itia Tëbu with Cesar Sanchez from Jorge Chavez; Eliseo Silvano and Oscar Lopez from Remoyacu; Mariano Manuyama, Ramon Jimenez, Glen Manuyama from Buen Perú, Noe Silvano from Paujíl; German Rodriguez and Gidebrando Tumi from San Mateo; and Juan Tumi from San Jose de Añushi. Guillermo Knell led the team at Actiamë that included Douglas Dunu and Daniel Nacua from Puerto Alegre; Mario Binches, Julio Tumi, and Leonardo Dunu from Buenas Lomas Nueva; Tomas Necca and Jaime Teca from Buenas Lomas

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invaluable maps and Ronald Rodriguez for coordinating the administrative and financial details of the inventory in Peru. We thank the Hotel Sadicita in Requena and the Hotel Doral Inn in Iquitos for tolerating the mud and occasional chaos.

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MISSION

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

In 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 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 decision-makers who set priorities and guide conservation action in the host country.

REPORT AT A GLANCE

Dates of fieldwork

25 October–6 November 2004

Region

Loreto province, northeastern region of the Peruvian Amazon, in the interfluvium between the Blanco, Gálvez, and Yaquerana rivers. The area is bordered on the west by the headwaters of the Río Gálvez, a mere 3 km from the Río Blanco. In the south, the area borders the proposed Zona Reservada Sierra del Divisor; in the east, it borders the Comunidad Nativa Matsés, and to the north, the area is 150 km from the city of Iquitos (Figure 2). This vast extension of lowland forests harbors an exceptional variety of soils and forest types.

Sites surveyed

Three sites in the Amazonian lowlands that border the Comunidad Nativa Matsés: Choncó, in the middle part of the Río Gálvez basin; Itia Tëbu, in the headwaters of the Río Gálvez, close to the Río Blanco; and Actiamë, along the banks of the main channel of the Río Yaquerana (Figures 3A, E, I).

Organisms surveyed

Vascular plants, fishes, reptiles and amphibians, birds, and large mammals

Highlights of results

Our most surprising and spectacular result was finding a large archipelago of white-sand forests, known locally as *varillales*, in the headwaters of the Río Gálvez. These extensive patches of white-sand forest—unknown to scientists until this inventory—contain floral and faunal endemics and represent a rare habitat in Peru and the rest of the Amazon. Because of the great edaphic variation across the proposed Reserva Comunal Matsés, from the poor white-sand soils to extremely rich soils, the area harbors a near complete sample of the extraordinary diversity of plants and animals living in *terra firme* forests of the Peruvian Amazon.

Plants: The forests in the proposed Reserva Comunal Matsés are tremendously heterogeneous and diverse, and appear to shelter a higher diversity of plants than any other reserve in lowland Peru. The botanists registered ~1,500 species of plants in the field, and estimate a regional flora between 3,000–4,000 species. Of the more than 500 fertile species collected during the inventory, several of the locally common species are potentially new records for Peru and/or new to science. The forests here are notably intact.

Fishes: During two weeks of sampling the rivers, lagoons, and blackwater, clearwater, and whitewater streams of the area, the ichthyological team recorded 177 species of the more than 300 species they estimate for the region. Ten of these species are new records for Peru, and up to eight species could be new to science. Much of the fish diversity is concentrated in forest streams, with a great richness of ornamental species (cichlids, pencil fish). The larger rivers support healthy populations of species consumed by humans, including *paiche*, *tucunaré*, *doncella* and *arahuana*.

Highlights of results
(continued)

Reptiles and Amphibians: The herpetological team registered 74 species of amphibians and 35 species of reptiles (18 lizards, 13 snakes, 2 caimans, 2 turtles) during the inventory. Three of the amphibian species are potentially new to science, including one species that appears to be restricted to white-sand habitats (a *Dendrobates* with golden legs, Figure 6C). The herpetologists recorded a new genus for Peru, *Synapturanus* (Figure 7C), when they heard the call of this subterranean species coming from under the mud. The team estimates more than 200 species of amphibians and reptiles for the region, including 100-120 species of amphibians, 25 lizards, 4 caimans, 8 turtles, and 70 snakes.

Birds: In the 14 day-inventory, the ornithological team recorded 416 of the 550 species of birds they estimate to live in the region. Several of their records represent substantial range extensions, and four of the recorded species are locally distributed in Peru, with fewer than 10 previous records. The three inventory sites were markedly different in community composition (diversity and abundance of species) reflecting the habitat differences between sites. The team found two white-sand habitat specialists during the inventory, one of which may be new to science. With additional inventories, we would expect to find more habitat specialists in the vast white-sand archipelago in the Matsés region.

Mammals: Western Amazonia is one of the areas with highest mammal diversity in the world. The proposed Reserva Comunal Matsés is no exception, with 65 large mammal species estimated for the region, and 43 species recorded during the inventory. The area supports healthy populations of many species threatened at the global level, including a high density of large primates (woolly and spider monkeys, Figure 9A). Two rare and endangered monkey species, *Cacajao calvus* and *Callimico goeldii*, are known from this area, although they were not seen during the inventory. The mammal community within the Matsés region does not bear signs of hunting impacts and appears remarkably intact.

Human Communities

The Matsés people have lived in this region for generations, on both sides of the border between Peru and Brazil. In 1993 the Peruvian Matsés, with the assistance of CEDIA, obtained legal title to their lands, an area now known as the Comunidad Nativa Matsés (CNM: 452,735 ha). Some 1,700 Matsés people live within the CNM, dispersed among 13 human settlements, or *Anexos*, along the Quebrada Chobayacu, and the Yaquerana and Gálvez rivers.

Main threats

Timber extraction and related impacts (tractor trails [Figure 10D], access points for colonists), presents one of the most serious threats to the region. On the west side of the Río Blanco, an area slated for timber concessions overlaps with a large expanse of white-sand forest. These forests—with their extremely short and thin

REPORT AT A GLANCE

Main threats (continued)

trees—exhibit such low levels of productivity that generations of Matsés consider them unproductive both for hunting and for farming. The destruction observed in other white-sand forests (e.g., forests close to IQUITOS in the Nanay river basin) demonstrates clearly that not only would timber extraction in white-sand areas be unproductive and an economic loss, it would devastate the singular biological communities that live there.

Resource extraction is a threat to areas outside of the Río Blanco as well. Within the Río Gálvez watershed, the Matsés experience strong pressures from loggers and other commercial traders interested in harvesting the natural resources found within the Comunidad Nativa Matsés.

Antecedents and Current Status

For generations, the forests in and around the Comunidad Nativa Matsés have supported the traditional lifestyles of the Matsés people. Together with CEDIA, the Matsés have been proposing formal, legal protection for the proposed Reserva Comunal for 14 years. With the results of this inventory and the previous work of CEDIA in the region, the Comunidad Nativa Matsés proposes the protection of 391,592 ha to establish the Reserva Comunal Matsés in the diverse lowland forests bordering their titled lands. They also propose to extend their native community (CNM) farther south to include an additional 61,282 ha.

Principal protection and management recommendations

- 01 Establish the Reserva Comunal Matsés (391,592 ha, Figure 2, Map 1) to protect a nearly complete gradient of terra firme habitats that border the Comunidad Nativa Matsés.
- 02 Secure the highest level of protection for the extensive white-sand forests (Map 2) that offer minimal potential for resource use—commercial or subsistence—and are extremely fragile and harbor endemic species.
- 03 Provide adequate protection for the headwaters of the Gálvez and Yaquerana rivers, and their source areas of animal and plant populations that are important for the Matsés.
- 04 Ensure that the *Jefe*, the *Junta Directiva*, and the *Asociación de Jóvenes* of the Comunidad Nativa Matsés are an integral and central part of the administration of the proposed protected area, the Reserva Comunal Matsés.
- 05 With the Matsés community elaborate management plans for the use of natural resources within the Comunidad Nativa Matsés.

Map 1

Proposed areas bordering the
Comunidad Nativa Matsés



Map 2

White-sand forests in the region



REPORT AT A GLANCE

Long-term conservation benefits

The conservation area we are proposing for the Matsés region represents an **opportunity to protect the impressive array of habitats and microhabitats within the region**, which encompass a very high proportion of Loreto's world famous biodiversity. The forests within the proposed Reserva Comunal Matsés also harbor great cultural diversity, providing refuge for **the Matsés and the natural resource knowledge** they have accumulated over generations. The creation of this new conservation area will protect:

- 01 an area of high cultural and biological value
- 02 the extensive white-sand forests, rare and poorly understood habitats, with high plant and animal endemism
- 03 a nearly complete gradient of the principal terra firme habitats in Amazonia
- 04 the headwaters of the Gálvez and Yaquerana rivers
- 05 the important source areas of plants and animals for the Matsés
- 06 the commitment of the Matsés to manage their natural resources

Why Matsés?

At first glance, the Matsés region appears to be typical lowland Amazonian forest—wet, hyperdiverse, and teeming with wildlife. Hills, both gentle and more sloped, dominate the region, and rivers and streams course through its intact forests. From space, satellite images reveal a rich collage of green hues that reflect the underlying plant diversity, punctuated by the occasional deep purple of a swamp forest, or the harsh blue of a regenerating forest or clearing (Figure 2). But a closer look reveals broad swathes of forest on either side of the Río Blanco that reflect a shade of lilac; these unexpected hues were our first hint that the Matsés region is extraordinary.

The lilac areas were a mystery to us. In initial overflights we saw extensive populations of short *Mauritia* and *Euterpe* palms, leading us to speculate that our inventory in these areas would land us in an oddly stunted swamp forest. However, once on the ground we realized that these palms were not the *Mauritia flexuosa* or *Euterpe precatoria* palms typical of Amazonian swamp forests, but instead were their white-sand cousins, *Mauritia carana* (Figure 3G) and *Euterpe catinga* (Figure 4J). The lilac-colored areas represent an enormous complex of white-sand forests previously unvisited by scientists and larger than any of the known white-sand forests in Peru (Figure 12A).

The Matsés—the region’s long-term inhabitants—have a deep knowledge of the natural resources within their territories. They have known about these white-sand forests for ages and consider them to be fragile and sacred areas. Over generations, they learned that these areas are unproductive for agriculture because of their nutrient-poor soils and are unsuitable for hunting because of their scarce game species.

But it was not just the white-sand forests that impressed us during the inventory. In a single day, we could walk through floodplains, lush upland forests, wet bottomlands and swamps, all underlain by a vast patchwork of different soils. This wilderness shelters an almost complete representation of the forest and river types in lowland Amazonia. The habitat mosaic, with its soil fertility and hydrological gradients, is a crucial laboratory of evolution. Preserving the proposed Reserva Comunal Matsés and the adjacent white-sand forest, with deep involvement from the Matsés, will protect this rich and unusual natural tapestry for this and future generations.

Why protect white-sand forests?

Forests growing on white-sand soils are some of the least species diverse of all Amazonian forest communities. Typically, the trees are slender and short, and animals are scarce. Why should we work to conserve these odd, low-diversity communities?

Although white-sand forests are barely one-fifth as diverse as the richest Amazonian *terra firme* forests, the species that occur there are largely endemics. In the last ten years, biologists working in white-sand forests near Iquitos have discovered more than two dozen species new to science, including five birds, and numerous plants and insects. These species have not been registered outside of white-sand forests and many occur only in Peru.

White-sand forest communities are rare throughout the landscape. In the entire Amazon basin, they represent ~3% of lowland forests and these mostly occur within the Río Negro basin in Venezuela and Brazil. In Peru, white-sand habitats are even less common. There are eight known patches of white-sand forest in Peru, representing less than 1% of lowland Peruvian rainforest (Figure 12A). Currently, only one of these areas is protected, the Reserva Nacional Allpahuayo-Mishana (58,069 ha), and only some 20% of this reserve is white-sand forest.

The eight white-sand patches are isolated from one another and from similar habitats in Colombia, Venezuela, and Brazil. This scattered distribution likely reinforces not only the endemism but also the vulnerability of Peru's white-sand flora and fauna. For example, a new species of gnatcatcher (*Polyoptila clementsii*) was described in 2005. Fewer than 25 individuals are known in the world, and all occur in

two white-sand forest patches in and near the Reserva Nacional Allpahuayo-Mishana.

White-sand forests are extremely fragile. These soils have some of the lowest nutrient availabilities recorded anywhere. Mineral nutrients reside within living organisms, and roots and fungi quickly capture any decomposing nutrients. If the trees are cleared in a white-sand forest, nutrients leach rapidly through the sand, and the soil degrades. Using these forests for extractive or agricultural activity is counterproductive economically, because more resources are expended in clearing the forests than could ever be recuperated from agricultural or logging enterprises.

Because white-sand forests are rare, fragile habitats that shelter vulnerable and endemic species, the proposed Zona Reservada Los Varillales (195,365 ha; Figures 2, 12A) represents a terrifically important conservation opportunity. Along the Río Blanco there are scattered small human settlements; however, the great majority of the area is uninhabited and intact forest. In only three days at this site, scientists found species never previously recorded in Peru, and some new to science. This area represents the largest known white-sand forest in Peru. Since larger populations are more resistant to extinction, the Zona Reservada Los Varillales will safeguard rare and endemic species that otherwise will disappear forever.

Overview of Results

LANDSCAPE AND SITES VISITED

For two weeks in October-November 2005, the rapid biological inventory team surveyed *terra firme* forests, floodplains, swamps, streams, and lakes in the proposed Reserva Comunal (RC) Matsés (391,592 ha; Figure 2). We focused on three uninhabited sites to the north, west, and south of the native territories of the Matsés people, the Comunidad Nativa Matsés. Concurrently, the social team visited seven Matsés settlements, and met with Matsés leaders to identify local assets and initiatives that can play an important role in conserving their lands and those that border their community. Although this area of Peru is intimately known to the Matsés, nearly the entire region was unknown to biologists before our inventory.

Our closest point of comparison was a rapid inventory of four sites along the Río Yavarí (Pitman et al. 2003). Since the Matsés region forms part of the Yavarí basin, we suspected the two areas would be biologically very similar. However, on the contrary, results for all the organisms surveyed—plants, fishes, amphibians, reptiles, birds, and mammals—indicated that the Matsés region harbors many unique species. Moreover, several habitats surveyed in the Matsés region were not explored during the Yavarí expedition, nor are these habitats apparent on satellite images of the Yavarí region. Below we give a more detailed overview of our results, placing them in a regional and global context wherever possible, and highlighting the unique features of the Matsés landscape.

GEOLOGY, HYDROLOGY, SOILS

Several techniques were used to assess the geology, hydrology, and soils of the Matsés region, ranging from large-scale examinations of satellite images to smaller-scale measures of topographical features, soil profiles, and water properties. These preliminary measures reveal a landscape with great heterogeneity in soil fertility and soil composition within and among sites.

Two large geological features underlie this heterogeneous landscape: the Iquitos Arch and the Bata-Cruzeiro fault. The Iquitos Arch is an uplifted formation that runs more or less along an east-west axis and is bisected by the Bata-Cruzeiro

fault near the Río Blanco (Figure 2). Evidence of faulting in the Amazon basin is less obvious than in mountainous areas such as the Andes, but a careful look at the satellite image reveals numerous, almost linear, streams running perfectly parallel to the Río Blanco along the fault lines. In addition, the Río Blanco valley is the lowest point (<100 m above sea level) in the surrounding landscape, suggesting that this area dropped downward during the faulting process.

Across the region, typically only 100-120 m separates the lowest and the highest points on the landscape, and the highest point we surveyed was ~220 m above sea level. Topography ranges from the steeply incised hills at Actiamë, to the gentler and broader hills at Choncó, and the flat-topped summits at Itia Tëbu (Appendix 1F, Figure II).

Over distances as short as tens of kilometers, one can encounter an almost complete gradient of soil types and habitats of lowland Amazonia, from poor white sands to rich clays and the array of sand-clay mixtures in between these extremes. White sands are rare soil types within the Amazon, and their origins are unknown. They may represent old alluvial sands, or they could reflect the weathering of texturally complex sediments. Seen via satellite, these nutrient-poor white sands occur on either side of the Río Blanco, and represent the largest expanse of white-sand soils known in Peru.

Within the region, surficial soils vary on large and small scales. Soils in the north are principally from the Pevas Formation (remnants of a large lake system formed 18 million years ago), and southern soils are more likely to be fluvial sediments. Despite this general tendency, both of these types of soil deposits can occur anywhere in the region. Rivers and streams frequently change course, cutting new channels through older and often much finer materials, exposing new soil layers. This dynamism results in a patchwork of soils that varies laterally and vertically over scales as small as tens of centimeters.

Not only do rivers and streams actively shape the landscape by changing course, their water chemistry

provides information about the soil fertility and nutrient dynamics in the surrounding forests. We found that the inventory sites range from low conductivities in Itia Tëbu with rather low concentrations of dissolved materials and nutrients, to intermediate conductivities at Choncó, and higher conductivities at Actiamë with more solutes, and higher nutrient concentrations.

VEGETATION AND FLORA

Loreto is renowned as a center of tropical plant diversity, and the Matsés region appears to be one of the brightest hotspots. Our two weeks of collecting, photographing, and identifying plants in the field resulted in a preliminary list of ~1,500 plant species, a little less than half of the plant species we suspect occur within the region. Other rapid inventories in Loreto, including along the nearby Río Yavarí (Pitman et al. 2003), and farther north along the Ampiyacu, Apayacu, and Yaguas rivers (Vriesendorp et al. 2004) estimate a regional flora between 2,500-3,500 species. We believe that the proposed RC Matsés likely supports additional species associated with more specialized habitats (e.g., white-sand forests), and may harbor greater plant diversity than any existing protected area in lowland Peru.

Our three inventory sites covered almost the entire range of forested habitats of lowland Amazonia: swamp forests, floodplain forests, and terra firme forests on rich, intermediate and extremely poor soils. At any given site in the proposed RC Matsés, local plant species richness ranges from some of the richest in Amazonia (upland areas of intermediate to relatively-rich soil fertility) to some of the most depauperate (white-sand forest areas).

Because of their low diversity and relatively simple structure, the white-sand forests are the easiest to characterize floristically. At Itia Tëbu the white-sand forests are dominated by an emergent palm, *Mauritia carana*; a canopy tree in the Rubiaceae (*Platycarpum orinocense*, a tree collected only three times previously

in Peru); and four smaller trees—*Pachira brevipes* (Bombacaceae), *Euterpe catinga* (Arecaceae), *Protium heptaphyllum* subsp. *heptaphyllum* (Burseraceae) and *Byrsonima* cf. *laevigata* (Malpighiaceae). Before this inventory, *Mauritia carana* was thought to be an exceedingly rare palm, yet in the white-sand areas in the Matsés region the population numbers in the tens of thousands.

Upland forests in the Matsés region, similar to other lowland Amazonian forests, are overwhelmingly diverse. The scope of the plant diversity is so great that most species are rare. As an example, botanists surveyed plants over 10 cm in diameter in a 100-m survey at Actiamë, and recorded 47 species in 50 stems.

Focusing on a single family can make it easier to place this high diversity within a broader context. During the two-week inventory, we found 41 different species of Burseraceae trees in the three inventory sites, an unofficial record for this family in Peru. For comparison, it has taken more than four years to collect 40 species across a broad range of terra firme habitats in the Reserva Nacional Allpahuayo-Mishana.

Most of the plant specimens from our inventory remain unidentified; nevertheless, we estimate that a dozen or more of our 500 fertile specimens are likely to be new species.

FISHES

The ichthyological team surveyed a great variety of aquatic habitats, sampling 16 rivers and streams, two small pools alongside streams, two lagoons, one flooded forest known as a *bajjal*, and a *Mauritia* palm swamp known as an *aguajal*. Of these 24 sites, 15 were blackwater, five were clearwater, and four were whitewater environments.

These surveys revealed that the aquatic environments of the Matsés region support a highly diverse community of fishes. In 12 days of fieldwork, including interviews with Matsés fishermen, ichthyologists generated a preliminary list of 177 fish species that

represent 113 genera, 29 families, and 9 orders. Several habitats were not surveyed during this study, including large rivers such as the Gálvez, Blanco, and Yaquerana, and the numerous whitewater and blackwater lagoons seen during overflights of the area. With additional sampling of these habitats, the team estimates that ~350 fish species inhabit the Matsés region.

The region supports a great variety of clearwater, blackwater, and whitewater environments, and all support heterogeneous fish communities, some abundant in fish biomass (oxbow lakes and the main rivers), and others which are species-rich but only support moderate to low densities of fishes (clearwater and blackwater streams). Overall, the greatest fish diversity was found in headwaters of the Río Gálvez and in the streams that feed the Yaquerana, where we registered 125 species (70% of all fish species registered in the inventory).

At least five Characidae species represent new records for Peru. In addition, during the inventory of the Gálvez headwaters, ichthyologists registered *Ammocryptocharax* (Crenuchidae)—the first time this genus has been recorded in the country. One of the *Ammocryptocharax* species appears to be new to science, and in total, this inventory registered 8-10 potentially new species, including several in the genera *Pariolius*, *Tatia* and *Corydoras*.

Compared to other recently inventoried areas in Loreto, the proposed RC Matsés harbors one of the richest fish communities in forested aquatic environments in Peru, with 45-50% of the species unique to the Matsés region. Of the 177 species registered during the Matsés inventory, 89 (50%) were also present in Yavarí (Ortega et al. 2003a) and 98 (55%) were registered in the inventory of the Ampiyacu, Apayacu, and Yaguas rivers (Hidalgo and Olivera 2004). The Matsés region merits protection as a source of biologically, culturally, and economically important fish species, and as an important regional center of fish diversity.

AMPHIBIANS AND REPTILES

This inventory was conducted during October and November, some of the drier months of the year, and typically these drier conditions are less favorable for finding amphibians and reptiles. Nonetheless, herpetologists recorded a very diverse herpetofauna in the Matsés region including 74 species of amphibians and 35 species of reptiles represented by 18 lizards, 13 snakes, 2 turtles and 2 caimans. In only 12 days, the team registered more than 60% of the expected amphibian species known from the Iquitos area (~115 spp), and more than 50% of the lizard species of the Amazon basin.

Three species new to science were recorded during the inventory, including two, a *Bufo* in the *margaritifer* group (“pinocchio”) and a *Hyalinobatrachium* (Centrolenidae), already confirmed as species new to science during the rapid inventory of Río Yavarí (Rodríguez and Knell 2003). In the white-sand forests in Itia Tëbu the team found a rare poison dart frog, *Dendrobates* in the *quinquevittatus* group, with a black body, pale stripes descending below the mouth, and golden limbs. This species is almost certainly new to science, and appears to be restricted to white-sand habitats.

Herpetologists uncovered a rare fossorial frog, *Synapturanus rabus*, when they heard an individual calling under several centimeters of mud. This represents the first record of this genus in Peru, and represents a range expansion of at least 500 km for the species. Another rare and little known species was found when Matsés collaborators working with the advance trail-cutting team discovered the pitviper *Bothrops brazili*.

The Matsés were excited to find the arboreal frog *Phyllomedusa bicolor* at Actiamë, along the Río Yaquerana. Known to the Matsés as *kampô* or *dauqued*, this species is culturally important to numerous indigenous groups in the Amazon. Both men and women apply secretions from the frog’s dorsal glands to self-inflicted burns in their own skin, to give themselves strength and courage.

Other rapid inventories in the Yavarí (Rodríguez and Knell 2003) and Ampiyacu, Apayacu, Yaguas (AAY) watershed (Rodríguez and Knell 2004) provide a regional context for the herpetological diversity found during the Matsés inventory. Although we sampled at least five fewer days, we recorded nearly equivalent numbers of amphibians in Matsés (74 species) as in Yavarí (77), and more species than in AAY (64). In the Matsés region, we recorded 26 amphibian and 11 reptile species not found in AAY and 20 amphibian and 10 reptile species not recorded in Yavarí.

BIRDS

Ornithologists recorded 416 species of birds during the rapid inventory of the proposed Reserva Comunal Matsés, an unofficial record for rapid biological inventories in Loreto. With more complete surveys we estimate that ~550 species would be found in the region.

We spent three days exploring the white-sand forests in the Matsés region, documenting the low-density and low-diversity bird community typical of these habitats. During this time, we managed to tape-record a *Hemitriccus* tody-tyrant that differs from recordings of Zimmer’s Tody-Tyrant (*Hemitriccus minimus*), and may represent an undescribed species. Only one other white-sand habitat specialist was observed, Yellow-throated Flycatcher (*Conopias parva*), although more than 20 birds are known to associate with white-sand and other extremely poor soils. In the last decade, five bird species new to science have been discovered in white-sand habitats in Peru, typically after years of intensive surveys. Our findings underscore the importance of additional surveys in white-sand areas in the Matsés region, to search for habitat specialists and species potentially new to science.

Outside of the white-sand habitats, we encountered the high diversity characteristic of lowland Amazonian bird communities. For example, our four-day survey of one of the richer soil terra firme habitats registered 322 species. A handful of our observations

represent substantial range extensions, the most notable being a single Northern Waterthrush, *Seiurus novaboracensis*, seen along a stream at Actiamë. This North American migrant is known in Peru from only two records, one south of Lima on the Pacific slope, and the other at the Río Curaray (T. Schulenberg, pers. com.). Our survey during late October-early November represents the height of migration, and we registered 19 species of migrants from North America during the inventory, mainly land birds.

To understand the singularity of the Matsés avifauna, we compare our results to two other rapid inventories in Loreto. The Yavarí inventory (Lane et al. 2003) sampled four sites within the Yavarí drainage, downriver from the Matsés inventory. The Ampiyacu, Apayacu, and Yaguas inventory (Stotz and Pequeño 2004) sampled three sites north of the Río Amazonas, within the Amazonas and Putumayo drainages. Although many species are shared between these three inventories, at least a third of the avifauna is unique to each.

MAMMALS

Previous inventories in nearby areas, including the Reserva Comunal Tamshiyacu-Tahuayo and sites along the Gálvez and Yavarí rivers, indicate that 65 species of medium and large mammals likely occur in the proposed RC Matsés. During our two-week inventory, we registered 43 of these species and the Matsés recognize at least 60 as ones they encounter in their lands. The Matsés region is among a select group of Peruvian sites (e.g., Yavari; Ampiyacu, Apayacu, and Yaguas; Parque Nacional del Manu; Reserva Comunal Tamshiyacu-Tahuayo) that rank among the areas of highest mammal diversity in the world.

Large primates and ungulates, often favored by hunters, were remarkably abundant in the region (Figures 9A, B). Except for the area along the Río Blanco (Figures 8A, 10A), we found little or no evidence of hunting in our inventory sites. We did find fewer mammals in white-sand forests than elsewhere in the

region; however, this almost certainly reflects the reduced productivity of these habitats.

Several rarities were sighted during the inventory. We observed jaguars and their tracks (*Panthera onca*) on several occasions, and a bush dog (*Speothos venaticus*) was seen at Choncó. A female pink river dolphin (*Inia geoffrensis*) was observed nursing her young at the mouth of a small tributary to the Río Yaquerana.

Two rare species were notably absent during the inventory. We hoped to find two globally threatened monkeys, Goeldi's marmoset (*Callimico goeldii*) and the red uakari (*Cacajao calvus*). The Matsés recognize both species, although only a few have seen Goeldi's marmoset, a species that is rare across its range. Many recognized the red uakari, a species that typically is found in *Mauritia* palm swamps, and can range over 150 km² areas. Neither of these species is protected within the Peruvian park system (SINANPE).

HUMAN COMMUNITIES

The proposed Reserva Comunal Matsés is bordered along its eastern edge by the Comunidad Nativa (CN) Matsés, the largest titled indigenous land within Peru. Some 1,700 Matsés live within the 452,735 ha of the CN Matsés, distributed among 13 settlements known as *Anexos* (Appendix 7). The Matsés are an autonomous ethnic group that represent themselves, and are not affiliated with any indigenous federations. For the last 26 years, the anthropologist Luis Calixto has lived and worked with the Matsés, studying their social organization and participating in their daily lives. His work, along with technical assistance from the Centro para el Desarrollo del Indígena Amazónico (CEDIA) to the Matsés community beginning in 1991, provided the social context for this inventory.

In 1997, the Matsés people proposed a conservation area to the west, south, and north of their community, in lands where they have hunted and fished for generations. Their vision for this conservation

area is a Reserva Comunal within the Peruvian park system (SINANPE), a category that provides long-term protection and permits sustainable use of natural resources. Currently, the Matsés are the unofficial stewards of these lands. A Reserva Comunal would formally recognize the importance of their role and ensure more effective and long-term conservation of this area.

The Matsés are uniquely positioned to take on a greater and more official conservation role. Previous social research in the region and data from the asset mapping of the rapid social inventory demonstrate that the Matsés society is highly organized with explicit decision-making mechanisms within and among settlements. Traditional resource use and a strong sense of ethnic identity form the core of the Matsés community, and are reinforced in younger generations by bilingual schooling in Spanish and Matsés. A newly formed youth association, known as CANIABO (*caniabo* is youth in Matsés), provides leadership opportunities and training to younger Matsés. These organizational and cultural strengths, coupled with small-scale resource use and subsistence hunting, are strong indications that the Matsés would serve as responsible on-the-ground administrators of these lands.

In addition to the Comunidad Nativa Matsés, there are several other human settlements in the region. On the western side of the proposed protected area there are scattered communities along the Río Ucayali, as well as along its tributary, the Río Blanco. Requena, a small city along the Río Ucayali, is a three-day walk for the Matsés, and they sometimes trade, sell, and buy goods there. To the north of the CN Matsés, Colonia Angamos is the nearest and largest settlement, with an airstrip that receives flights to and from the city of Iquitos.

There are no known human settlements within the proposed Reserva Comunal. However, according to reports from the Matsés, uncontacted and/or voluntarily isolated Matsés people do inhabit those lands, as well as areas within the Comunidad Nativa.

THREATS

The gravest threats to the area are the timber concessions west of the Río Blanco, adjacent to the proposed RC Matsés. These concessions overlap directly with the largest patch of white-sand habitat in Peru, and represent an imminent threat to these fragile habitats. Plants grow exceedingly slowly in these nutrient-poor areas, resulting in trees that are stunted, slender, and decidedly unsuitable for timber. Only a specialized group of plants and animals can survive in these extreme soils. Not only would timber extraction in white-sand areas be unproductive, it would completely devastate the singular biological communities that live there.

Two additional activities are potential threats to the area: unmanaged hunting and illegal drug processing in temporary camps. Currently, both appear to have had minimal impacts in the region; however, if unchecked, each could produce more severe effects in the long-term. In much of Amazonia, hunting poses the greatest threat to animal communities, especially when hunting efforts are intense and large-scale. Illegal drug processing camps, because of their lawlessness, represent a danger both to human and biological communities.

Our inventory provides a preliminary assessment of these two threats, and their impacts. We found scattered evidence of past hunting (shotgun shells, a peccary skull in an old hunting camp), yet we also observed substantial and healthy populations of species typically favored by hunters (e.g., guans, curassows, agoutis, large monkeys). Near the Peru-Brazil border we found an abandoned drug processing camp, a small trail network, and a large oil drum. We suspect the abandoned airstrip on the Brazilian side of the river was part of the same operation. Although such temporary camps can have negative impacts on fauna, the abundant animal populations at this one suggest that drug runners at this camp may not have hunted game. However, the direct impact of this temporary camp on human populations, on either side of the Peru-Brazil border, remains unknown.

Our evidence of past hunting expeditions comes from Itia Tëbu near the Río Blanco, and the site abandoned by drug processors was found at Actiamë along the Río Yaquerana. Not surprisingly, both occur on major rivers. Because they provide access to otherwise remote areas, rivers represent the most vulnerable entry points for the region.

Given the timber interests, the potential for unregulated hunting, and the illegal drug processing camp, perhaps the most overarching threat for the biological and human communities of the area is the lack of formal protection. The proposed RC Matsés is one of the jewels of the Peruvian lowlands—encapsulating such a broad range of soil types that establishing a conservation area here would protect much of the floral and faunal diversity of the Peruvian Amazon. The headwater streams of the Yavarí, one of the principal tributaries of the Amazon, originate in this region, and the drainage network in the area harbors economically important fishes as well as new records, rare species, and species new to science. The Matsés region represents an enormous opportunity to protect a spectacular diversity of lowland terrestrial and aquatic habitats while they still remain intact.

CONSERVATION TARGETS

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

ORGANISM GROUP	CONSERVATION TARGETS
Biological Communities	<p>Major terra firme habitats in the Peruvian lowlands, from nutrient-rich clay soils to sandy loam hills with intermediate fertility to impoverished white-sand soils</p> <p>Extensive white-sand forests, a habitat representing less than 1% of the Peruvian Amazon (Figure 12A), with many endemic species</p> <p>Extremely acidic forest streams draining white-sand areas (Figure 3D)</p> <p>Swamp hummock complexes near the Río Gálvez headwaters</p> <p>Heterogeneous aquatic ecosystems found in the Río Gálvez headwaters and the Río Yaquerana watershed (including blackwater, clearwater, and whitewater)</p> <p>Headwaters of the Río Yaquerana and Río Gálvez rivers, critical to ensuring the integrity of the Yavarí watershed</p> <p>Upland forest communities, including flooded lowlands, palm swamps (<i>aguajales</i>) and white-sand forests with high amphibian and reptile diversity</p> <p>Intact and heterogeneous habitats that serve as a source of game species, especially in the headwaters of the Río Yaquerana and the Río Gálvez</p>
Vascular Plants	<p>Plants endemic to white-sand forests, including large populations of <i>Mauritia carana</i> (Arecaceae, Figure 3G), <i>Platycarpum orinocense</i> (Rubiaceae, Figures 4A, C), and <i>Byrsonima</i> cf. <i>laevigata</i> (Malpighiaceae)</p> <p>Populations of commercial timber species heavily exploited elsewhere in Loreto, including Spanish cedar (<i>Cedrela odorata</i>, Meliaceae), kapok or <i>Iupuna</i> (<i>Ceiba pentandra</i>, Bombacaceae) and <i>palisangre</i> (<i>Brosimum utile</i>, Moraceae)</p>
Fish	<p>Biologically, culturally, and economically important species in the region such as <i>Osteoglossum bicirrhosum</i> (<i>arauana</i>), and <i>Cichla monoculus</i> (<i>tucunaré</i>)</p> <p>Large catfish such as <i>Pseudoplatystoma tigrinum</i> (<i>tigre zúngaro</i>), which are exploited intensely in other parts of Amazonia</p>

<p>Fish (continued)</p>	<p>Rare species and those with restricted distributions such as <i>Myoglanis koepckeii</i> (Figure 5F)</p> <p>Valuable ornamental species like <i>Paracheiroidon innesi</i> (<i>tetra neón</i>), <i>Monocirrhus polyacanthus</i> (<i>pez hoja</i>), <i>Boehlkea fredcochui</i> (<i>tetra azul</i>)</p> <p>A diverse group of species in the <i>Apistogramma</i> genus (<i>bujurqui</i>), common in clearwater and blackwater within the heterogeneous forests in the Matsés region</p>
<p>Reptiles and Amphibians</p>	<p>Communities with many (up to 10) species of coexisting Dendrobatidae</p> <p>Amphibian species associated with white-sand forests and surrounding areas, such as the frogs <i>Osteocephalus planiceps</i> and a potentially new species of <i>Dendrobates</i> in the <i>quinquevittatus</i> group (Figure 6C)</p> <p>Populations of <i>Synapturanus</i> (Microhylidae, Figure 7C), a new genus for Peru</p> <p>Species with commercial value, such as turtles (<i>Podocnemis unifilis</i>, <i>Geochelone denticulata</i>) and caiman (<i>Caiman crocodilus</i>)</p>
<p>Birds</p>	<p>Birds of white-sand forest habitats, including potential habitat specialists and species new to science</p> <p>Diverse avifauna of terra firme forests</p> <p>Game birds threatened in other parts of their range, including Razor-billed Curassow (<i>Crax tuberosum</i>) and White-winged Trumpeter (<i>Psophia leucoptera</i>)</p>
<p>Mammals</p>	<p>An extremely diverse primate community (14 species) with abundant, large species such as <i>Lagothrix lagothricha</i>, <i>Ateles paniscus</i> (Figure 9A) and <i>Alouatta seniculus</i></p> <p>Populations of giant armadillo (<i>Priodontes maximus</i>), listed as endangered on the World Conservation Union's (the IUCN) Red List (2004)</p> <p>Habitat specialists such as <i>Callimico goeldii</i> and <i>Cacajao calvus</i>, both of which are listed as vulnerable on the IUCN's Red List (2004)</p> <p>Large mammals that have suffered local extinctions in parts of their range because of habitat loss or overhunting</p>
<p>Human Communities (Matsés)</p>	<p>High organizational capacity for managing a natural protected area</p> <p>Economic activities and production methods of a type and scale compatible with conservation (Figures 11F, I)</p>

CONSERVATION TARGETS

Human Communities (Matsés)
(continued)

In-depth cultural knowledge of the environment, including white-sand forests (*varillales*)

Commitment to conservation and to sustainable use of natural resources

RECOMMENDATIONS

Our shared long-term vision with the Matsés for their landscape is a mosaic of land-use areas that conserve the region's diverse and intact forests and the traditional practices and lifestyles of the Matsés communities living in them. Two priorities emerged from the integrated results of the rapid inventory and CEDIA's 14 years of work with the Comunidad Nativa Matsés: (1) conservation of the diverse landscape bordering the Matsés territories through the creation and consolidation of the Reserva Comunal Matsés and (2) conservation of the singular biology of white-sand forests through the creation of a dedicated protected area. Below we offer our recommendations for establishing these two protected areas—the Reserva Comunal Matsés and the Zona Reservada Los Varillales—including our suggestions for protection and management, zoning, future inventories, research, and monitoring and surveillance.

Protection and management

Reserva Comunal Matsés

- 01 **Establish the Reserva Comunal Matsés (391,592 ha) inside the boundaries outlined in Figure 2.** This area merits immediate protection based on its large and intact expanses of forests, its extraordinary biological richness, and its cultural importance for the Matsés. The area is directly adjacent to the proposed white-sand protected area (see White-sand Forests, below).
- 02 **Negotiate a process between the Junta Directiva Matsés and the Peruvian park service, INRENA, to ensure the integral involvement of the Matsés in the long-term conservation and administration of the Reserva Comunal Matsés.** There are compelling and practical reasons for the Reserva Comunal Matsés to be an indigenous-administered protected area. For 14 years the Matsés have worked with CEDIA to protect this area. They have an intimate knowledge of these forests, and are experienced in addressing invasion, encroachment, and resource extraction threats. Most importantly, the egalitarian decision-making process of the Matsés—which relies on building consensus—provides a strong foundation for administering and managing a protected area (see p. 218, Socio-cultural assets of the Comunidad Nativa Matsés).
- 03 **Involve members from all of the Matsés settlements, or *Anexos*, in the protection and management of the Matsés wilderness.** Work directly with Matsés officials (*Junta Directiva* and the *Juntas de Administración*) to promote local participation in protection efforts including:
 - **Involving members of local communities as park guards, managers, and educators.**
 - **Involving young Matsés in the conservation efforts, via the CANIABO Association** (*caniabo* means youth in Matsés).
 - **Managing harvest of game birds, mammals, and fish by members of the Matsés communities.** We recommend immediate participatory research

RECOMMENDATIONS

Protection and management
(continued)

(see Research 03, below) on the use of the landscape by native communities, their traditional management of game harvests, and the impact of hunting on more vulnerable species. We recommend implementing a management plan—designed by the community and based on the research results—to ensure sustainable hunting, including establishing strictly protected areas where hunting is prohibited to serve as source areas and sites for recovery of game populations.

- 04 Secure sustainable funding for the implementation of the Reserva Comunal.**
- 05 Provide technical and financial assistance** to the Comunidad Nativa Matsés and appropriate NGOs to improve the effectiveness and long-term viability of their efforts as they administer and protect the Reserva Comunal Matsés.
- 06 Map, mark, and make known the boundaries of the Matsés protected area.** Most vulnerable are the boundaries near the western and northern limits of the reserve, susceptible to incursions by people from farther upriver, along the Río Blanco, or Iquitos, and people from Angamos.
- 07 Train Matsés park guards.** Establish protocols with the Matsés, including routes for patrolling and procedures to stop illegal activities (e.g., logging).
- 08 Minimize impacts to headwaters within the region to protect the entire drainage network of the Yavarí and Yaquerana rivers.** Conserving the entire drainage, from the small forested streams of the headwaters, to the principal waterways like the Río Yavarí, is critical for protection of the watershed and of the communities of fishes, invertebrates, and vertebrates, as well as humans, who depend on the integrity of the watershed.
- 09 Expand the Comunidad Nativa Matsés to the south,** within the boundaries as outlined in Figure 2. The current southern boundary of the CN Matsés bisects a Matsés settlement (Buenas Lomas Antigua). The boundary should be expanded to the south to include the entire settlement, as well as the settlement at Puerto Alegre and the surrounding area. The extension is 61,282 ha.

White-sand Forests

- 01 Create the Zona Reservada Los Varillales (195,365 ha, Figure 2), to protect the biological uniqueness of the white-sand forests (*varillales*) on either side of the Río Blanco (see maps p. 145).** This area presents the largest expanse of white-sand forests in Peru. Logging and colonist incursions threaten this area; during the rapid inventory we observed several abandoned agricultural plots and a network of persistent and destructive trails cut by logging tractors. Timber is not

being extracted from the white-sand areas; these areas are razed for access to timber further inland. Our best estimates suggest that the white-sand vegetation destroyed by these tractor trails will take several hundred years, if not more, to recover. We recommend creating a Zona Reservada, and ultimately a Santuario Nacional (see below), to ensure immediate protection for the fragile white-sand forests.

02 Relocate logging concessions planned for the white-sand forests on the western side of the Río Blanco. White sands are the poorest soils in the Amazon basin and the trees they support are short and thin. These low-productivity areas are decidedly unsuitable for timber extraction, yet they are rich in endemic species and extremely valuable for conservation.

03 Determine the category and elaborate boundaries for the white-sand protected area. Our rapid inventory results support the strictest level of protection for this area, either as a national park or as a national sanctuary. We recommend joint discussions with the Regional Government of Loreto, INRENA, and Matsés officials to determine the final category. To elaborate the boundaries for the white-sand protected area, we recommend inviting experts in satellite imagery analysis to participate in the discussions: preliminary analyses by R. Stallard are a useful starting point (Figure 2, 12A).

04 Institute patrols for park guards to prevent logging, poaching, and other incursions.

Zoning

Engage the CN Matsés in participatory workshops to develop a zoning plan.

In conjunction with CEDIA, the Matsés have begun to develop maps of their current use of resources in the region. These should serve as a first step towards developing a zoning plan that protects the valuable biological communities in the area, and at the same time allows the Matsés to continue their traditional use of the forest, but under a plan for sustainable management.

Further inventory

01 Continue basic plant and animal inventories, focusing on other sites and other seasons, especially March-August. Priority aquatic areas for inventories include the Gálvez, Blanco, and Yaquerana rivers, and the unexplored lagoons, or *cochas*, observed during the overflights. The highest priority terrestrial habitats are the white-sand forests (see 02 below) and the forests along the blackwaters of the Río Gálvez and its tributaries.

02 Conduct long-term surveys of the white-sand forests in the Río Blanco area with biologists experienced in similar habitats in Amazonia. White-sand forests

RECOMMENDATIONS

Further Inventory
(continued)

harbor a great number of endemics and we suspect longer-term surveys will register additional rarely collected or new species, especially of plants and birds. Although we found only two birds specializing on white-sand habitats during this inventory, long-term inventories of smaller patches of white-sand forests near Iquitos (Reserva Nacional Allpahuayo-Mishana) have uncovered five species of birds new to science.

- 03 Confirm reports of two globally endangered primates in the region.** The red uakari monkey, *Cacajao calvus*, and Goeldi's marmoset, *Callimico goeldii*, have been reported in the region by the Matsés and others, but were not seen during our inventory. We recommend an expedition with the Matsés to confirm the presence of these monkeys, and to map their distribution within the area.

Research

- 01 Investigate the genetic structure and population connectivity of populations of white-sand specialists, compared to populations in other white-sand areas.** Species restricted to white-sand forests occupy a naturally patchy habitat. Understanding whether populations in one patch maintain gene flow with other patches will assist in understanding the evolution of these habitat specialists and in managing their populations.
- 02 Evaluate the ecological impact of subsistence hunting and gathering on biological communities in the region.** This research is the logical extension of the resource-use maps (see Zoning above), and should be directed towards preserving fauna and flora while maintaining the quality of life of subsistence hunter-gatherers and their families.
- 03 Evaluate the importance of habitat gradients in driving evolution.** The mosaic of habitats in the Matsés region constitutes a natural laboratory of evolution. These juxtaposed habitats represent an important resource for future investigations into the origin and maintenance of Amazonian plant diversity, as well as the diversity of insects, birds, and many other organisms.
- 04 Evaluate species range limits and biogeographic barriers in the region.** Although there are no obvious barriers to dispersal (e.g., broad rivers) east of the Río Ucayali, several bird species replace one another and/or species reach the edge of their range in this area. This includes 24 species of birds common in the Amazon and known from areas to the north, south, east, and west, but seemingly absent from the Yavari drainage (see p. 203, Birds). Understanding these distributions will help set boundaries for management areas, especially for forest-based species that may not be restricted to watersheds.

05 Measure the efficacy of boundary signs and patrols in reducing illegal incursions and encroachment into the newly protected areas of Reserva Comunal Matsés and the Santuario Nacional Los Varillales.

Monitoring/Surveillance

01 Track movements and demographics of Matsés settlements within the Comunidad Nativa Matsés (Figure 13, p. 217). Traditionally, Matsés settlements moved every 3-5 years. In the last 30 years the settlements have become more sedentary. Because the CN Matsés borders the reserve, the relocation or change in population size of Matsés settlements (*Anexos*) may influence the distribution of fauna and flora within the Reserva Comunal Matsés, and management plans should be revised accordingly.

02 Survey fish and game populations, including turtles and caimans. These data will be important for determining population baselines, setting conservation goals, and establishing zoning boundaries.

03 Design and conduct social research on the challenges and opportunities experienced by different stakeholders (indigenous communities and organizations, government agencies, relevant local/international NGOs) involved in the protection and management of the Reserva Comunal Matsés. As one of the few indigenous-administered protected area in Peru, the RC Matsés would serve as a model for other areas in Peru and Latin America. We recommend an evaluation of the workings of this process, with a goal of making policy recommendations to support the creation of political and legal frameworks capable of ensuring effective co-management of protected areas by indigenous peoples.

04 Develop a practical monitoring program that evaluates progress towards site-specific management goals. Combine results of research and inventories with the storehouse of Matsés traditional knowledge to establish baselines and targets for vulnerable species or populations.

05 Track threats to the area (including logging, colonization, and ephemeral drug processing stations). To identify and target the most vulnerable areas of the reserve, monitoring methods should include a combination of GIS, remote-sensing and traditional patrols of the area by Matsés, including Matsés park guards.

Technical Report

OVERVIEW OF INVENTORY SITES

(Corine Vriesendorp, Robert Stallard)

The proposed Reserva Comunal (RC) Matsés is a 391,592-ha area of lowland forest in the Peruvian Amazon, ~150 km from the city of Iquitos at its northernmost edge and ~250 km from Pucallpa at its southernmost edge. The area traces a rough crescent shape as it arches around the western and southern borders of the titled indigenous lands of the Comunidad Nativa Matsés (Figure 2).

Situated between the Yaquerana, Gálvez, and Blanco rivers, the proposed RC Matsés forms part of the middle Yavarí River basin, between the Sierra del Divisor to the south, and the confluence of the Yavarí and the Amazonas to the north. Small hills dominate the region: lower and wider ones in the northern portion of the proposed protected area, and steeper and narrower ones to the south.

These forests are underlain by a great variety of soils, from nutrient poor white-sand soils to fertile floodplains. Annual rainfall ranges between 2,500 mm in the south and 3,000 mm in the north, with a weakly defined drier season from June through August (Marengo 1998). Average temperatures are ~26°C.

During the rapid biological and social inventory of the proposed Reserva Comunal Matsés from 25 October to 6 November 2004, the social team surveyed seven communities within titled Matsés lands, while the biological team focused on three uninhabited sites to the north, west, and south of the native communities (Figure 2). In this section we give a brief description of the sites visited by both teams.

SITES VISITED BY THE BIOLOGICAL TEAM

In November 2003, representatives from the Matsés communities, The Field Museum, CEDIA, and INRENA flew in a small plane over the proposed RC Matsés and the Matsés native community. Combining observations from the overflight with our review of regional satellite images, we selected three sites that span a gradient from the smallest waterways to the largest, from the small headwater streams of the Río Gálvez (Itia Tëbu), to a mid-basin area within the Gálvez watershed (Choncó), to the broad main channel of the Río Yaquerana (Actiamë; Figures 3A, E, I).

Once sites were selected, an advance field team flew to each by helicopter to establish a temporary campsite, a small heliport, and ~15 km of trails. Members of every Matsés settlement (known as *Anexos* in Spanish) participated in preparing campsites and trails, and at each site, several Matsés formed part of the inventory team (Figures 11B, D). Site names, which are in the Matsés language and were chosen by the Matsés team members, represent a biologically or culturally important feature of the landscape (Figures 3C, G, L).

Below we describe these sites broadly, emphasizing the wide range of variation in soil fertility, drainage patterns, and forest types that characterize this region. Technical descriptions of these landscapes can be found in *Landscape Processes: Geology, Hydrology, and Soils* (p. 168).

Choncó (05°33'23"S 73°36'22"W,
~90-200 m elev., 25-28 Oct 2004)

Our first inventory site was the farthest north of the three sites we surveyed, mid-basin within the Río Gálvez watershed. For four days we explored the low, gently sloping hills in the area—entirely different from the flat-topped ridges so abundant at Itia Tëbu (see below)—with 100 to 200 m typically separating one hilltop from the next.

Soils varied from place to place on these hills, with yellow-brown sandy clay loams on hilltops and sandy clay on the slopes, all of them covered by a 5- to 10-cm thick root mat. We found a single patch of white-sand forest, on a flat hilltop not otherwise distinguishable from other nearby hilltops. The white-sand hilltop was not the highest part of the surrounding landscape, unlike the white-sand areas in the headwaters. Several of the dominant white-sand plants in this small area were not seen elsewhere, underscoring the patchy distributions of these habitats on the landscape. Draining this white-sand area was the only blackwater stream we encountered.

A large network of clearwater streams flows through the clay bottomlands at this site (Figure 3D). The valley bottoms are flat and probably flood. Most of the small streams have 0.5- to 1.5-m incised banks

and all have relatively simple, straight channels with the exception of the stream nearest camp, which was tightly meandering. In a 2-km walk along a single trail at this site one could cross all of the major stream types here: meandering streams with steeply-incised banks, rapidly rushing streams, temporal streams and a stream-fed swamp.

We camped on a bluff overlooking the largest stream (~10 m wide) in the area, and one of our trails explored its broad floodplain. Fauna was plentiful at this site; we awakened every morning to *Callicebus* monkeys. Treefalls, landslides, and major disturbances were rare with one exception. On one hillside we encountered a large regenerating forest, or *purma*, one of several such patches visible on the satellite image. A sharp and forceful downburst of air creates these large-scale treefalls, an infrequent and unpredictable event across Amazonia.

The Matsés sometimes hike from their settlements to Requena, a large town on the Ucayali river, to trade and purchase goods. On one of these three-day hikes in the past some of our Matsés guides had walked through the area near this inventory site. We found evidence (an abandoned temporary shelter, small patch of secondary forest) of a small settlement in the area, unknown to the Matsés. They estimate it was abandoned ~5-10 years ago.

The Matsés named the site for the *choncó* palm (*Pholidostachys synanthera*; Figure 3C) they use for roof thatching. Locally depleted near their settlements, this palm was remarkably abundant at this inventory site. Palms in general were a dominant part of the landscape here, and overall palm diversity was remarkable, numbering over 30 species (Figure 4G). We did not observe any extensive *Mauritia flexuosa* palm swamps, known as *aguajales*, though we did find several lone individuals, and some scattered patches of a dozen stems.

Itia Tëbu (05°51'30"S 73°45'37"W,
~100-180 m elev., 29 Oct-2 Nov 2004)

This was the second site we visited during the rapid biological inventory, along the westernmost edge of the

proposed RC Matsés. For three days, we explored more than 15 km of trails through a complex of short, flat-topped hills and broad valley bottoms. We camped along one of the many streams in the area, part of an extensive blackwater network of streams, isolated pools, and larger, interconnected ponds.

Although only 3 km from the Río Blanco, extensive geological faulting in the area causes streams in this area to drain in the opposite direction, towards the Río Gálvez, and ultimately, to the distant Río Yavarí. Major rains on 28 October flooded a substantial part of the trail system, encouraging several frogs to breed explosively for the next several nights. Satellite images show this flooded area to be the western edge of a small lake that drains via a network of tributaries to the Río Gálvez.

Most soils at this site were sandy, ranging from nutrient-poor sandy loams in the valley bottoms to extremely impoverished white sands on the hilltops—the poorest soil type in Amazonia (Figure 3C). A porous root mat, 10 to 40 cm thick, covers the forest floor.

Paradoxically, the lowest vegetation grows on the highest points in the landscape. Spindly stems, rarely reaching more than 15 m in height, grow on the flat ridge tops; these white-sand forests are known locally as *varillal*. A more extreme version of *varillal*, known as *chamizal*, grows on the purest white sands and exhibits an even shorter canopy, typically 3-5 m tall (Figure 3E). Both the *varillal* and *chamizal* are species-poor habitats, dominated by a handful of species, most of them endemic to this habitat (see pp. 176-77, Flora and Vegetation). The white-sand forests in this area represent the greatest extent of this habitat anywhere in Peru (Figure 12A).

The Matsés guides accompanying us had not visited this site previously, but they were familiar with white-sand forests because small patches occur near their settlements. They christened this site Itia Tëbu, for the *Mauritia carana* palm that dominates the white-sand forest (Figure 3G).

In addition to the mosaic of white-sand ridges and valleys, we were able to survey the Río Blanco, a tributary of the Ucayali. From camp we followed a

wide, old logging trail (Figure 10D) for 3 km through several large patches of secondary forests recovering from agriculture and logging tractors, traversing three valleys parallel to the Blanco before reaching the river. These valleys are presumably associated with the faulting along the length of the Blanco (see Landscape Processes: Geology, Hydrology, Soils, p. 168). The Blanco (Figure 8A) is a whitewater river, ~50 m wide, and meanders actively. We surveyed the narrow floodplain along its eastern bank, as well as a large, blackwater, floodplain lagoon.

Along the Río Blanco we found the greatest evidence of human impacts of the three sites we visited, including an agricultural plot recently burned for manioc, some temporary shelters, and various shotgun shells (Figure 10A). The *ribereño* village Frontera (~15 families) is only an hour's canoe paddle upstream from here.

Actiamë (06°19'03"S 73°09'28"W, ~80-190 m elev., 2-7 Nov 2004)

This was our southernmost site, and our only campsite along a large river, the Río Yaquerana (known to the Matsés as Actiamë, Figure 3L). We camped on a levee within the extensive Yaquerana floodplain, a fairly flat area with a limited herb layer. Sediment deposits in fallen logs suggest that this area floods completely at times. Four trails radiated from camp and traversed a range of habitats, including a complex of hills and valleys, the Yaquerana floodplain, a small *Mauritia* palm swamp, and a floodplain lake, or *cocha*.

During our four days here we explored some of the steepest terrain we encountered during the inventory, with one trail repeatedly ascending high hills only to descend quickly again into narrow valleys. These climbs illustrated some remarkable soil transitions. Initially, soils were a yellow-brown sandy clay loam, typical of terrace deposits, while higher up on the slopes, we encountered a reddish, dense, and sticky clay. Farther from the river, the trails continued to climb gradually, giving way to a tierra firme upland with flat-topped summits and fairly sandy soils, sometimes with a series of terraces as one ascended from the stream valleys.

One stream valley was unlike any of the others that we observed during the inventory. The stream exhibited especially high conductivity, and was walled with hard sedimentary deposits that included dense blue mudstones and gravels of much harder rocks. All these characteristics indicate that the sediments are from the Pevas Formation, deposits typically found farther north, closer to the Amazon (see Landscape Processes: Geology, Hydrology, and Soils, below).

Another trail explored the floodplain, following the Yaquerana downriver until reaching and crossing one of its large tributaries. In this tributary, we occasionally observed river dolphins, including one nursing its young (see Mammals, p. 209). Most of the streams crossing the floodplain and entering the major tributary were backed up by flooding a few days before, causing extensive muddy backwater deposits in the stream channels.

Although ichthyologists were unable to explore the Río Yaquerana itself because of high waters, they surveyed a large floodplain lake ~500 m inland, and found plentiful fishes there. This was the only site we visited with a significant *Mauritia* palm swamp, although it was small by Amazonian standards and is barely visible on the satellite image.

Fauna, especially large monkeys, were abundant at this site, presumably drawn to the high density of fruiting trees, the greatest that we observed during the inventory (Figure 3K). Although the animal communities here appeared intact, we did find scattered evidence of previous human visits to the area. A trail network, some temporary settlements, and a gas drum (Figure 10B) suggest this area was previously used as a cocaine trafficking/processing camp, perhaps five years ago. In addition, our Matsés guides report that Matsés do hunt in this area occasionally. During our stay we observed one canoe descending the river with tapir and peccary meat (Figure 10C).

COMMUNITIES VISITED BY THE SOCIAL TEAM

While the biological team was in the field, the social team surveyed seven of the 13 native communities

within the Matsés territory (Figures 2, 11E). Along the Río Galvéz we worked in five communities: San José de Añushi, Buen Perú, Remoyacu, Paujíl, and Jorge Chávez. To the southeast, along the Quebrada Chobayacu, we visited two communities: Buenas Lomas Nueva and Buenas Lomas Antigua. All of these communities, as well as the six others in the region that the social group did not visit, are discussed in more detail in Territorial History of the Matsés (p. 215).

LANDSCAPE PROCESSES: GEOLOGY, HYDROLOGY, AND SOILS

Author: Robert F. Stallard

Conservation targets: Exceptional soil diversity; ancient patches of white-sand soils with distinctive vegetation, a defining feature of the Loreto landscape insufficiently protected by the Peruvian protected areas system (SINANPE); extremely acidic forest streams draining white-sand areas; swamp hummock complexes

INTRODUCTION

The Peruvian side of the middle Río Yavarí basin is a tierra firme upland that became elevated between three and five million years ago. The sediments at the ground surface tend to be the Pevas Formation in the north and fluvial sediments to the south. Both of these types of deposits exhibit marked lateral variations in texture and composition (Linna 1993). The Pevas Formation tends to have blue clays, lignites, silts, and sands. Some lithologies contain easily weathered minerals such as calcite (CaCO_3), gypsum (CaSO_4), pyrite (FeS), and apatite ($\text{Ca}_5(\text{PO}_4)_3(\text{F,Cl,OH})$). Soils produced by weathering can range from rich to poor depending on the substrate lithology and the duration of weathering (Kauffman et al. 1998). All fluvial sediments in the region have been pre-weathered in a previous cycle of erosion. Subsequent weathering produces rich soils on young fluvial deposits, but strongly leached soils on older fluvial deposits (Klammer 1984; Irion 1984a,b; Johnsson and Meade 1990; Stallard et al. 1990; Kauffman et al. 1998; Paredes Arce et al. 1998). In the Iquitos region, as well as in the area visited during the

rapid biological inventory, this leaching of fluvial sediments has produced white, quartz-sand soils (Kauffman et al. 1998).

There are few published studies of the geology or the soils of the middle Yavarí region. An overview of these studies, as well as a broader look at the region's geology and landscape, is given in Appendix 1A. In this chapter I review the most obvious features of the sites visited during the rapid biological inventory.

METHODS

Soils, topography, and disturbance

Along every trail at each camp, I assessed soil color visually, with Munsell soil color charts (Munsell Color Company 1954), and soil texture by touch, with the help of charts developed in English and Spanish by the Smithsonian Center for Tropical Forest Science (Appendix 1B, 1C). Because the soil was generally covered by leaf litter and often a root mat, I used a small soil auger to retrieve samples. Along the trails I also noted activities of bioturbating organisms (such as cicadas, earthworms, leaf-cutting ants, and mammals), frequency of treefalls involving roots, presence of landslides, the importance of overland-flow indicators (rills, vegetation wrapped around stems indicating surface flow), and evidence for flooding (sediment deposited on fallen tree trunks, extensive gley soils).

In addition to looking at soils, I also made an attempt qualitatively to describe hillslopes and large-scale disturbances. In the case of hillslopes, this included 1) an estimate of topographic relief, 2) spacing of hills, 3) flatness of summits, 4) presence of terraces, and 5) evidence of bedrock control. The major types of natural disturbance expected for western lowland Amazonia are extensive blow-downs (Etter and Botero 1990, Duivenvoorden 1996, Foster and Terborgh 1998), small landslides (Etter and Botero 1990, Duivenvoorden 1996), channel migrations by alluvial rivers (Kalliola and Puhakka 1993), and rapid tectonic uplift or subsidence that changes hydrology (Dumont 1993).

Rivers and streams

I assessed all bodies of water along the trail systems visually and via measurements of acidity and conductivity. Visual characterization of streams included 1) water type (white, clear, black), 2) approximate width, 3) approximate flow volume, 4) channel type (straight, meandering, swamp, braided), 5) height of banks, 6) evidence for overbank flow, 7) presence of terraces, and 8) evidence of bedrock control of the channel morphology.

To measure pH, I used an ISFET-ORION Model 610 Portable System with a solid-state Orion pHure pH/Temperature Systems electrode. For conductivity, I used an Amber Science Model 2052 digital conductivity meter with a platinum conductivity dip cell. The use of pH and conductivity to classify surface waters in a systematic way is uncommon, in part because conductivity is an aggregate measurement of a wide variety of dissolved ions. However, graphs of pH vs. conductivity (see Winkler, 1980) are a useful way to classify water samples taken across a region into associations that provide insights about surface geology (Stallard and Edmond 1983, 1987; Stallard 1985, 1988; Stallard et al. 1990).

RESULTS

Stream chemistry

The primary result of the water chemistry analyses is that streams from a given site tend to group together (Figure I in Appendix 1F). Río Gálvez headwater streams around Itia Tëbu tend to be blackwater streams. The stream near that campsite had the most acid natural surface water (pH=3.76) that I have ever sampled in the tropics. By contrast, Río Gálvez mid-basin streams around Choncó tend to have clear waters, with minor blackwater streams (Figure 3D). These waters have low conductivities, indicating rather low concentrations of dissolved material and therefore low nutrients. The conductivity and pH of the water in the Río Gálvez near Remoyacu-Buen Perú is largely derived from clearwater streams similar to the streams at the mid-basin site.

The streams near the Río Yaquerana (Actiamë, Figure 3L) are also clear-water streams, but the higher conductivities indicate considerably more solutes. The stream with the highest conductivity (210 µS, micro Siemens per cm) drains the Pevas Formation. Conductivities of this level indicate that soluble minerals are contributing to the solute mix. In the Pevas Formation, the most likely contributors are calcite (CaCO₃), gypsum (CaSO₄), and pyrite (FeS₂).

Site descriptions

In presenting the results of this study, I begin with the headwaters (Itia Tëbu), proceed downriver to mid-basin (Choncó), then to the main channel on the lower Río Yaquerana (Actiamë), and finally to the main channel of the Río Gálvez (Remoyacu-Buen Perú). Stream sampling locations and analyses are in Appendix 1D, 1E.

Headwaters of the Río Gálvez: Itia Tëbu

This region appears to be a recently formed headwaters of the Río Gálvez, created when the previously more extensive headwaters region was cross-cut by the Río Blanco, presumably on a fault system that connects to the Bata Cruzeiro Inverse Fault. The numerous small streams that parallel the main trend of the Río Blanco valley indicate that the faulting is both active and probably recent, and suggests that the Río Blanco has only recently captured the former headwaters of the Río Gálvez. Accordingly, it is reasonable to expect landscape features seen in this study to continue across the Río Blanco fault.

The landscape around the camp appears to be formed on ancient floodplain deposits from an earlier alluvial plain of the ancestral Río Amazonas/Río Ucayali system. The textural variation of sediment composition in such deposits is complex, varying from coarse gravels (channel bottoms) to fine clays (floodplain lakes). This variation is both lateral and vertical, because channels shift their courses frequently, cutting new courses through older, often much finer, material. In the field, one seldom sees much consistency from site to site without more detailed mapping than can be done here (Linna 1993).

Soils and topography: The *varillal* forests here grow on quartzose white-sand soils on flat-topped hills and ridges (Figure IIA in Appendix 1F). These flat summits likely represent remnants of the former fluvial landscape. The quartz sands could have been alluvial sands, or they could have been derived from texturally complex sediments by weathering. The white-sand soils in the flattest areas are covered by a dense, peaty root mat about 10 cm thick. Below this is sand with an organic matrix, and finally a clean sand at 20 cm. In the deepest soil core, roots were found to 35 cm, and at 40 cm, the sand was saturated. The presence of a root mat, which has a major role in nutrient retention, is indicative of extremely nutrient-poor soils (Stark and Holley 1975, Stark and Jordan 1978).

Almost all slopes had yellow-brown sandy clay loam to yellow-brown loamy sand soils. These yellow-brown soils are covered with a root mat about 10 cm thick, which is more porous and less dense and peaty than that in the *varillales*. There were a few ridge and summit areas that had similar yellow-brown sandy clay loam to yellow-brown loamy sand, but these were subordinate in the landscape and tended to be lower in elevation than the flat hilltops.

The terrain around camp was on yellow-brown sandy loam covered with a dense and almost unbroken root mat. The small nearby stream was tea-colored, very acidic (pH = 3.76) black water draining one of the *varillales*. Most of the other streams in the area are also blackwater, reflecting the abundance of *varillales*.

Hummock swamps: The broader valley bottoms and extensive lowlands were filled with hummock swamps of palms, large and small trees, and many shrubs. Between these hummocks are pools and interconnected networks of blackwater. Everything that is not a pool or flowing water is covered with a porous root mat, 10 to 40 cm thick.

When entering one of these swamps, one first comes across scattered, isolated pools. As one advances, the pools become larger and start to connect. These areas transition into areas where there is a network of connected pools interfingering with connected mounds

and then to areas where the mounds form islands in one large body of water. Finally, one reaches a broad flooded area with the occasional hummock. Many of the hummock swamps end with a stream flowing against a steep rise up to *terra firme* forest (which, in turn, sometimes slowly transitions into another swamp or into varillal). Some hummock swamps are perched, such that many of the steeper upslopes have terra firme forest, but a short distance after topping the crest, either a hummock swamp or white-sand forest begins.

The root mat may have a role in developing this typical transition in hummock swamp topography. The hummocks are not simple mounds of organic materials, but have cores of mineral soil—often white sand, but sometimes yellow-brown loamy sand to yellow-brown sandy clay loam. The largest mounds (10-50 m diameter) had yellow-brown sandy clay loam and more terra firme-like trees. The pool bottoms between hummocks have no root mat, just leaf litter over mineral soil. The slightly raised mineral soils that form the cores of the hummocks indicate that the low areas are low because something has depressed the mineral soil there relative to the hummocks.

One possible explanation is that low areas are pits left from old treefalls. A few pools and mounds clearly have this origin. However, most pools are too large for treefalls to be a satisfactory explanation, and the predictable transition from scattered pools to scattered hummocks suggests that the causative factor is not entirely random. A second explanation is that the hummock topography is erosional. Simple physical erosion through a channel network would not work because of the lack of connectivity to channels in the second (flat terrain with pools) and third (interfingering hummocks/pools) types of hummocky terrain. Possibly the pools and water channels are the equivalent to solution pits, where the clays have been dissolving out of the sands under the thick root mat and the sand is collapsing into the pools. Possibly, the initial pits are just treefalls, but the excavated material is partially lost through dissolution, leaving a hole. The water in the hole is both acid and full of complexing agents that

can dissolve the clays and the iron and aluminum sesquioxide minerals that form the fine-textured components of soil. Perhaps this reactive water eventually expands the pools into connected networks.

Varillal extent: The characteristic appearance of varillal/chamizal vegetation in satellite imagery led Räsänen et al. (1993) to infer correctly that there were white-sand soils in this region. I used a photo editing program to map regions that, based on field observations, are likely to be *varillales* and *chamizales*. The exercise indicates that the region occupied by white quartz-sand soils is probably quite large (Figures 12A, B). Given the slowness of the leaching process that produces these soils, involving subtle interactions between soil texture, soil-water chemistry, and plant colonization, and considering the general rareness of varillal vegetation in northern Peru, the soils of this region deserve maximum protection.

Mid-basin of the Río Gálvez: Chonco

The landscape around the Chonco seems to have developed on older fluvial deposits much like those in the headwaters. The landscape consists of low convexo-concave hills, often ridge-like in nature, perhaps partially guided by the early floodplain topography or vertical and lateral changes in sedimentary-deposit type (Figure IIB in Appendix 1F). The stream network is largely dendritic, and many streams, including the larger stream near camp, cross-cut these ridges. This area did not have any of the flat-topped hills and ridges found in such abundance near the headwater camp. This would be consistent with the deeper erosion often encountered in river-basin interiors. GPS elevations on the highest topography mid-basin (about 180 m) were greater than the highest topography near the divide (about 160 m). The lower headwater elevation may be a GPS problem or it may reflect the possibility, discussed in Appendix 1A, that the present headwaters may be near the old main channel of the Río Gálvez.

We encountered just one area of white quartz-sand soils, on a flat hilltop not otherwise distinguishable

from the other hilltops on the trail. Moreover, the hilltop was not the highest part of the surrounding landscape, as were the white quartz-sand areas in the headwaters. Thus, this white quartz-sand soil probably is not an erosion remnant of a landscape that once resembled the headwater area. Instead, it seems likely that the soil is forming in place. The stream that drained this sand was the only blackwater stream encountered at this site.

Except for bank failures along the stream and the rare blow-down (a few of which are evident on the satellite photo) there seems to be little major disturbance on this landscape. Treefalls were rare along the trails, and the gentle topography did not appear to generate landslides.

Main channel of the Río Yaquerana: Actiamë

The landscape adjacent to the Río Yaquerana is a strong contrast to that of the headwater and mid-basin sites in the Río Gálvez. This camp provided access to the floodplains of the Yaquerana, the floodplains of a major tributary, a lake (*cocha*), an *aguajal*, and a hilly upland.

The camp was built on the floodplain of the Yaquerana near a drainage swale that cuts through the levee deposit. The modern floodplain was 3-4 m above the (somewhat oscillating) stage of the Yaquerana at the time we occupied the site. The levee deposit is a mound of higher ground that is nearest the river on the terrace. Between the levee and a higher terrace, about 4 m above the modern floodplain, is a complex of swale drainage features that includes well-developed *aguajales*.

Soils in the higher terrace at this campsite vary from sandy soils to dense, sticky clays. One valley here has near-vertical walls composed of much older sediments than the fluvial sediments that underlie headwater and mid-basin sites in the Río Gálvez. The tougher layers, dense blue to green mudrock typical of the Pevas Formation, form several small cascades in the streambed. This streambed has softer clay gravel from the dense mudrock as well as harder gravel eroded out of the softer layers of the older sedimentary deposits. The harder gravel includes quartz, feldspar, and very hard fine-grained sediments. The very hard fine-grained

sediments indicate either an Andean or shield origin for the gravel, probably Andean. The gravel and rocks were enough of a novelty for the Matsés workers that they collected samples to take home to show others.

Above this stream was perhaps the highest and definitely the steepest ridge in the trail system. It had clay soils from top to bottom, including its summit. On the other side of this ridge was a second stream that, while smaller than the previous one, had similar features. One other stream in the area also had similar gravel in its bed.

Many of the other hills, especially those with flat tops, had sandy soils on top. On some of the flat-topped hills, this cream-colored sandy layer lies above a redder, more clay-rich soil horizon. The creamy color indicates some leaching, perhaps in the direction of quartz-sand-soil formation.

Throughout the trail system, the slopes of many hills are interrupted by a terrace about 3 m above the valley bottom. This is matched by the similar terraces on the Río Yaquerana, mentioned earlier, and on the large tributary river. Thus, we have at least three major terrain levels in this landscape: 1) the flat hilltops, 2) the various older terraces on the main rivers and many of the stream valleys, and 3) the modern floodplain (Figure IIC in Appendix 1F). There may be two older terrace levels, but without precise topographic measurements this is hard to confirm. With these observations, we can hypothesize five steps of erosional history. The first step is an erosional plain from which the flat-topped hills are derived. Second, this surface was eroded and the drainage network that we see today formed; erosion continued until many of the stream valleys became flat bottomed. Third, a change in base level promoted the incision of these valleys, leaving the remnants of the old valley bottoms as terraces. Fourth, new flat valley bottoms formed. Finally, streams are now being incised in some of the modern flat valley bottoms. This may indicate a new adjustment or it may be part of the natural progression of valley widening.

Stream conductivity data indicate far higher levels of dissolved ions in the streams of the Río

Yaquerana and its tributary than those in the upper and middle Río Gálvez. Most streams and the tributary were 30 to 40 μS . The Yaquerana was 50 μS , while the stream draining the older formation was 210 μS . The last value is quite high for rivers draining exclusively silicate rocks and suggests influence from carbonates or perhaps pyrite. The higher conductivity in the Yaquerana indicates that there may be similar high-conductivity streams upriver.

Main channel of the Río Gálvez (Remoyacu-Buen Perú)

Although our short visit to Remoyacu-Buen Perú was not an official sampling camp, it afforded an opportunity to extend the characterization of the Río Gálvez basin. The topography of the area was quite similar to that of the mid-basin site. Hills were a very simple undulating form with occasional broad flat valleys (Figure IID in Appendix 1F). The town of Remoyacu may be on a terrace and the field behind the town, on which the helicopter landed, may be a lower terrace.

Bedrock exposed along the river is generally a dense red and yellow mud, sticky when wet and with a popcorn texture when dry, typical of montmorillonite-rich deposits. Near the river were abundant calcareous nodules and fossil shell fragments, consistent with upper units of the Pevas Formation. The Río Gálvez is a dilute clearwater stream with low conductivity and intermediate pH. This would indicate very little interaction with sediments such as those described above, which tend to produce streams with high conductivities and high pH. The presence of Pevas Formation in Remoyacu-Buen Perú and its absence from the site in the middle Río Gálvez to the south is consistent with a tilting of the sedimentary deposits to the south as envisioned by Räsänen et al. (1998).

DISCUSSION

The southward dipping of sedimentary formations, which exposes the Pevas Formation in the north and along Río Yaquerana and younger, more weathered formations to the south has created an extensive region of deeply weathered soils, including quartz-sand soils in much of the southern Río Gálvez basin. Based on

conductivity, this includes most of the basin south of Remoyacu-Buen Perú. These soils are covered with a root mat and would be susceptible to severe nutrient depletion from deforestation or extensive agriculture. Areas of Pevas Formation within the region have rich soils. The result is a complex landscape with many soils and water types: the foundation of a biodiversity engine. Soils and geology were not explicitly examined in the Yavarí and Ampiyacu, Apayacu, and Yaguas surveys (Pitman et al. 2003, 2004). The Pevas Formation type locality is at the mouth of the Río Ampiyacu, and the southward tilt of the sedimentary formations would argue for a greater abundance of Pevas Formation sediments in those two regions and therefore richer soils.

THREATS, OPPORTUNITIES, AND RECOMMENDATIONS

The Peruvian sector of the middle part of the basin of the Río Yavarí, which encompasses the basins of the Río Gálvez and the lower Río Yaquerana, has an exceptional variety of soils and forests. The most notable landscape feature is the presence of extensive areas of white quartz-sand soils that are especially common along the divide between the Río Gálvez and the Río Blanco. These soils and their varillal vegetation appear to have developed *in situ* over millions of years through the weathering of older fluvial soils in a process involving the dissolution of clays and aluminum/iron sesquioxides by organic acids and complexing agents. The enormous time that it takes white quartz sand soils to form in place, and their extreme sensitivity to the hydrologic changes and the erosion caused by roads and even trails (Figure 10D), makes complete protection essential. If the soils are damaged both they and the associated varillal vegetation will not recover for thousands of years, if ever. These quartz-sand soils should receive maximum protection.

RESEARCH, EDUCATION, AND PARTICIPATORY WORK

With the purchase of soil charts and an inexpensive coring tool, soils and underlying material exposed in

stream channels can be easily mapped in a way that is sufficient to characterize much of this landscape. The soil texture tables in the appendices of this report are also required (Appendix 1B). The mapping would involve extracting a soil plug and recording location, presence and thickness of root mat, color and texture of core top, color and texture of texture of core bottom, stream type, channel shape, and description of bank material (Pevas/not Pevas). The only instrumentation required is a GPS for measuring location in regions without suitable maps.

FLORA AND VEGETATION

Authors/Participants: Paul Fine, Nállarett Dávila, Robin Foster, Italo Mesones, Corine Vriesendorp

Conservation targets: Extensive white-sand forests, a habitat representing less than 1% of the Peruvian Amazon, with many endemic species; plants endemic to white-sand forests, including impressively large populations of *Mauritia carana* (Arecaceae, Figure 3B), *Platycarpum orinocense* (Rubiaceae; Figures 4A, C), and *Byrsonima* cf. *laevigata* (Malpighiaceae); populations of commercial timber species heavily exploited elsewhere in Loreto, including Spanish cedar (*Cedrela odorata*, Meliaceae), kapok or *Iupuna* (*Ceiba pentandra*, Bombacaceae) and *palisangre* (*Brosimum utile*, Moraceae); all the major *terra firme* habitats in the Peruvian lowlands, spanning a complete gradient from nutrient-rich clay soils to sandy loam hills with intermediate fertility to extremely impoverished white-sand soils

INTRODUCTION

Loreto, the largest department in the Peruvian Amazon, is one of the world's plant diversity hotspots (Gentry 1986, 1989; Vásquez Martínez 1997; Ruokolainen and Tuomisto 1997, 1998; Vásquez Martínez and Phillips 2000). The extraordinary species richness documented near Iquitos derives from the variety of forest types and the remarkably heterogeneous soils in the area, putting these forests in marked contrast to edaphically and floristically more uniform western Amazonian forests such as Yasuní National Park in Ecuador and Manu National Park in southern Peru.

Due to the unique geology and ecology of the Iquitos area, it is difficult to extrapolate its diversity

patterns to other parts of Loreto, especially unsurveyed areas, such as the proposed Reserva Comunal (RC) Matsés. In forests farther away from Iquitos, the botanical diversity remains relatively unknown, with the exception of Jenaro Herrera (Spichiger et al. 1989, 1990), inventories in northern Loreto (Grández et al. 2001), data from scattered collecting trips (e.g., Encarnación 1985, Fine 2004, N. Pitman et al. unpublished data) and two rapid botanical inventories (Pitman et al. 2003, Vriesendorp et al. 2004). The forests in and around the Comunidad Nativa Matsés are a several-day journey by boat from Iquitos, and very few scientists have traveled to these forests. One notable exception is the work of Fleck and Harder (2000) that describes 47 distinctive habitat types recognized by the Matsés. However, their study site along the Río Gálvez was >25 km from the areas visited and their study did not document the area's botanical diversity, apart from listing all the palm species. Our rapid inventory almost certainly represents the first visit to this area by non-Matsés botanists.

METHODS

We used a variety of methods to characterize the flora and vegetation at the three sites (Figure 4D). Much of our time was occupied by slowly walking the trails searching for plants that were in flower or in fruit, making notes on all observed plants, and comparing forest composition in different habitats. R. Foster took more than 1,190 pictures of common and interesting plants, many to be used as part of a field guide of the plants of the proposed RC Matsés. We conducted quantitative sampling at each site using 0.1 ha plots and variable area transects. By keeping track of the largest tree diameters and species diversity, we characterized the forest structure in different habitats at each site. Two of us (P. Fine and I. Mesones) recorded and identified all Burseraceae individuals that we encountered, and took detailed notes on their habitat type (Appendix 2B). We collected 600 different species, including more than 500 represented by fertile collections that we deposited at the Herbarium Amazonense in Iquitos, the Museum of

Natural History in Lima, and the Field Museum of Natural History in Chicago.

FLORISTIC RICHNESS, COMPOSITION AND ENDEMISM

Our three inventory sites covered almost the entire range of flooded and terra firme habitats of lowland Amazonia: swamp forests, floodplain forests, and terra firme forests on rich, intermediate and extremely poor soils. Since the majority of Western Amazonian plant species are associated with only one or two of these soil types (Fine 2004, Fine et al. 2005), we suspect that the proposed Reserva Comunal Matsés may contain greater plant diversity than any existing protected area in lowland Peru.

We generated a preliminary list of ~1,500 plant species for the proposed RC Matsés (Appendix 2A). It includes all plants that were collected, photographed, and/or observed and identified in the field, and represents perhaps one third to one half of the flora of the proposed RC Matsés. Flora estimates for other rapid inventories in Loreto (Yavarí, Pitman et al. 2003; Ampiyacu, Apayacu, and Yaguas (AAY), Pitman et al. 2004) ranged from 2,500-3,500 species, and we believe that the proposed RC Matsés likely supports equivalent numbers. This region probably harbors additional species because of its greater edaphic and habitat diversity; for example, we encountered 100-200 species from more specialized habitats in the proposed RC Matsés that were not observed or collected in the other two inventories.

At any given site in the proposed RC Matsés, plant species richness ranges from some of the most depauperate in Amazonia (the white-sand forest areas, Figure 3H) to some of the richest (all of the upland areas of intermediate to relatively-rich soil fertility; Figures 3B, J). The species diversity patterns of the different habitats have less to do with the local ecological processes, and relate more to the relative sizes and histories of sand and clay habitats in the Amazon basin. For example, white-sand forests in the western Amazon generally are small habitat islands surrounded by a sea of forests atop more nutrient-rich soil types.

In the proposed RC Matsés, even though white-sand forests cover a larger area than any other white-sand habitat in Peru, they still cover only a small percentage of the total region. In the Río Blanco area where they are most extensive, they appear as an archipelago of habitat islands, even though some are many square kilometers in size. Like all islands, these habitats are characterized by low species diversity and local dominance of species that have either dispersed from other white-sand areas or evolved *in situ*.

In contrast, fertile clay soils and the sandy clay loam soils of intermediate fertility have been present for at least 8 million years and cover a vast area of the western Amazon (Hoorn 1993). Therefore, it is not surprising that a hectare of white-sand forest sites at Itia Tëbu typically contains ca. 50 species of trees >5 cm in diameter, while a hectare of clay forest at Actiamë or the sandy loam sites at Choncó probably contains at least six times that number.

Family and genus level composition of forests in the Matsés appear to be typical of the Amazonian lowlands (Gentry 1988). Many of the families that were common in other Loreto inventories are also common in the RC Matsés: the Fabaceae, Arecaceae, Moraceae, Rubiaceae, Annonaceae, Sapotaceae and Sapindaceae. Burseraceae appeared to be especially species rich in the region, with 20% more species found in the proposed RC Matsés than in the two other Loreto inventories. Other groups that seemed especially diverse compared to the other inventories were *Bactris* (Arecaceae, 11 species), *Tachigali* (Fabaceae, 11 species), and *Dendropanax* (Araliaceae, 4 species). Some taxa were not as common or as diverse as one would expect in lowland Amazonia, including the families Lauraceae, Myristicaceae, and the genera *Licania* (Chrysobalanaceae) and *Heliconia* (Heliconiaceae).

It is difficult to estimate levels of endemism within the proposed RC Matsés. Because much of its forests grow on sandy loam and clay soils that are common throughout Amazonia, it is unlikely that there are more than a few endemic plants occurring in these habitat types. In contrast, the substantial

white-sand forests along the Río Blanco, probably the most extensive in the western Amazon, are very likely to contain endemic plants. In this inventory we collected numerous odd plants from white-sand forests that we suspect, with review by specialists and further study, will prove to be new species or varieties, incipient species, or substantial range extensions of species known from the Guianan Shield (Figures 4E, I).

VEGETATION TYPES AND HABITAT DIVERSITY

The proposed RC Matsés varies less than 100 m in elevation but encompasses an impressively wide range of soil diversity—from impoverished white-sand quartz to sandy clay loam terraces of intermediate fertility to sticky, nutrient-rich Pevas Formation clays. In addition to the diversity of soil types, the topography of the landscape and the flooding patterns of the local larger rivers, as in many other parts of Amazonia, create habitats that are flooded for months at a time. These long bouts of inundation also strongly influence the appearance and species composition of the forest. For example, at camp Choncó, we found twice the density of large trees (diameters >60 cm) in non-flooded sites compared with flooded sites (Table 1), with no overlap in species composition.

In addition to topography, the relative amounts of clay and sand in the soils appear to influence both the nutrient availability and drainage patterns that in turn drive forest structure and species composition.

At Actiamë, our site with the greatest soil fertility, large trees were five times more abundant than at Itia Tëbu, the camp with the lowest soil fertility (Table 1). And of the 100 species of large trees that we encountered at the two camps, only six species were shared between both sites.

The three sites lie along a marked gradient of soil fertility, although all were punctuated with flooded and unflooded habitats. Here we describe the main forest types at each site, starting with the nutrient-poor white-sand forest and sandy flooded and unflooded terraces at Itia Tëbu and Choncó, and continuing to the fertile clay ridges and floodplains of Actiamë.

White-sand forests (Choncó and Itia Tëbu)

The most exciting part of the expedition was encountering the vast areas of white-sand forest around the Río Blanco (Figures 12 A, B). Based on satellite imagery, Räsänen et al. (1993) speculated about the possible existence of these white-sand forests; however, our visit to the area was the first opportunity to confirm their existence on the ground. Within the proposed Reserva Comunal Matsés, these forests represent ~5-10% of the area, and are concentrated in the headwaters of the Río Gálvez. Moreover, these forests cover a larger area than any of the known white sand patches in Peru, including the famous white-sand forests of the Iquitos area in the Nanay Basin that harbor many rare and endemic species of plants and animals (Alvarez et al. 2003; Figure 12A).

Table 1. Richness and abundance of large trees (dbh > 60 cm) in the three inventory sites (N. Dávila).

Site	Habitat	Km of trail	Trees > 60 dbh	Trees per km	Number of species	Species per individual
Choncó	Sandy loam	4	52	13	27	0.52
Choncó	Inundated clay	1.5	11	7	6	0.55
Itia Tëbu	White-sand	1	0	0	0	0
Itia Tëbu	Sandy loam	10	51	5	20	0.39
Itia Tëbu	Inundated clay	2	10	5	8	0.8
Actiamë	Clay and sandy clay	1.1	90	82	20	0.22
Actiamë	Floodplain	3	90	30	20	0.22

In both Choncó and Itia Tëbu, white-sand forests grew on flat hilltops flanked by gradual slopes of brown sands and sandy loams that supported substantially taller trees. This odd juxtaposition of stunted forests growing on the highest points in the landscape surrounded by lower areas with taller canopies creates a false impression from the air that the white-sand forests grow in valleys.

White-sand soils like the ones we visited at Choncó and Itia Tëbu have an extremely low nutrient availability. These forests develop a short stunted canopy of thin boles, so that much more light reaches the understory than in typical Amazonian forests (Figure 3E). Lianas and epiphytes are much rarer in white-sand forests, and perhaps due to the smaller canopy, treefalls are much less frequent than in forests on nutrient-rich soils. Large gaps are never seen. The plants develop a thick root mat that efficiently traps nutrients decomposing from the often very thick layer of accumulated leaf litter.

The species composition of white-sand forests is distinct from forests that grow on more fertile soils, almost certainly because species must have specific adaptations to survive in a nutrient-stressed environment. Local dominance by a few species that account for more than half of all individuals is a common phenomenon in these forests (Fine 2004).

We conducted an inventory of woody stems >5 cm dbh in 50 x 20 m plots in both a low-canopy white-sand forest (canopy ~8-10 m) at Itia Tëbu, and a high-canopy white-sand forest at Choncó (canopy ~30 m). The plot at Itia Tëbu was located near the center of the lightest patch on the satellite map, and likely was representative of all the nearby low-canopy white-sand forest. We visited a similar forest patch ~5 km distant and found the same composition of dominant species. The white-sand forests surveyed at Itia Tëbu were dominated by an emergent palm, *Mauritia carana* (Figure 3G); a canopy tree in the Rubiaceae (*Platycarpum orinocense*, a tree collected only three times previously in Peru; Figures 4A,C); and four smaller trees—*Pachira brevipes* (Bombacaceae, Figure 4E), *Euterpe catinga*

(Arecaceae, Figure 4J), *Protium heptaphyllum* subsp. *heptaphyllum* (Burseraceae) and *Byrsonima* cf. *laevigata* (Malphiaceae). The understory was composed mostly of juvenile trees of the most common overstory species, but also common were two Rubiaceae shrubs in the genus *Retiniphyllum*, and small trees of *Neea* spp. (Nyctaginaceae) and *Dendropanax* sp. At Itia Tëbu we found 35 species in 346 stems, while at Choncó we found 49 species in 138 stems.

In contrast to the extensive archipelago of white sand forests near the Río Blanco in Itia Tëbu, we encountered a single small (~0.5 ha) patch of white-sand forest at Choncó. Similar small patches may be scattered throughout the entire Gálvez basin, within a matrix of forests growing on sandy clay loam soils. The plot we surveyed in this patch was dominated by Fabaceae, Euphorbiaceae, Annonaceae, and Lauraceae, which together accounted for 59% of all stems. The common species included *Adiscanthus fusciflorus* (Rutaceae); *Pachira brevipes* (Bombacaceae), *Hevea guianensis*, *Micrandra spruceana* and *Mabea subsessilis* (Euphorbiaceae); *Macrobium limbatum* subsp. *propinquum* and *Parkia panurensis* (Fabaceae); and *Jacaranda macrocarpa* (Bignoniaceae); these have all been collected in other white-sand forests in Loreto. The understory was dominated by shrubby trees of *Neoptychocarpus killipii* (Flacourtiaceae), *Calyptanthus bipennis* (Myrtaceae), and *Geonoma macrostachys* (Arecaceae).

Other White-sand Forests in Loreto

Counting both high- and low-canopy white-sand forest, we registered ~90 species of trees in Matsés white-sand forests (Appendix 2A). About 50 of these have been collected before in other white-sand forests of Loreto (Fine 2004). The remaining 40 are possibly new, although many of them still need to be compared to herbarium specimens and sent out to specialists. About 20 of these species were collected with flowers or fruits, and represent an enormous value in characterizing the flora of Peruvian white-sand forests. For example, we collected the fruits of a rare lowland *Ilex* (Aquifoliaceae)

that has been collected previously in other white-sand forests in Peru, but almost never fertile. Previous collections of this taxon have been provisionally identified as *I. andarensis*, native to higher elevation forests in the Andes, or *I. nayana*, a rarely collected lowland tree. We suspect that several of our fertile collections will lead to the description of new species of endemic white-sand specialists (e.g., García-Villacorta and Hammel 2004).

Another fascinating finding was the enormous population of the palm *Mauritia carana* (Figures 3G, 12B). This palm is a Río Negro basin species, known from Peru only from the white-sand forests of Iquitos (where <100 individuals are known) and Jeberos, 500 km west of Iquitos (where the known population is even smaller). In the proposed RC Matsés, this palm dominates the canopy of all the low-canopy white-sand forest that we walked through and saw from the air, and its population undoubtedly numbers in the tens of thousands (Figure 12B).

The diversity of the white-sand plots that we inventoried at Choncó and Itia Tëbu falls within the average range for white-sand forests in Loreto. A similar low-canopy white-sand forest in Allpahuayo-Mishana exhibits 34 species in 343 stems, compared to Itia Tëbu's 35 species in 340 stems. A high-canopy white-sand forest in Allpahuayo-Mishana had 36 species in 96 stems, comparable to Choncó's 49 species in 138 stems (Fine 2004).

Although many of the common species from other white-sand forests in Loreto are present in the Matsés white-sand forests, we did not find many species that are common and dominant in Allpahuayo-Mishana. For example, we never registered *Dicymbe uiaparaensis* (Fabaceae), a characteristic multi-stemmed tree found in the white-sand forests of Allpahuayo-Mishana, the upper Nanay river, and Jenaro Herrera. Indeed, of the 17 dominants reported for six Loreto white-sand forests by Fine (2004), only 11 were found at Matsés, and three of these were observed only once. It is important to note, however, that white-sand dominants are often found in large, clumped populations and that we only sampled

two small areas (quite close together) from the large white-sand area near the Río Blanco. Another intriguing possibility that could explain the absence of some of the dominant white-sand species from other parts of Peru is that white-sand forests in the Matsés region have a more recent origin, and that species are still dispersing into the area (or becoming specialists *in situ*). Comparing the Matsés white-sand forests with other white-sand forests in Peru and other Amazonian countries is an exciting avenue of future research.

Sandy clay loam forests in terra firme

(Choncó and Itia Tëbu)

The sandy clay loam soils of intermediate fertility surveyed at Choncó and Itia Tëbu cover the low hills that dominate the Matsés region. Coarsely, we estimate that this forest type covers ~70-80% of the Río Gálvez basin, and ~40% of the Río Yaquerana basin. Where unflooded, the forest reaches a canopy of 40-50 m with emergents up to 50 m, with a well-developed understory sub-canopy, many lianas and at Itia Tëbu, very abundant epiphytes. The largest trees had diameters in the range of 70-80 cm, with one *Caryocar* cf. *amygdaliforme* (Caryocaraceae) exceeding 100 cm. Due to the high sand content of the soil, most trees do not have large buttresses and spreading roots. This leads to the formation of fewer large gaps, because when trees die and fall over, their roots do not cover such a large area, and thus fewer neighboring trees are affected.

In these forests, diversity of canopy species is high with some overlap in species between both the high-canopy white-sand forests and the sandy clay *terra firme* forests of Actiamë. Representative emergent trees included *Cedrelinga cateniformis* and *Parkia nitida* (Fabaceae), and *Cariniana decandra* (Lecythidaceae). The understory was dominated in many parts by the palm *Lepidocaryum tenue*, known locally as *irapay*. Common small trees included many species from the families Annonaceae and Lauraceae, many species from the genera *Miconia* (Melastomataceae), *Mouriri* (Memecylaceae), *Guarea* (Meliaceae), *Protium* (Burseraceae), and *Tachigali* (Fabaceae), and an impressive variety (30+ species) and abundance of small and medium-sized palm species.

The tall herb *Ischnosiphon lasiocoleus* (Marantaceae) is conspicuously common in the understory.

Although we did not have time to conduct a quantitative inventory of this habitat type for trees greater than 10 cm in diameter, N. Dávila and M. Ríos inventoried a 1-ha plot in similar soils in the Reserva Comunal Tamshiyacu-Tahuayo. In that plot, they registered ~217 species out of ~500 individuals (N. Dávila and M. Ríos, unpub. data). Although average when compared with the astonishingly diverse tree plots in other parts of Loreto (Pitman et al. 2003, Vriesendorp et al. 2004), this plot is quite diverse by Amazonian standards. We expect a similar diversity of trees per hectare in the sandy clay loam forests that occur in the proposed RC Matsés.

Periodically flooded forests of intermediate fertility (Choncó and Itia Tëbu)

Adjacent to the unflooded sandy clay loam soils of intermediate fertility in Choncó and Itia Tëbu were silty lower-elevation areas with a high clay content, although these areas probably exhibit similar levels of nutrient availability (see Hummock swamps, Landscape Processes: Geology, Hydrology, and Soils, p. 170-71). At the landscape-scale, periodically flooded forests cover 10-20% of the Río Gálvez basin, and 5% or less of the Río Yaquerana basin. These forests appear to be flooded intermittently after heavy rains, and may be flooded seasonally for three or more months of the year. The canopy is lower than the unflooded areas, with the largest trees reaching a diameter of 50 cm, with many fewer gigantic trees (Table 1), but with many large gaps and many more lianas and epiphytes, especially Araceae.

Flooding is a distinct stress on plants, and requires specific adaptations to survive anaerobic conditions. Thus, although the nutrient availability in flooded sites is likely very similar (see Landscape Processes: Geology, Hydrology, and Soils, p. 168) to that of upland sites, the plant species composition was markedly different, with almost no species overlap between habitats. Species richness in flooded habitats appeared to be substantially lower than in upland forest,

and we noticed the same common species occurring again and again whenever the trail dropped below the floodline. The dominant large canopy trees belonged to the families Fabaceae (*Dialium guianense*, *Tachigali macbridei*) and Lecythidaceae (*Eschweilera* cf. *itayensis*). Smaller trees that we frequently encountered were *Socratea exorrhiza* (Arecaceae), *Rinorea racemosa* (Violaceae), *Sorocea* sp. (Moraceae), and *Calliandra* sp. (Fabaceae). Understory plants included the palms *Bactris maraja* and *Iriartella stenocarpa*, and *Clidemia* spp. (Melastomataceae), *Neea* sp. (Nyctaginaceae), *Psychotria* spp. (Rubiaceae) and *Palicourea* spp. (Rubiaceae).

Large-scale tree blowdowns, or purmas (Choncó) (C. Vriesendorp)

Catastrophic tree blowdowns occur patchily throughout the lowland Amazon, and are the consequences of a strong, directed downburst of wind (Nelson et al. 1994). Often these areas are obvious on satellite images as bright patches within the forested landscape, similar in appearance to secondary forests near rivers or human settlements. At Choncó, using the satellite image as a guide, we cut a trail to one of these areas, and found a regenerating secondary forest, known as a *purma* in Peru. Using the size of the largest trees as a guide, we estimate that the blowdown occurred 10-15 years ago.

We found similar blowdowns in the Ampiyacu, Apayacu, and Yaguas inventory; there, however, the giant herb *Phenakospermum guyannense* (Strelitziaceae) was one of the dominants (Vriesendorp et al. 2004). At Choncó it was absent. The Choncó *purma* was dominated by 15-35 cm diameter *Cecropia sciadophylla* (Cecropiaceae) trees, with a species-poor understory of Melastomataceae shrubs, a *Psychotria* sp., a *Drymonia* sp. (Gesneriaceae), and juvenile palms of *Oenocarpus bataua* (Arecaceae).

Floodplain Forests (Actiamë)

At Actiamë, we found several distinctive habitats not encountered at Choncó and Itia Tëbu, including extensive areas of floodplain forest growing on relatively rich soils

of a high clay content. Floodplain areas are essentially absent from the Río Gálvez, and cover 5% or less of the area within the Río Yaquerana basin. These floodplain areas showed no evidence of protracted annual flooding, and the largest trees were gigantic emergents with diameters exceeding 150 cm and with heights of ~50 m or more. Below the emergents grows an even canopy of trees taller than 40 m, a well-defined subcanopy, and an abundance of lianas and epiphytes. Large treefall gaps were common, and we observed a well-developed community of pioneer and secondary forest species.

Species composition of these forests did not overlap substantially with any of the previously mentioned habitats. However, there was some overlap between the plants in the floodplain and the upland clay forests at Actiamë, especially in the areas where the two habitats converged. The emergent trees were represented principally by *Ceiba pentandra* and *Matisia cordata* (Bombacaceae), *Spondias venosa* (Anacardiaceae) and a diverse assemblage of *Ficus* spp. including many individuals of *Ficus insipida* (Moraceae). Common smaller trees and shrubs included *Otoba parviflora* (Myristicaceae), *Quararibea wittii* (Bombacaceae), the palms *Attalea* spp. and *Astrocaryum* sp., *Rinorea viridifolia* (Violaceae), *Oxandra* “mediocris,” (Annonaceae) and *Calyptanthus* spp. (Myrtaceae). Common climbers were noted from the family Menispermaceae and the aroid epiphytes *Anthurium clavigerum*, *Rhodospatha* sp., and *Philodendron ernestii* were frequently spotted. While the plant diversity of this habitat is not particularly high when compared to the (non-white-sand) terra firme forests, many of the species found here were not encountered in any other of the habitats we surveyed. Thus, the floodplain forests add an important component to the overall diversity of the region. The floodplain flora has much in common with most of the whitewater floodplains of the upper Amazon, such as the Río Manu in Madre de Dios.

Clay and Sandy Clay Terra Firme Forests (Actiamë)

Steep ridges rise about 30 m above the floodplain, in some parts covered in extremely fertile clays from the

Pevas Formation (see Landscape Processes: Geology, Hydrology, and Soils, p. 168). The clay and sandy-clay forests on these ridges were structurally similar to the floodplain forests, with large gaps often forming from treefalls and landslides. These forests appear to be relatively rare (<5%) within the Río Gálvez basin, and fairly common (~50%) within the Río Yaquerana basin.

Enormous trees with diameters greater than 60 cm were more common in this habitat than any of the others visited, and these giants were frequently found growing on the hillsides between the ridges (Figure 3J). These forests harbored the highest diversity of any of the habitats that we surveyed. The canopy appeared to be dominated by the families Fabaceae (like most sites), Bombacaceae, and Moraceae (unlike the other two sites; Figure 4F). Some common species included *Pterygota amazonica* (Sterculiaceae), *Eriotheca globosa* (Bombacaceae), *Parkia nitida*, *Dussia tessmannii* (Fabaceae), *Cariniana decandra* (Lecythidaceae) *Clarisia racemosa* and *Pseudolmedia laevis* (Moraceae). In a ~100 m transect, we surveyed 50 trees >10 cm diameter and found 47 species! In the same transect we also surveyed 100 stems in the 1-10 cm size class and found 82 species. Lumping the 150 individuals together hardly increased the number of repeats—125 species out of 150 individuals. These diversity totals are very similar to the terra firme forests reported in Yavarí and AAY (Pitman et al. 2003, Vriesendorp et al. 2004). Extrapolating to a 1-ha plot we would estimate more than 300 species per ha in the Matsés clay terra firme forests. This is almost certainly an overly high estimate, but even samples with 10% fewer species would place these forests among the most diverse in the world.

One group that deserves special mention at Actiamë is the Moraceae (Figure 4F). Out of the 150 trees in the transect, 20 of these individuals belonged to 14 species of Moraceae in the genera *Sorocea*, *Naucleopsis*, *Ficus*, *Brosimum*, *Perebea*, and *Pseudolmedia*. Other common genera encountered were *Guarea* and *Trichilia* from the Meliaceae, *Compsoeura*, *Otoba*, *Iryanthera*, and *Virola* (Figure 3K) from the Myristicaceae, *Inga* (Fabaceae) and *Protium* (Bursaceae).

Swamp Forests (Actiamë)

On the Yaquerana floodplain at Actiamë was a small swamp forest with standing water dominated by the canopy palm *Mauritia flexuosa*, known as *aguaje* in Peru. From the air, we observed more extensive palm swamps in the Matsés region, but overall this habitat is rare, covering less than 1% of the Río Gálvez basin, and less than 5% of the Río Yaquerana basin. Since the *aguaje* palm does not have a very large canopy, these forests have an open appearance to them. Lianas are practically absent, and epiphytes are rare.

Species composition is distinct from the adjacent floodplain forest because of the permanent flooded environment. Common understory species noted were an *Ischnosiphon* (Marantaceae) not found in other habitats, *Sorocea*, *Croton* (Euphorbiaceae), and Lauraceae treelets, and a third species of *Rinorea*.

BURSERACEAE

(P. Fine and I. Mesones)

Comparing the species composition and evaluating species overlap from one habitat to another is especially difficult in sites like this with such extraordinary plant diversity. As a surrogate for overall diversity, researchers can focus on certain guilds (e.g., understory herbs, emergent trees) or taxonomic groups (e.g., palms, particular plant families) and examine turnover in species composition among habitats (Higgins and Ruokolainen 2004). With the goal of gaining a preliminary understanding of species distributions across soil types in the proposed RC Matsés, we took detailed notes on all Burseraceae species at the three inventory sites. Matching notes on the soil types and topography with the satellite image and the field data collected by R. Stallard (see Landscape Processes: Geology, Hydrology, and Soils, p. 168) allowed us to characterize the habitats with respect to their nutrient availability and flooding regime.

The family Burseraceae is an important component of the Amazonian flora (Daly 1987, Gentry 1988, Oliveira and Mori 1999). The genus *Protium* (Figure 4B) often ranks as the most abundant in

Amazonian forests as widely spaced as Manu and Yasuní (Pitman 2000), Iquitos (Vásquez Martínez and Phillips 2000), Manaus (Oliveira and Mori 1999), and Belem (Daly 1987). Burseraceae species are found in all *terra firme* forests in the western Amazon and its species are generally restricted to one or two soil types (Fine et al. 2005).

During the two-week inventory, we found 41 different species of Burseraceae trees in the three inventory sites, an unofficial record for this family in Peru. For comparison, it has taken us more than four years to collect 40 species in a range of terra firme habitats in the Reserva Nacional Allpahuayo-Mishana. Comparing Burseraceae collections in the RC Matsés (Appendix 2A, 2B) to other hyper-diverse regions in the western Amazon, Yavarí had 27-33 species, AAY had 25-29 species. Forests at Yasuní have 12 species, and Manu has ~8 (N. Pitman, unpub. data).

Of all the species collected at our other field sites in Loreto, only *Protium divaricatum* subsp. *krukovii* and *Crepidosperrum pranceii* were not encountered in the Matsés inventory. Three species of *Protium* never before found by us were collected in the proposed RC Matsés, one in flower and one in fruit; at least one appears to be new to science (Figure 4B).

Almost all of the Burseraceae species that we encountered were found in only one or two of the five major habitat types (Appendix 2B). While the majority of the Burseraceae were found in the most widespread habitats of Loreto (fertile clay and intermediate sandy clay loam), eight species were found only in white-sand forests or floodplain (Appendix 2B). A similar pattern is seen among the 56+ species of palms (Arecaceae) in the Matsés area: the vast majority on the fertile clay and intermediate sandy clay loam, a smaller subset only on the floodplain, and only two on the white sand.

NEW SPECIES, RARITIES, AND RANGE EXTENSIONS

Most of the plant specimens from our inventory remain unidentified at the time of this publication. Nevertheless, we estimate that a dozen or more of our

500 fertile specimens are likely to be new species. As more species are identified, or additional new species are confirmed, we will update our plant list at <http://www.fieldmuseum.org/rbi/>. In Appendix 2A we include collection numbers for each potential new species or range extension, as a reference to collections housed at the Herbarium Amazonense, the Museum of Natural History in Lima, and the Field Museum of Natural History in Chicago.

Several new species likely occur within the unidentified fertile collections from our white-sand forest inventories. A species of *Byrsonima* (Malpighiaceae) with red persistent sepals and green fruits, one of the dominant trees in white-sand forests at Itia Tëbu, looks very similar to *B. laevigata*, a species that is currently known from the Guianas and nearby Brazil. This collection will likely prove to be either an enormous range extension or a new species. Similar possibilities exist for fertile collections of *Retiniphyllum* (Rubiaceae), *Ilex*, *Pleurisanthes* (Icacinaceae; Figure 4H), and a *Pagamea* (Rubiaceae), among others.

We encountered unusual and potentially new species outside of the white-sand forests as well. For example, in the Matsés town of Remoyacu, a species of *Dicorynia* (Fabaceae, Figure 4I) was collected with flowers. This genus is not known from Peru (Pennington et al. 2004), and the genus is typical of the Guianan Shield. We collected three unknown Burseraceae, two of which were fertile and are strongly suspected to be new species (Figure 4B). One of them is a close relative of *Protium hebetatum* but was found on the floodplain, while *P. hebetatum* was encountered only at Actiamë on the upland slopes. The putative new species has glossy green fruits (like *P. hebetatum*), but has smaller leaves, distinctive secondary venation, and a glabrous leaf underside, unlike the hairy *P. hebetatum*. A second potential new species is in the *Protium* Pepeanthos group (Daly, *in press*), one of several *Protium* species with milky white latex. This suspected new species has white flowers and very small leaflets with no hint of a pulvinulus, a combination of characters not known from any currently named *Protium* in the Pepeanthos group.

Several collections in the proposed RC Matsés extend the known ranges of species hundreds of kilometers south and/or west. Many of these are white-sand specialists, like *Mauritia carana* and *Platycarpum orinocense*, previously known from the Iquitos area and nowhere farther south in the Peruvian Amazon. *Couma* sp. (Apocynaceae) may be a new species for Peru. Many of the white-sand specialists that we found are known from just a few previous records (*Ilex* sp., *Remijia pacimonica* (Rubiaceae), *Protium laxiflorum*, *P. calanense*).

THREATS, OPPORTUNITIES, AND RECOMMENDATIONS

The gravest threats to the region are the timber concessions west of the Río Blanco, adjacent to the proposed RC Matsés. These concessions include large swaths of white-sand forest habitat. Even though there are few (or no) valuable timber species in the white-sand forest of the RC Matsés, the small stems of the white-sand forests provide little resistance to tractors, and could be seriously damaged by roadbuilding to access populations of valuable timber trees growing in soils adjacent to the white-sand forests.

At Itia Tëbu we found a tractor trail (Figure 10D) cut through white-sand forest, presumably towards a large *tornillo* (*Cedrelinga cateniformis*). This trail illustrates the extremely fragile nature of white-sand forests. Because trees grow so slowly in these poor soils, regeneration of white-sand forest takes much longer than in other forests. If completely cleared (or worse, burned), the forests will not grow back for many human lifetimes (see the Iquitos-Nauta road for examples of white-sand wastelands, Maki et al. 2001). As impractical as it would be to begin large-scale timber operations there, a very real danger is that timber companies will clear the white-sand forests to gain access to the valuable trees growing at slightly lower elevations, on the intermediate fertility sandy clay loam soils that border all of the Río Blanco white-sand areas. This would precipitate an ecological disaster for the

entire Río Blanco basin, creating white-sand wastelands that would be useless for people, wildlife and plants.

A second threat is opportunistic commercial logging of Spanish cedar trees (*Cedrela odorata*) in the floodplain and richer soil forests that we found at Actiamë. This species has become increasingly rare in the Peruvian Amazon, and very few reproductive individuals are left. Since *C. odorata* is often found near rivers, they are easily harvested and transported to market, and as a consequence, have been locally extirpated from most of its broad geographic distribution.

A lesser threat is intensive use of certain forest resources by the Matsés people. Robinson, our Matsés counterpart at Choncó, observed that the *Pholidostachys* palm (*choncó*, Figure 3C) most preferred by the Matsés for roof thatching was very common at Choncó (and Itia Tëbu) but was absent in the forests near most Matsés communities. Other large commercially important species such as *tornillo* (*Cedrelinga cateniformis*) and *palisangre* (*Brosimum utile*) were common and represent healthy reproductive populations that can replenish more heavily used adjacent areas.

Recommendations

Protection and Management

- 01 We recommend strict protection of the white-sand forests on both sides of the Río Blanco, shielding these fragile areas from timber extraction, clearing for agriculture and/or tractor trails.
- 02 We recommend giving strict protection to large areas of the other, more productive terra firme habitats not only to protect the diverse flora, but also as a major source of fruit resources for animal populations. The fertile soil and floodplain forests likely represent a refuge for animal populations that potentially disperse to adjacent areas within the hunting grounds of the Matsés. Actiamë appeared to be a site of continual fruit production for the abundant animal species in the area. These habitats serve as an important source of food for animals and seeds of economically important plant species

for the Matsés people and will be an important investment for future Matsés generations.

Research/future inventories

- 03 We recommend long-term surveys of the white-sand forests in the Río Blanco area by biologists with experience in similar habitats in Amazonia. The many white-sand experts working at IIAP (Instituto de Investigaciones de la Amazonía Peruana) in Iquitos are an obvious choice, as they could reach the area in a three-day boat ride on the Río Blanco, and could provide direct comparisons to the better-known white-sand forests in Peru, such as Allpahuayo-Mishana and Jenaro Herrera. Since white-sand forests harbor a great number of endemics, we suspect longer-term surveys will uncover many more rarely collected or potentially new species.
- 04 We recommend research in the white-sand forests along with the more fertile forest types that border them. Strong ecological gradients have been shown to be an important driver of evolution (Smith et al. 1997, Fine et al. 2005), and preserving these sharp boundaries between habitat types ultimately preserves the processes that are germane to population structuring, adaptation, and ultimately speciation. The mosaic of habitats in the Matsés constitutes a natural laboratory of evolution, and represents a fabulous resource for future investigation into the origin and maintenance of Amazonian plant diversity, as well as the diversity of insects, birds, and many other organisms.

FISHES

Participants/Authors: Max H. Hidalgo and Miguel Velásquez

Conservation targets: Highly diverse fish communities inhabiting different aquatic environments in the Matsés region; heterogeneous aquatic ecosystems found in the Río Gálvez headwaters and the Río Yaquerana watershed (including blackwater, clearwater, and whitewater); biologically, culturally, and economically important species in the region such as *Osteoglossum bicirrhosum* (*arahuana*), *Cichla monoculus* (*tucunaré*); large catfish such as *Pseudoplatystoma tigrinum* (*tigre zúngaro*), which are intensely exploited in other parts of Amazonia; rare species and those with restricted distributions such as *Myoglanis koepcke* (Figure 5F); numerous valuable ornamental species like *Paracheirodon innesi* (*tetra neón*), *Monocirrhus polyacanthus* (*pez hoja*), *Boehlkea fredcochui* (*tetra azul*); and a diversity of species in the genus *Apistogramma* (*bujurqui*), common in clearwaters and blackwaters within the heterogeneous forests in the Matsés region

INTRODUCTION

Ichthyologic inventories in the Peruvian Amazon have been increasing in recent years. Surveys have been conducted around the Río Ampiyacu, in an area between the Amazonas and Medio Putumayo rivers (Hidalgo and Olivera 2004); in Sierra del Divisor, within the Sierra de Contamana and Río Abujao watershed (Proyecto Abujao 2001); and in the Río Yavarí watershed (Ortega et al. 2003). In addition, there is one study underway in Jenaro Herrera, in the Río Ucayali watershed (H. Ortega, pers. com.).

The proposed Reserva Comunal (RC) Matsés is situated between the Río Ucayali and Río Yaquerana, and includes the Río Gálvez headwaters and part of the Río Yaquerana watershed, which come together to form the Río Yavarí. A rapid inventory along the Río Yavarí registered extremely high fish diversity; nonetheless, fishes remain unstudied in a large part of this watershed, especially the headwaters.

Our primary objective was to study the composition and current state of fish communities inhabiting different aquatic environments in two sites within the Río Gálvez watershed and one site within the Río Yaquerana watershed, and to use the results of our rapid inventory to evaluate the proposal to create a protected area here.

METHODS

Fieldwork

During 12 days of fieldwork, we studied as many aquatic environments as possible and worked closely with a Matsés collaborator (Figure 5A). In the Río Yaquerana, we used a small canoe. In total, we sampled 24 locations, between 6 to 10 sampling locations per inventory site. We noted the coordinates for each sampling location and described the basic characteristics of the aquatic environment (Appendix 3A).

Of the 24 sampled sites, 16 were lotic rivers and streams. Six were lentic and these included two still water pools located along the course of streams with slow moving currents, two extensive lowland areas called *bajiales* (one a flooded forest and the other a palm swamp known as an *aguajal*), and two lagoons. Fifteen were blackwater, five were clearwater, and four were whitewater environments.

In the large rivers, we were able to sample from the banks only on one occasion since the water levels were too high. We were able to sample more extensively in streams and sampled up to three locations within the largest streams. The Río Blanco (Figure 8A) and Río Yaquerana (Figure 3L) were the least studied because of the high water levels. We did not sample the Río Gálvez; this is an important site for future inventories.

Collection and analysis of biological material

We collected fish using 10 x 1.8 m and 5 x 1.2 m fine-meshed dragnets (5 mm and 2 mm, respectively). This gear was used to repeatedly sweep towards the bank, in the stream's principal channel, in order to sample fish associated with submerged vegetation (fallen branches and leaves). We also used the nets as traps, after removing the sand, mud, clay, branches and leaves.

Our other fishing gear included a hand net, known as a *calcal*, that we used to explore shallow areas, mostly along the banks of small streams, and in the *bajiales* between roots and submerged trunks, and in deep holes along the stream channels. We used hook and line only in the rivers and large streams. We made direct observations from the water's surface in

clearwater and blackwater environments to identify additional species not captured with the nets.

To preserve the collections, we used a 10% formaldehyde solution for 24 hours and then transferred the specimens to 70% alcohol. Preliminary identification was done in the field. Certain species were not readily recognized, and we provisionally sorted these to morphospecies. Some of these species could represent first records for Peru and some are undoubtedly new to science (Figures 5B, E). This same methodology has been used in other rapid inventories in Yavarí and Apayacu, Ampiyacu, Yaguas (Ortega et al. 2003, Hidalgo and Olivera 2004). All specimens have been deposited in the Museo de Historia Natural in Lima, Peru.

DESCRIPTION OF INVENTORY SITES

Itia Tëbu

This campsite is southwest of the Río Gálvez headwaters, on the left margin of the watershed, and very close to the Río Blanco sub-watershed, which forms part of the Río Ucayali drainage system. Almost all of the aquatic environments in this camp are blackwater (except for the Río Blanco), acidic (< 4.5 pH), and have low conductivity (< 20 $\mu\text{s}/\text{cm}$) (see Landscape Processes: Geology, Hydrology, and Soils, p. 168; Appendix 1D, 1E). Most of the streams were small, less than 4 m wide on average; shallow, less than 50 cm depth; slow-moving; had narrow banks; were influenced by the soils and surrounding vegetation; and their waters were typically tea-colored with white sand streambeds.

The streams, in addition to being numerous, had a lot of vegetative material in their beds, mostly fallen leaves, branches, and trunks. Their channels were winding, and several neighboring streams joined during a heavy rain while we were here and flooded a forested area > 1 km wide. Flooded forests, such as these far from the Río Gálvez, can grant fish species access to new refuge sites and a greater diversity of forest resources.

At this site, we evaluated several streams and *bajiales* within the Río Gálvez watershed. In the Río Blanco watershed we sampled a blackwater lagoon and the Río Blanco itself. The Río Blanco (Figure 8A)

is a whitewater river with cream-colored waters. It is ~ 70 m wide, and we did not observe any riverside beaches during our sampling. Its flow is moderate, and we estimate a maximum depth of 5 m. The blackwater lagoon in the Río Blanco watershed appears to have formed from a meander; it is close to the river (< 20 m) and shaped like a “U”. This lagoon is ~ 35 m wide and more than 100 m long. Oddly, despite its proximity to the whitewaters of the Río Blanco, the lagoon contained blackwater. We observed this same pattern during overflights of the region, with blackwater lagoons along both sides of the Río Yaquerana, another whitewater river.

Choncó

This campsite is situated along the mid-southwest portion of the Río Gálvez watershed, and it represents our northernmost inventory site. All of the aquatic environments sampled here were streams and their associated waters (temporary pools, unconnected and partially connected to the streams). Unlike the aquatic environments in Itia Tëbu, most of the streams were clearwater and only a few were blackwater (Figure 3D). In addition, some of the streams were intermediate between clear and black, with a dark tea color typical of blackwater, but with clearwater physicochemical properties. Water types and their characteristics are detailed in Landscape Processes: Geology, Hydrology, and Soils (p. 168); and Appendix 1D, 1E.

Generally, the streams were 1-12 m wide.

The largest and deepest stream was a clearwater stream with depths up to 2 m. The streambeds varied between sand, mud, and clay. In some forested areas close to the largest streams, it was possible to find medium-sized pools (up to 8 m wide).

Actiamë

This campsite was located in the mid-upper region of the Río Yaquerana watershed, on the left margin (on the Peruvian side). The Río Yaquerana (Figure 3L) is a whitewater, meandering river with a large quantity of suspended solids. The Río Yaquerana has relatively high conductivity when compared with the blackwater and

clearwater of the other two inventory sites and the Río Yavarí (see Landscape Processes: Geology, Hydrology, and Soils; Appendix 1D, 1E). In this campsite, most of the aquatic environments were clearwater sites, except for the large lagoon, the Río Yaquerana, and the largest stream sampled during this rapid inventory. The blackwater environments were found mostly in *aguajales* (palm swamps) and in some small streams, but their waters were not as black as those found in the white-sand habitats between the Río Blanco and Río Gálvez.

The Río Yaquerana is ~70 m wide and ~5 m deep, with a muddy-clay riverbed and moderately sloped (~40°) banks. During our inventory, the water level was high and we were unable to find beaches or banks where we could sample. This drastically reduced our survey work, as we were limited to environments lateral to the Río Yaquerana such as lagoons, major streams that flow into the river, and upland streams with > 50% vegetative cover.

The streams were 2-15 m wide. We sampled both clearwater and blackwater streams and one whitewater stream. Most of their beds were sand and mud, but one streambed was hard rock with small quartz particles (like gravel) and other minerals. This type of streambed is common in streams in the Andean foothills (e.g., Cordillera Azul). The only lagoon we sampled was of fluvial origin, whitewater, and close to Yaquerana, with a muddy substratum and small trees hanging up to 4 m over the water. We did not observe floating plants in this habitat. During an overflight of this site, we observed many blackwater lagoons on both sides of the Río Yaquerana that we were unable to sample. These would be interesting sites for future inventories.

RESULTS

Species diversity and community structure

Based on our collections (~2,500 fishes) and information from conversations with community members who helped us during our inventory, we generated a preliminary list of 177 fish species that represent 113 genera, 29 families, and 9 orders (Appendix 3B). Taking into account the aquatic environments not included in

this study, such as the main channel of the Río Gálvez and related habitats (like flooded areas and lagoons), the large number of whitewater and blackwater lagoons in Yaquerana's watershed, and part of the Blanco watershed seen during overflights, we estimate that the number of fish inhabiting the proposed RC Matsés region is ~350 species.

The most diverse group of fishes were in the Order Characiformes (fish with scales, without fin bones) with 95 species, and the Order Siluriformes (catfish) with 56 species. Together, these orders represent 85% of the total diversity registered in the inventory. Of the nine other orders, the Perciformes (fish with bones in odd-numbered fins, like *pez boja* and cichlids), and the Gymnotiformes (electric fish) represent 12% (21 species) of the ichthyofauna registered in the proposed RC Matsés, and the remaining five orders were represented by one species each.

At the family level, the Characidae family had the greatest species richness (63 species), much more than any other family registered in this inventory. The Characidae are the most diverse neotropical fish group, accounting for more than one fifth of species known to date (Reis et al. 2003). In the proposed RC Matsés area, small fish in the genera *Moenkhausia*, *Hemigrammus* and *Hyphessobrycon* were best represented, and it is likely that several are new to science. Other well-represented families with lower species richness were Loricariidae (19), Cichlidae (13), Crenuchidae (11), and Callichthyidae (10).

In terms of species richness and relative abundance, communities of small- to medium-sized fish (adults on average >12 cm long) were most diverse and abundant. These smaller-sized species represent more than 65% of the diversity registered during our study. Approximately 20% of the species were medium-sized, between 12 and 20 cm, and the remaining 15% were large-sized, greater than 20 cm. Examples of these larger species include *Mylossoma (palometa)*, *Serrasalmus (piraña, Figure 5D)*, *Triportheus (sardina)*, *Liposarcus (carachama)*, and *Pseudoplatystoma tigrinum (tigre zúngaro)*. The *tigre zungaro* we observed were ~1 m

long and represent an important protein source for the Matsés. Other large game species include *Osteoglossum bicirrhosum* (*arahuana*), *Cichla monoculus* (*tucunaré*), *Calophysus macropterus* (*mota*), and the *Electrophorus electricus* (*anguila eléctrica*). Eels are not part of the everyday diet of the Matsés people but were present in the Río Yaquerana and can reach 2 m, like the individual observed further downriver in the Río Yavarí inventory.

Site and habitat diversity

Actiamë was the most diverse site (103 species), with species from lagoons, large streams, and the main channel of the Río Yaquerana. In Choncó, we registered 85 species and in Itia Tëbu, 50 species. The number of species per sampling location varied between 5 and 35, from the low diversity area in the *aguajal* in Actiamë to the highly diverse main stream in Choncó.

Among the distinct habitat and water types, the streams were the most diverse with 120 species recorded there. We registered lower species richness in other habitats such as temporary forest pools (47 species), lagoons (41), rivers (37), and flooded areas (11). This is not unexpected since streams were the dominant habitat type in all camps and our sampling effort was greatest there (15 of 24 sampling locations were streams). If we had sampled from more lagoons and from more points along the large rivers we would have recorded additional species. Clearwater environments had the greatest species richness (114), then whitewater (76), followed by blackwater environments (51).

Fish communities inhabiting streams are mostly medium to small-sized fishes, principally in the Characiformes, such as *Hemigrammus*, *Hyphessobrycon*, *Moenkhausia*, *Characidium*, *Bryconella*, *Astyanax*, and *Knodus*, and Siluriformes, such as *Corydoras*, *Ancistrus*, and *Tatia*. Cichlids were also frequent in this habitat, such as *Apistogramma* and *Aequidens*, especially in blackwater streams. The largest stream species were *Hoplias malabaricus*, *Leporinus* sp. and various Heptapteridae catfish like *Pimelodella* and *Rhamdia*. The rare or scarce catfish *Myoglanis* and *Cetopsorhamdia*

were only present in the streams and were not registered in any other habitat type.

Interesting records

The results of our inventory, when compared to other studies in more thoroughly explored portions of the Peruvian Amazon and recent inventories in Loreto, indicate that the proposed RC Matsés contains among the greatest variety of fish inhabiting forested aquatic environments in Peru (see Discussion). We found high fish diversity in headwaters of the Río Gálvez and in the Yaquerana streams, where we registered 125 species (70% of all those registered in the inventory) living in small- to medium-sized streams and associated microhabitats (flooded zones and temporary pools).

Another interesting finding is the large number of lagoons, which were not thoroughly explored during this inventory but appear to support a great abundance of fish (Figure 5C). These lagoons are important for the Matsés. They appear to harbor many species for human consumption, such as *arahuana* and *tucunaré*, and several Matsés mentioned that they fished there. During the inventory, we found a large variety and abundance of fish in the sampled lagoons. Frequent dolphin sightings in the Río Yaquerana are also related to this fish abundance.

In the proposed RC Matsés, there is a great diversity and moderate abundance of commercially important ornamental fish, such as *Paracheirodon innesi* (*tetra neón*), *Monocirrhus polyacanthus* (*pez hoja*), *Boehlkea fredcochui* (*tetra azul*), *Apistogramma* spp. (*bujurquis*), *Hemigrammus* spp., and *Hyphessobrycon* spp. (*tetras*) among others. The ornamental pet trade is economically important in Loreto, suggesting that the proposed RC Matsés could serve as an important source of these fishes and potentially provide benefits to the Matsés community and the Loreto region.

We found the genus *Ammocryptocharax* (Crenuchidae) in the small streams in the headwaters of Gálvez; this is a new generic record for Peru (Figure 5E). Moreover, one of the species found within the genus appears to be new to science. Other notable findings

included several small catfish in the Heptapteridae family, such as *Myoglanis koepckeii*. Originally, Chang (1999) described this species based on three individuals (holotype and paratype) found in the Nanay watershed. Our finding represents a southeast expansion of this species' range and also increases the number of individuals in scientific collections.

Another species, *Pariolius* sp. (Heptapteridae; Figure 5B), appears new to science, and is apparently the same unknown species we found in Ampiyacu, Apayacu, and Yaguas (similar to *Myoglanis koepckeii*; Figure 5F) in clearwater and blackwater streams with sandy beds. We suspect that at least another five Characidae species will be new records for Peru. These species might be new to science as well, given predictions made about the number of undescribed species for this group (Reis et al. 2003). *Tatia* and *Corydoras* are two additional genera likely to contain new species.

Another interesting finding is the variety of clearwater, blackwater, and whitewater aquatic environments in small areas and forested areas flooded by streams, all with high fish diversity. Variation in the underlying geology and vegetation can create microhabitats and different aquatic environments with particular physicochemical characteristics that favor the presence of heterogeneous fish communities, some of which are abundant in biomass (like in the oxbow lakes and principal rivers of medium to high conductivity), or rich in species but of moderate to poor densities (like in the clearwater and blackwater streams).

DISCUSSION

The Matsés region is home to a very diverse ichthyofauna, which makes it among the richest areas in Peru compared with other known high diversity areas in Loreto (Ampiyacu, Yavarí, Cordillera Azul) and the Peruvian Amazon. In contrast to previous rapid biological inventories, we spent fewer days in the field this time because we thought fish communities would be similar to those reported from Yavarí because these regions share headwaters. This expected similarity was

not borne out by our results. Instead, our findings suggest that the differences and peculiarities of the Matsés ichthyofauna compared to the Yavarí and other watersheds in Peru are substantial enough to support creating a new protected area.

Overall, the proposed RC Matsés harbors a unique ichthyofauna associated with blackwater and clearwater aquatic environments of terra firma forests and flooded areas of the Yaquerana watershed. There are some similarities with other lowland areas in the Peruvian Amazon, especially Yavarí, and with the ichthyofauna of the middle Ucayali (between Contamana and Pucallpa). Certain fish groups (*Creagrutus*, *Characidium fasciatum* group, *Ancistrus tamboensis*) that were abundant in clearwater streams with hard or rocky bottoms in Matsés, closely resemble fish communities and conditions observed in Andean piedmont areas, like in the Alto Pisqui watershed in Cordillera Azul, in the Pachitea, and in the Bajo Urubamba. On the other hand, brightly-colored fish (considered ornamental) such as *Paracheirodon innesi* (*tetra neón*), and *Apistogramma* spp. (*bujurquis*) were present in environments with sandy bottoms, mostly in blackwater, that are found in the lowlands and are less similar to Andean environments.

The principal rivers such as the Yaquerana, the Gálvez, and the Blanco probably sustain a larger ichthyofauna than we documented, including larger species and greater densities of fishes. Some notable examples we encountered include large catfish (*Pseudoplatystoma tigrinum*, *Pinirampus pinirampus*, *Goslinia platynema*), large schools of fish commonly fished by humans including species of *lisas*, *palometas*, and other valuable species like *tucunaré*, *arahuana*, and *paiche*. Most of these species are relatively common in Loreto and throughout the Peruvian Amazon (although *arahuana* has not been registered in Madre de Dios and *paiche* has been introduced), and differences in their relative abundances might be seen more clearly at the watershed and sub-watershed levels. Many of these species benefit from flooded forests; not only do they act as nurseries for juvenile fishes during periods of high water when they provide

resources, but many species find shelter from predators that inhabit main waterways and cannot access these temporary habitats.

During our study, we observed that the divide between the Río Blanco and the headwaters of the Río Gálvez does not provide a complete barrier for the ichthyofauna. Low altitude hills separating the watersheds, and their proximity to the Río Blanco (which is part of the Ucayali watershed) allow certain species to cross from one watershed to another, especially during the rainy season when waters are high. This would, in part, explain the similarities found for some fish groups. More importantly, this situation allows species to move between two large watersheds (Ucayali and Yavarí).

Comparison with other studies in the Peruvian Amazon

When compared with the ichthyofauna reported in other inventories in Peru, the inventory for the proposed RC Matsés reveals high fish diversity (177 species). More fish were registered in RC Matsés than in various other sites throughout Loreto, including Cordillera Azul (93 species, Rham et al. 2001); Jenaro Herrera (streams of lowland hill forests), close to Requena (102 species, H. Ortega, pers. comm.) and Sierra del Divisor (86 species, Proyecto Abujao 2001). In addition, diversity in the proposed RC Matsés is greater than that of the Río Pachitea between Huánuco and Pasco (158 species, Ortega et al. 2003a), of the Río Heath watershed in Madre de Dios (105 species, Ortega and Chang 1992), and recent samples in the Los Amiguillos watershed in Madre de Dios (~125 species, Goulding et al. unpub. data). The collection effort (in days) employed in the majority of these studies was much greater than the number of collection days during this inventory.

Other regions within Loreto where fish diversity is greater than in RC Matsés include the Ampiyacu, Apayacu and Yaguas watersheds with 207 species (Hidalgo and Olivera 2004), the Río Yavarí with 240 species (Ortega et al. 2003), and Reserva Nacional Pacaya Samiria with 240 species (J. Albert, pers. comm.). In the Pastaza watershed, although a WWF report

(2002) reported 165 species, actual species diversity is greater, with 315 species (Willink et al. 2005).

Comparison with previous inventories (Yavarí and Ampiyacu, Apayacu, and Yaguas)

Our study increased the number of known species inhabiting the Yavarí watershed from 240 to 315 species (considering only those registered in Ortega et al. 2003). That is, 43% of the species in Matsés (excluding 13 that were registered during a very rapid exploration in the Río Blanco) were additional registries for the Yavarí watershed. Considering combined collection effort for both inventories, 27 days, the Yavarí watershed's diversity is very high, especially considering that it is a medium-sized river when compared to the Ucayali or Marañón rivers. In the context of conservation, these results support the idea that entire watersheds need protection.

In the lower Yavarí watershed, a greater extension of forests flood for a greater period of time than in the headwaters, which allow fish to use a greater diversity of resources for food and reproduction. The situation in the headwaters of the Matsés region, those of the Río Gálvez and Río Yaquerana watersheds, is different. Their influence helps maintain the hydrological regime throughout the Yavarí, especially in the lower parts. According to our results, the ichthyofauna of these terra firma forests in the headwaters differs from the ichthyofauna of the lower part of the watershed. Almost all bodies of water contribute to fish diversity and abundance from the small headwater tributaries to the flooded areas; this is even more evident in the lagoons that maintain connections with the main river channels, especially in terms of fish abundance.

During the analysis of our results, we had expected to find more compositional similarities with Yavarí watershed than with Ampiyacu, Apayacu and Yaguas (AAY) watershed, considering that the Matsés region makes up part of the Yavarí watershed. We were surprised to find that the results were opposite of what we expected.

Of the 177 species registered in Matsés, 89 (50%) were also present in Yavarí, and 98 (55%) were registered in AAY. More terra firme streams were studied in AAY (as in Matsés) than in Yavarí, where there was access to more oxbow lakes and large streams directly influenced by the Yavarí's flood regime. Barthem et al. (2003), in a study conducted in Madre de Dios, found that the ichthyofauna of the rivers and the flooded zone (in Matsés, lagoons along the Yaquerana and Gálvez rivers would be included) is similar in both richness and composition, while the ichthyofauna of the streams located in high terrace forests is more distinct and varied. This could help explain why there are more similarities between Matsés and AAY. Nonetheless, although the similarities between Matsés and AAY or Yavarí is close to 50%, the remaining 50% of ichthyofauna found during this inventory is different, and should be conserved.

THREATS, OPPORTUNITIES AND RECOMMENDATIONS

Threats

The main threats in this region are related to collateral effects of potential deforestation in the proposed RC Matsés area. Changes in forest structure directly affect the aquatic trophic network in the short term. Unlike other organisms, especially terrestrial vertebrates, aquatic communities react almost immediately to any change in water quality. One of the primary effects of the deforestation of riparian vegetation is a change in water chemistry. Once vegetation is removed and soil exposed, erosion increases and thereby increases the amount of suspended solids in the water. Unstable soil can also produce landslides that sometimes result in immediate, massive fish kills because of gill obstruction. Over the medium term, landslides change the composition of streambeds and lead to decreased organism diversity because of microhabitat loss or changes.

For the proposed RC Matsés, this threat is more serious considering that the blackwater streams, in addition to high diversity, have lower fish densities

than whitewater environments. The ichthyofauna of the proposed RC Matsés is particularly interesting in aquatic environments associated with *varillales* and forest streams far from principal rivers—we encountered new records, rare species, and species new to science in these environments. These habitats are threatened by the ever-expanding search for timber—loggers must penetrate deeper and deeper into the forest as valuable timber species are no longer found along main waterways. In addition, during the rainy season when water levels are high, loggers use these tributary streams to float logs to the main rivers. Loggers have additional impacts because they dump garbage, motor oils, and gasoline into the water. They occasionally fish using toxic substances while they are in the forest.

Although there were very few Matsés communities located near our inventory sites, use of substances like *barbasco* (a plant in the Solanaceae family whose roots produce a toxin used to kill fish) is still a common threat to aquatic organisms, especially in areas where subsistence fishing is common. Lagoons with abundant fishes, such as those we found along the Río Yaquerana, could be seriously affected if toxins are used. It is of the utmost importance to work with the communities so that over time this fishing method is phased out. This will help maintain healthy fish populations in these habitats.

Recommendations

Protection and management

During this study, we observed that the Matsés region (the headwaters of the Yavarí watershed) harbors a species-rich ichthyofauna. Its aquatic habitats in upland forests harbor communities with unique species that differ from those inhabiting the principal river and its floodplain. In conservation terms, this means that it is important to protect the entire watershed, which is further supported by the idea that the best way to conserve and adequately manage aquatic environments is by protecting the entire drainage network. By conserving the entire network, from the headwaters

(where small streams are covered by the forest canopy), to the extensive areas of the principal rivers and floodplains, like the Río Yavarí, protection of fish communities and other vertebrates dependent on these aquatic systems is guaranteed.

The geographic location of the Matsés region is important in SINANPE's protected area mosaic since it would connect Yavarí and Sierra del Divisor. At the same time, this connection is biologically essential to maintain flow of species from the Gálvez-Yaquerana headwaters to the Río Blanco (Figure 2). Therefore, we recommend including the Río Blanco watershed in the proposed Reserva Comunal Matsés.

Research

The presence of new species, rare species, probable endemics, and highly valuable ornamental species makes the Matsés ichthyofauna very important. In addition, it is an indispensable source of protein for local people (Figure 11F). Because these fish communities are varied and associated with every type of Amazonian aquatic environment, there are many different species, which represents an excellent opportunity for conservation and scientific research.

Additional inventories are needed in the Gálvez, Blanco and Yaquerana rivers. Lagoons were the least explored habitat during this inventory, and because their fish populations are important for human consumption, these habitats deserve special attention and should be priority research sites. An analysis of fish stocks in the Matsés communities is necessary if management measures are to be proposed. In Parque Nacional Cordillera Azul, after participative workshops with communities settled in the park's buffer zone, low-impact use measures are being promoted, including reducing *barbasco* use (CIMA 2004). While implementing management actions is important and necessary for medium- and long-term conservation, research is a prerequisite step in order to ascertain which species are present, which areas are used for fishing, and other basic information.

Monitoring

Commercially important species flourishing in the lagoons, such as *arabuana*, *tucunaré*, and large schools of Cypriniformes (Curimatidae, Prochilodontidae), should be monitored. Basic studies are needed to characterize and identify aquatic resource use, of both the Matsés communities and other fishing boats in the proposed RC Matsés region. By using such diagnostics and monitoring fishing in the region, species could be identified, catch sizes documented, and fishing zones identified in order to evaluate the state of the fishing resources and to determine whether overfishing is occurring, like it is in Iquitos (De Jesús and Kohler 2004).

AMPHIBIANS AND REPTILES

Participants/Authors: Marcelo Gordo, Guillermo Knell and Dani E. Rivera Gonzáles

Conservation Targets: Upland forest communities with high amphibian and reptile diversity, including flooded lowlands, palm swamps (*aguajales*) and white-sand forests (known as *varillales* in Peru and *campinas* or *campinaranas* in Brazil); 10 species of sympatric Dendrobatidae; amphibian species associated with white-sand forests and surrounding areas, such as the frogs *Osteocephalus planiceps* and a potentially new species of *Dendrobates* (*quinquevittatus* group, Figure 6C); *Synapturanus* (Microhylidae, Figure 7C), a new genus for Peru; species with commercial value, such as turtles (*Podocnemis unifilis*, *Geochelone denticulata*) and caimans (*Caiman crocodilus*)

INTRODUCTION

The biodiversity of large expanses of Amazonia remain unknown; the proposed Reserva Comunal (RC) Matsés is one such site. Preliminary work in areas in western Amazonía indicates high amphibian and reptile species richness in the area, including sites near the Río Amazonas (Dixon and Soini 1986), adjacent to the Río Napo (Rodríguez and Duellman 1994), in the Ecuadorean Amazon (Duellman 1978), surrounding Iquitos, Loreto (Lamar 1998), in Sierra do Divisor in Brazil (Souza 2003), and within the Río Ampiyacu, Río Apayacu and Río Yaguas (Rodríguez and Knell 2004). The closest reported inventory to the proposed RC Matsés is the rapid

inventory of the Río Yavarí (Rodríguez and Knell 2003) undertaken only a dozen kilometers north of our inventory sites, and reported extraordinary amphibian and reptile diversity (109 species).

METHODS

Between 25 October and 6 November 2004, we sampled three sites, two between the Río Blanco and Río Gálvez (Choncó, Itia Tëbu) and one between the Río Blanco and Río Yaquerana (Actiamë; Figures 2; 3A, E, I). Over 12 days, we recorded all the amphibians and reptiles found during diurnal and nocturnal surveys of trails that traversed a variety of microhabitats. Our sampling effort was similar among the three sites, and in total we recorded 134 person-hours of active searching. We include opportunistic observations and collections made by other investigators of the inventory team and the advance trail-cutting team.

Most of the specimens were photographed alive and then released. For species we could not identify in the field, we collected voucher specimens (77 examples of 38 species) to compare to museum specimens and species descriptions. Our collections have been deposited in the Museo de Historia Natural de San Marcos in Lima. In addition, we made recordings of vocalizations of 23 species of anurans.

Sampled habitats

The three sites inventoried represent a large range of habitats and microhabitats, and differed in the quantity and quality of resources for amphibians. Small palm swamps (*aguajales*) and temporal ponds were the microhabitats with the largest concentration of amphibian species (34), followed by leaf litter (27) and vegetation (7). Few amphibian species were exclusively found in vegetation near streams (4) or in more particular microhabitats, such as the soil between roots (*Synapturanus* cf. *rabus*, Figure 7C) and in tree holes in the forest canopy (*Trachycephalus resinifictrix*, Figure 7B). Many species were found in more than one microhabitat, such as *Osteocephalus taurinus*, which was observed near ponds and in forest vegetation, and

Bufo dapsilis, which was found reproducing in small ponds, as well as in leaf litter along trails.

In Choncó we sampled vegetation in dense upland forests, in addition to a few areas of vegetation on sandy soils that were more open and along the largest stream where the forest was periodically flooded. All the trails had an abundance of streams and ponds near them.

Itia Tëbu was a mixture of tall, relatively open forest in hilly areas and short open forest (*varillales*) in high flat areas. Both forest types were on sandy soils and had an abundance of temporary ponds and some small streams.

Actiamë supported a dense forest, very diverse clay soils, hilly terrain and extensive palm swamps. Large parts of the forest flooded periodically with clearwater; it appeared, however, that flooding was very brief. Ponds, pools and a lagoon were found here, along with abundant streams of various sizes draining into the Río Yaquerana (Figure 3L).

RESULTS AND DISCUSSION

Herpetological diversity

We recorded 74 species of amphibians (6 families, 26 genera) and 35 species of reptiles (Appendix 4). Of the reptiles, 18 species were lizards (7 families, 11 genera), 13 were snakes, 2 were turtles and 2 were caiman. These numbers are a strong indication that this region has a very diverse herpetofauna. In only 12 days, we recorded more than 60% of the amphibian species expected in the northern regions of Iquitos (~115 spp.; Rodríguez and Duellman 1994; Rodríguez and Knell 2004) and in the southern region of Sierra del Divisor (120 spp., Souza 2003). In addition, we recorded more than 50% of the expected lizard species in Amazonía (Figure 6A). In general, reptiles are more difficult to observe during a rapid inventory because they are more cryptic, do not vocalize, and generally occur at low densities.

New species and other records of special interest

In this inventory, we encountered three potentially new species. We recorded two species, a *Bufo* in the *margaritifera* group (“pinocchio”) and a

Hyalinobatrachium (Centrolenidae), already confirmed as species new to science during the rapid inventory of Río Yavarí (Rodríguez and Knell 2003). In addition, we collected a *Dendrobates* of the *quinquevittatus* group in the white-sand forests (*varillales*) of Itia Tëbu that appears to be new to science (V. Morales, pers. com., Figure 6C). This *Dendrobates* has a coloration pattern that has not been described for this group (Frost 2004, Caldwell and Myers 1990). The body is black with longitudinal white stripes below the mouth, which have either a yellow or blue pattern. The chin area is yellowish and the limbs are golden. A similar species was registered in 2003 during another inventory in the Yavarí zone by the Wildlife Conservation Society (M. Bowler, pers. comm.), but that species did not have continuous stripes nor did it have yellow under the mouth.

Another interesting record was the fossorial frog of the genus *Synapturanus*, which is known from Brazil, Colombia and Ecuador. Currently, there are three known species in the genus. The species we found in the white-sand forests (*varillales*) in Itia Tëbu appears to be *S. rabus* (Figure 7C), according to the original description for this species. However, our observation represents a range expansion of at least 500 km for the genus and species, as well as a new generic record for Peru.

Our records of *Colostethus trilineatus* and *C. melanolaemus* expand the known geographical distributions of both of these species. This is especially true for *C. melanolaemus*, which is known only from two sites north of Río Amazonas, near the Río Napo and Río Ampiyacu. *C. trilineatus* has recently been collected in more central regions in Amazonía (Grant and Rodríguez 2001, Rodríguez and Knell 2003).

Among the most important snakes collected was *Bothrops brazili* (Figure 7E), an extremely rare and little known species (Cunha and Nascimento 1993).

Notes on the sampled sites

Choncó

Field work at this site lasted four days. The most abundant amphibian species were the arboreal frog

Osteocephalus taurinus, the toad *Bufo margaritifer* and the small frog *Phyllonastes myrmecoides*. Other species, such as *Hypsiboas granosa*, *Dendropsophus brevifrons*, *D. leali*, *D. miyatai* and *Osteocephalus buckleyi*, were very abundant but with localized distributions and were found only in one pool, one stream or one small part of a pond. Among the lizards, we most frequently observed *Anolis nitens tandai* and *Kentropyx pelviceps*.

Some of the frogs we observed had very interesting biologies and behaviors. The hylid *Trachycephalus resinifictrix* (Figure 7B) lives in the highest branches in the forest and utilizes large tree trunk cavities, which accumulate water, to deposit its eggs and develop its tadpoles. *Osteocephalus deridens* is another hylid that lives in trees but reproduces in water that accumulates in epiphytic bromeliads. *Hypsiboas boans* is the largest tree frog in South America. This hylid deposits its eggs in small holes that it constructs in stream banks. By the time the streamwater overflows these miniature pools, the tadpoles are relatively well developed and have a better chance of escaping aquatic predators. The small frog *Synapturanus* cf. *rabus* is exclusively fossorial, living in spaces between roots in the soil. Its reproduction involves depositing gelatin-wrapped eggs in underground chambers, where the eggs remain until they hatch.

Itia Tëbu

Work in this white-sand forests (*varillales*) complex lasted three days. The most abundant species here were the new species of *Dendrobates* with golden legs (sp. nov., *quinquevittatus* group, Figure 6C), and the arboreal frog *Osteocephalus planiceps*. These two species appear to be strongly associated with the white-sand forest vegetation. The *Dendrobates*, which has diurnal habits, was observed as often on the forest floor as it was climbing trunks in the white-sand forest, and was commonly observed investigating the terrestrial bromeliads that are abundant in this type of forest. Individuals were observed also on the spongy forest floor in small gaps. The *Osteocephalus* was recorded almost every night and was observed in the white-sand

forest area as often as in flooded ponds and small patches of palm swamp (*aguajal*), in large vocalizing groups. The palm swamps were the only place where we observed this species reproducing, and a similar pattern was found in the white-sand forests in Parque Nacional do Jaú (Neckel-Oliveira and Gordo 2004).

Other common species included *Leptodactylus rhodomystax* and *L. leptodactyloides*, as well as several hylids such as *Dendropsophus parviceps*, *Scinax* sp. and the microhylid *Chiasmocleis ventrimaculatus*. Although the terrestrial frog *Hemiphractus scutatus* (Figure 7D) is considered a rare species, it was recorded three times at this site. Reptiles were not common, but the species observed most often were *Anolis nitens tandai* and *Kentropyx pelviceps*; the same species were common in Choncó.

Snakes were rare but the few observations we did make were interesting, especially our record of *Bothrops brazili* (Figure 7E). This species has a wide distribution in Amazonia, but always occurs in low densities and, due to its size and coloration, it is often confused with *Lachesis muta* (Cunha and Nascimento 1993).

Actiamë

We visited this site for five days and recorded the highest species diversity in this study, perhaps because of the great variation in habitat, vegetation and topography found in this site. The most common amphibian species were *Epipedobates habneli*, *Colostethus* sp. 2 *marchesianus* group (cream stripes), *Hypsiboas granosus* and *H. lanciformis*.

Other species were observed in large groups, but these groups were not frequently observed in the forest, pools, streams or ponds. These more localized species included *Dendropsophus parviceps*, *Colostethus melanolaemus*, *Chiasmocleis bassleri*, *Eleutherodactylus* sp. (orange legs) and *Hamptophryne boliviana*.

The genus *Phyllomedusa* was very diverse here and found only at this site during the inventory. Three species, *Phyllomedusa vaillanti*, *Phyllomedusa tomopterna* and *Phyllomedusa bicolor* (Figure 6B; see The Matsés and the frog *Phyllomedusa bicolor*, below), were recorded.

Phyllomedusa displays an interesting form of reproduction. Frogs in this genus wrap their eggs in leaves of plants overhanging ponds and streams. After ~11 days, the tadpoles begin to fall into the water and can swim immediately. In this manner, the eggs can escape the dangers that exist in the water, such as predatory fish and insects. However, the eggs are still not safe from aerial predators, such as wasps and flies, or terrestrial predators, like ants, and snakes such as *Leptodeira annulata*.

In a pond of ~40 m², we found various species including *Hamptophryne boliviana*, *Ctenophryne geayi*, *Dendropsophus parviceps* and *Scinax funereus*. The *Scinax* were explosively reproducing, and vocalized day and night. Millions of eggs formed a gelatin-like film across the entire surface of the pond.

Lizards were more common and diverse (11 species) here than at the other sites. This was especially true for the genus *Anolis* with three species. Two of the species, *Anolis fuscoauratus* and *Anolis nitens tandai*, live on the forest floor. The other, *Anolis punctatus*, prefers middle to high strata in the forest canopy and descends only occasionally. *Gonatodes humeralis* was the most abundant species of gecko. In Actiamë, we also recorded larger-sized reptiles, including a white caiman (*Caiman crocodilus*) in one of the lagoons and two turtles (*Podocnemis unifilis*) in the Río Yaquerana. These species form an important part of the diet for people throughout Amazonia.

In general, snakes were very rare during the expedition, but in Actiamë we observed five species of the family Colubridae. The majority of these species were observed while walking during the day. Species found in this manner include two species of *Chironius* sp. and *Spilotes pullatus*, which are predominately terrestrial species found in the leaf litter, and *Xenoxybelis argenteus*, found in shrubby vegetation.

Community structure and composition

The differences between community structure and composition between the three sites we visited suggest that the landscape heterogeneity plays an important role in the regional species pool. Some species are restricted

to or are much more abundant in particular habitats or microhabitats. Others have patchy distributions and unpredictable abundances in the different forest types of the region.

Some species were very common, such as *Bufo margaritifer*, *Epipedobates hahneli*, *Osteocephalus planiceps* and *Kentropyx pelviceps*, while other species were restricted to certain microhabitats and sites, like *Phyllomedusa* spp., *Dendrobates* sp. nov. of the *quinquevittatus* group (Figure 6C), *Synapturanus* cf. *rabus* (Figure 7C) and *Osteocephalus* cf. *deridens*. Others were very uncommon, such as *Adenomera andreae*, *Leptodactylus knudseni*, *L. rhodonotus*, *Cruziobhyla craspedopus* (Figure 7A), *Bufo glaberrimus*, *B. marinus* and two species of *Dendrobates* of the *quinquevittatus* group. It is difficult to confidently state relative species abundances, especially as we sampled these communities for a short period of time in a single season of the year. This is compounded by the cryptic behavior of some species and some microhabitats that we were unable to sample.

Among amphibians, the most diverse group was Dendrobatidae, with 10 species, including 4 of the genus *Colostethus*. Such diversity surpasses that found in the region of Iquitos (Rodríguez and Duellman, 1994), which is known as one of the regions with the most sympatric species in the Dendrobatidae family. For reptiles, the lizards in the genus *Anolis* were relatively common and diverse, with five species.

It should be noted that although we observed several blackwater lagoons near Actiamë during flights between camps, these lagoons could not be inventoried because they were too far from camp. We suspect that these bodies of water and their typical floating vegetation could support some hyloid species not recorded during the inventory such as *Hypsiboas punctata*, *H. raniceps*, *Dendropsophus walfordi*, *Scinax* of the *rostratus* group and species of *Sphaenorhynchus*.

Comparisons with previous inventories

Because of their proximity, similar habitats, and similar methodology, we can compare this inventory with those

in the watersheds of the Río Ampiyacu (Rodríguez and Knell 2004) and the Río Yavarí (Rodríguez and Knell 2003) to sketch a preliminary portrait of the distribution and diversity of the herpetofauna in the region.

One important factor in this comparison is seasonality, as amphibian abundances change seasonally and seasonality differences between samples can influence sampling success during the inventories. Our inventory in RC Matsés did not take place during the most favorable season for amphibians, which is between December and March and corresponds with the reproductive “boom” associated with the rainy season. Despite this, in less time and during a less favorable season, we recorded almost the same quantity of amphibian species as in the Yavarí inventory (77 Yavarí, 73 Matsés). In comparison to the Ampiyacu, Apayacu, and Yaguas inventory (64 spp. of amphibians), in our inventory we found more species in less time, but the Ampiyacu, Apayacu, and Yaguas inventory took place during the dry season. The region of RC Matsés appears to house various unique species. We recorded 26 amphibian and 11 reptile species that were not found in Ampiyacu, Apayacu, and Yaguas and 20 amphibian and 10 reptile species that were not recorded in Yavarí. However, the entire Amazon forest region in the Loreto area appears to have high herpetofauna diversity.

THE MATSÉS AND THE FROG *PHYLLOMEDUSA BICOLOR*

Although the arboreal frog *Phyllomedusa bicolor* (Figure 6B) occurs throughout Amazonía, it is especially important in the region of the Matsés and the eastern Brazilian Amazon (the valleys of the Río Yavarí and Río Juruá), where various ethnic groups, including the Matsés, use the secretion produced by the dorsal glands of the frog. During the height of the reproductive season, the frogs, known as *kampô* or *dauqued* in Matsés, are captured in the vegetation near the ponds where they reproduce. Their four feet are bound with string and the animal is stretched over a small fire. This stresses the animal into producing a skin secretion that

can be collected with a small stick. Once the secretion is collected, the animals are returned to the forest.

Using the tips of lianas or the aerial roots of plants in the Araceae family, small areas are burned on the arm or shoulder of the men and the belly of the women. Over these burns, with skin delicately pulled back, a little of the secretion is applied after it has been moistened with water.

Physiological alterations rapidly follow, with increases and decreases in blood pressure, sweating, nausea and intestinal pain, which can last for 20-30 min. After this, the Matsés feel that their senses are sharpened, and they feel more courageous for the next one or two days. During these days, the Matsés hunt and gather and feel that the secretion applications help them to better perform these tasks. Among the Matsés, applying the skin secretions can occur once every 8-10 months. However, in other ethnic groups, the use is often more frequent and the application area for women is changed to the leg. Others non-indigenous inhabitants in the Brazilian Amazon have adopted this custom, calling it the “vacina do sapo”, and its use has spread throughout Brazil. The people believe that this ritual purifies the blood, eliminating numerous diseases. In reality, this medicinal power has not been proven, though investigators do believe that the secretion has antimicrobial properties (C. Bloch, pers. comm.).

THREATS, OPPORTUNITIES, AND RECOMMENDATIONS

Alteration of the vegetation or destruction of reproductive microhabitats (in the case of amphibians) can negatively impact herpetofauna, leading in some cases to local extinctions and/or invasions by species adapted to open or altered environments. Agriculture, cattle and logging are major threats in many parts of Amazonía. In the Matsés region, timber concessions are currently the principal threat, especially in the white-sand forests (*varillales*) and surrounding areas. Because these forests are located on sandy, nutrient poor soils,

any sort of damage to the vegetation or the ground will cause irreversible damage, as these forests grow at such slow rates (Figure 10D). This damage would threaten the reproductive sites for amphibian populations restricted to these forests, such as the dendrobatid *Dendrobates* sp. nov. gr. *quinquevittatus* (Figure 6C) and the hylid *Osteocephalus planiceps*.

Nothing is known about the structure and dynamics of the caiman or turtle (aquatic and terrestrial) populations that are hunted in this region. In many parts of Amazonía, hunting and egg gathering have dramatically reduced turtle populations (*Podocnemis expansa* and *Geochelone* spp.) and black caiman populations (*Melanosuchus niger*). In periodically flooded forests with highly complex microhabitats, some species (e.g. *Melanosuchus niger*) find refuge because these habitats are difficult for people to reach. In the Matsés region and along the upper Yavarí and its tributaries we did not notice large flooded or inaccessible areas that would provide such a refuge. Hunting and egg gathering on river beaches, without an adequate management plan, could endanger these populations.

To protect amphibian and reptiles we recommend that the most fragile habitats, such as the white-sand forests (*varillales*, Figure 3D) and surrounding areas, including large forested areas with high diversity of habitats and microhabitats, be completely protected to ensure a source of colonizing animals for exploited areas. This includes game animals, along with animals used in different rituals, like the *kampô* or *dauqued* (*Phyllomedusa bicolor*, Figure 6B).

For caiman and turtles, research is needed on their distribution and reproductive sites, along with information on their biology, behavior, population dynamics and the effects of hunting. Moreover, we recommend exploring ways to implement management plans with support and input from the local human populations, as participatory mechanisms are critical to providing a chance for conservation actions to succeed.

BIRDS

Participants/Authors: Douglas F. Stotz, Tatiana Pequeño

Conservation targets: Birds of white-sand forest habitats, including potential habitat specialists and species new to science; diverse avifauna of *terra firme* forests; game birds threatened in other parts of their range, including Razor-billed Curassow (*Crax tuberosum*) and White-winged Trumpeter (*Psophia leucoptera*)

INTRODUCTION

The area of the proposed Reserva Comunal (RC) Matsés represents the Peruvian portion of the upper Río Yavarí drainage. Ornithologists have conducted surveys in the lower part of the Yavarí, including limited collections by Castelnau and Deville in 1846, H. Bates in 1857-1858, J. Hidasi in 1959-1961 and C. Kalinowski in 1957 (see Lane et al. 2003 for details). Only C. Kalinowski surveyed sites farther south of the mouth of the Río Yavarí, collecting a few specimens from the confluence of the Yaquerana and Gálvez rivers near the northeastern limit of the proposed RC Matsés in August 1957 (Stephens and Traylor 1983). However, the most relevant comparison to our rapid inventory of the proposed RC Matsés is the rapid biological inventory of three sites along the Río Yavarí during March-April 2003 (Lane et al. 2003).

Otherwise, there has been little ornithological work in this part of northern Peru. A. Begazo surveyed birds in the Reserva Comunal Tamshiyacu-Tahuayo, along east bank tributaries of the Río Ucayali, immediately west of the Río Yavarí Mirín drainage (Lane et al. 2003). Farther south, the most significant collections come from the Río Ucayali basin, near Contamana (J. Schunke in 1947, P. Hocking in 1960-80), and from a 1987 Louisiana State University expedition to the Río Shesha. These sites are 165 km and 200 km southwest of our southernmost camp at Actiamë.

In addition to the limited ornithological information from Peru, some surveys exist from far western Brazil. Sites on the Brazilian side of the lower Río Yavarí at tourist lodges, especially Palmari Lodge, have been surveyed by several ornithologists

(A. Whittaker, B. Whitney, K. Zimmer; see Lane et al. 2003). Sites in the Río Jurua drainage in the Serra do Divisor, ~135 km southeast of Actiamë, were surveyed by teams from the Emílio Goeldi Museum, Belem, Brazil. Most of these results are unpublished, although a new species, *Thamnophilus divisorius*, was described from the Serra do Divisor survey (Whitney et al. 2004).

METHODS

Our protocol consisted of walking trails, looking and listening for birds. Stotz and Pequeño conducted their surveys separately to increase the amount of independent observer effort. Typically, we departed camp before first light, remaining in the field until mid-afternoon, returning to camp for a 1-2 hour break, and going back to the field until sunset. Occasionally, we remained in the field through the day and returned to camp after dark. We tried to cover all habitats within an area, although total distance walked at each camp varied with trail length, habitat, and density of birds. At Itia Tëbu, each observer typically covered 12-20 km a day, while at the other two sites walking distances were 5-12 km.

Both observers carried a tape recorder and microphone to document species presence and to confirm identification using playback. We kept daily records of species abundances, and compiled these records during a round-table meeting each evening. Our observations were supplemented by those of other members of the inventory team, especially Debby Moskovits at all three sites, and José Rojas at Actiamë.

We spent four full days at Choncó and Actiamë, and three at Itia Tëbu. Stotz and Pequeño spent ~92 hours observing birds at Choncó, ~62 hours at Itia Tëbu, and ~87 hours at Actiamë. In addition, Pequeño and Stotz spent ~10 hours visiting the Río Blanco (Figure 8A), a tributary of the Río Tapiche that flows into the Río Ucayali, a mere 3-km walk from Itia Tëbu. Stotz made observations for ~8 hr between 6-8 November near the village of Remoyacu on the Río Gálvez. We report birds recorded at Río Blanco and Remoyacu separately in Appendix 5.

In Appendix 5, we estimate relative abundances using our daily records of the number of birds we observed. Because our visits to each of these sites were short, our estimates are necessarily crude, and may not reflect bird abundance or presence during other seasons. For the three main inventory sites, we used four abundance classes. Common indicates birds observed daily in substantial numbers (averaging ten or more birds); fairly common indicates that a species was seen daily, but represented by fewer than ten individuals per day. Uncommon birds were encountered more than two times, and rare birds were observed only once or twice as single individuals or pairs. For Río Blanco and Remoyacu, we modified this scheme because our visits to these sites were shorter. For these sites we use common for species with ten or more individuals during at least one of the days at the site, uncommon for species seen more than once but fewer than ten times at the site, and rare for birds seen only once at the site.

RESULTS

We recorded 416 species of birds during the rapid inventory of the proposed Reserva Comunal Matsés. Of these, 376 were found in the three inventory sites, while 39 other species were observed in brief visits to the Río Blanco in the Río Ucayali drainage basin or at the Remoyacu along the Río Gálvez within the Comunidad Nativa Matsés. One species, *Butorides striatus*, was seen only by the anthropological team during their visit to communities along the Quebrada Añushiyacu.

Avifaunas at surveyed sites

Bird species richness followed the soil fertility gradient, with the highest richness recorded on the richest soils at Actiamë (323 species in four days), intermediate richness registered at Choncó (260 species in four days), and the lowest richness recorded on the poor soils at Itia Tëbu (187 species in three days). The three sites we surveyed differed substantially in soil types as well as the type and number of river-influenced habitats. Below, we report our major findings at each site, with a brief

description of the habitats we surveyed, starting with the poorest soils at Itia Tëbu, and loosely following an increasing soil fertility gradient. We also discuss our observations along the Río Blanco (Figure 8A) and our brief visit to the Matsés community, Remoyacu.

Itia Tëbu

White-sand soils dominate the forests at Itia Tëbu, and even areas without white sand are still sandier than most of the soils at the other two camps. Low areas, sometimes filled with water, surrounded the sandy hills. We encountered few well-defined flowing streams, and many swampy areas without discernible water flow.

We found that the white-sand forests supported a low species richness of birds (187 species), with richness decreasing with forest stature within these white-sand areas. The bird community was essentially a depauperate terra firme avifauna, although we did find a small number of species that are associated with open or short-statured habitats in Amazonia. These included White-chinned Sapphire (*Hylocharis cyanus*, Figure 8C), Fuscous Flycatcher (*Cnemotriccus fuscatus*), White-lined Tanager (*Tachyphonus rufus*), Blackish Nightjar (*Caprimulgus nigrescens*, Figure 8D), and a *Hemitriccus* sp. The *Tachyphonus* has very restricted distribution in Peru, with populations limited to drier habitats in the Río Mayo, Río Marañon, Río Ene and Río Urubamba.

Our most interesting record was a *Hemitriccus* tody-tyrant that we managed to tape-record, but could not identify to species. Zimmer's Tody-Tyrant (*Hemitriccus minimus*) typically occurs in white-sand areas, even small ones. However, our recording, while similar in pattern to *H. minimus*, differs in tone and may represent an undescribed species according to J. Álvarez, who has extensively studied birds in white-sand forests in northern Peru.

There is a well-defined set of species associated with forests on white sands in the Iquitos area (Álvarez and Whitney 2003), including at least five recently described species restricted to these forests in northeastern Peru. Of the 21 species listed by Álvarez and Whitney (2003) as associated with white-sand and

other extremely poor soils, we registered only Yellow-throated Flycatcher (*Conopias parva*) at Itia Tëbu.

In our experience, this species is not strongly specialized on white-sand or even extremely poor soils, as we found *C. parva* fairly commonly in tierra firme forests on relatively rich soils along the Río Ampiyacu, north of the Río Amazonas (Stotz and Pequeño 2004). However, in the forests inventoried within the proposed RC Matsés, this species did show a strong predilection for poor soils, especially white sand. It was the most common bird in the short-statured white-sand forests at Itia Tëbu, and was common elsewhere at this site. In the poor soils without white sand at Choncó, the species was less common, but still widespread in the terra firme forest. In forests on richer clayey soils at Actiamë, we recorded *C. parva* only once in hilly terra firme forest, at a site far from the richest soils near the Río Yaquerana. *C. parva* was also found on the Yavarí RBI, but was recorded only once at Quebrada Buenavista (Lane et al. 2003).

Our only record of Ruddy Spinetail, *Synallaxis rutilans*, was in the largest patch of short-statured white-sand forest at Itia Tëbu. This represents one of the few records of this species in Peru from east of the Río Ucayali.

Choncó

At Choncó the soils were nutrient-poor, with deep leaf litter in most areas. Although we found a small patch of white-sand forest, we did not see any white-sand specialist birds in the area. Most of this site was hilly terra firme forest, and terra firme species dominated the avifauna, although we did find some species more typical of low-lying forest along a large stream that ran by the camp.

We recorded 260 species at Choncó during our four-day survey, a reasonable number for an Amazonian site that is almost entirely terra firme forest. The species richness is similar to the 241 species we recorded in five days at Maronal, a terra firme site north of the Amazon on the Ampiyacu, Apayacu, and Yaguas inventory (Stotz and Pequeño 2004).

The numbers of parrots, especially macaws, was low at this camp. Only four species (*Ara ararauna*, *Brotogeris cyanopectus*, *Pionus menturus* and *Amazona farinosa*) were observed daily, and typically only in small numbers. On the other hand, other large frugivorous species (pigeons, toucans, trogons, and guans) were abundant.

Mixed-species flocks were more common and larger than at the other sites we surveyed on this inventory, but nevertheless were small and few in number by Amazonian standards. This was particularly true of understory flocks, where none contained all the expected species of *Myrmotherula*, and the majority contained only one of the two species of *Thammomanes* antshrikes, although each of these species was fairly common. In 18 flocks surveyed by Stotz, the average number of species in understory flocks was less than seven in Choncó, compared to averages ranging from 10 to 19 species elsewhere in Amazonian terra firme forest (Stotz 1993, pers. obs.).

Actiamë

This camp was situated along the Río Yaquerana, which joins the Río Gálvez 80 km to the north to form the Río Yavarí. In the area we surveyed, relatively high banks border the Yaquerana, leaving essentially no beaches exposed. Forest immediately along the river edge did not appear to be regularly underwater for extensive periods, though we did find small areas of inundated forest along two of its major tributaries.

Despite this, the avifauna included a number of riverine species that were absent from our other main camps. Some of these were directly associated with the river itself (herons, shorebirds, swallows), but most were found in the forest along the river bluff. These riverine species contributed substantially to the avifauna at this site, and combined with a diverse terra firme bird community resulted in the highest species richness of the three inventory sites, with 323 species recorded in our four days at Actiamë.

We did not find Gray Wren (*Thryothorus griseus*), a species known from the Río Yavarí on the

Brazilian side but unrecorded from Peru. It was not found during the Yavarí inventory either (Lane et al. 2003). It may not occur this far south in the Yavarí drainage, since it seems unlikely that the narrow Río Yaquerana would act as a barrier.

Río Blanco

We surveyed the Río Blanco (Figure 8A) during three brief excursions to the site from Itia Tëbu. The habitat around the Río Blanco is disturbed, and dominated by a large agricultural clearing and planted fruit trees. In our brief survey, we were able to survey some river-edge vegetation, and this is where we found most of the interesting species at this site. In ~10 hours of observation during two days, we recorded 124 species, including 13 not seen elsewhere during the inventory.

This is the only area we surveyed within the Río Ucayali drainage; all other sites were in the Río Yavarí basin. A number of species that are known to occur along the Río Ucayali well south of the area we surveyed are not known from the Yavarí drainage. In our brief survey, we recorded three such species, *Sakesphorus canadensis* (Figure 8B), *Capsiempis flaveola* and *Megarynchus pitangua*, and suspect that further surveys of the Río Blanco would likely uncover others.

Sakesphorus canadensis (Figure 8B) is locally distributed in Peru along the Río Ucayali and Río Amazonas, especially near blackwater lakes. *Capsiempis flaveola* was only recently found in Peru (Servat 1993). Currently, there are three disjunct populations known from Amazonian Peru (Schulenberg et al. in prep), and although the two southern populations are associated with bamboo patches, the northern Peruvian population is not. Our record on the Río Blanco is the southernmost record of *C. flaveola* in northern Peru.

Remoyacu

The areas surveyed at Remoyacu in a day and a half were dominated by open habitats around the village and disturbed forests along the Río Gálvez. Because we were working on presentations and reports, we did not survey the area intensively. Nonetheless, we observed

144 species, including 19 species not recorded elsewhere during the rapid inventory. The majority of the species not observed elsewhere were associated with the secondary habitats around the village. However, we observed a few forest species here, like Pied Puffbird (*Notharchus tectus*) and Solitary Cacique (*Cacicus solitarius*), that we did not encounter elsewhere.

Other significant records

A handful of our observations represent substantial range extensions. The most notable was a single Northern Waterthrush, *Seiurus novaboracensis*, seen by Stotz along a stream at Actiamë. This North American migrant is known in Peru from only two records, one south of Lima on the Pacific slope, and the other at the Río Curaray (T. Schulenberg, pers. com.). There are only a few records from Amazonia in Ecuador (Ridgely and Greenfield 2001), and one from eastern Amazonian Brazil (Sick 1993). Besides these scattered records, typically the southernmost wintering records are in northern South America (Paynter 1995).

We observed single males of the poorly-known White-bellied Dacnis, *Dacnis albiventris*, in a mixed tanager flock at Choncó at the edge of the heliport, and singing in second-growth forest at Remoyacu. The species is known only from scattered localities in western Amazonia, and its distribution and preferred habitat remain unclear.

Pequeño observed an Emerald Toucanet, *Aulacorhynchus prasinus*, in a fruiting tree in floodplain forest at Actiamë. This species occurs mainly on lower montane slopes in Peru, although in southeastern Peru it regularly occurs farther from the Andes. Our record is the northernmost Peruvian record this far from the Andes. Moreover, the bird was observed across the river from Brazil, where the species has been recorded only a few times (Whittaker and Oren 1999). Despite the paucity of records, we suspect that this species may be regular in southwestern Amazonian Brazil.

Pequeño observed a single Zigzag Heron, *Zebrilus undulatus*, at a small pool in floodplain forest at Actiamë. The advance trail-building team at Actiamë

also reported seeing a *Zebrilus* in the same area while they worked on the camp (G. Knell, pers. comm.) This small heron is known from only a handful of sites in Peru, and is generally rare throughout its range.

Gray-chested Greenlet, *Hylophilus semicinereus*, was common at the Río Blanco, where several pairs were present and tape-recorded. Stotz also observed one at Choncó along a small stream in dense, tangled vegetation. This greenlet was only recently found in Peru for the first time (Begazo and Valqui 1998). It is currently known in Peru from a few sites south of the Río Amazonas west to Pacaya-Samiria. Our records are the southernmost in Peru.

Migrants

We found 19 species of migrants from North America. We saw only one species of austral migrant, Lined Seedeater (*Sporophila lineola*) Most of the migrants were associated with open habitats or were shorebirds at the edge of rivers. However, several species were regularly encountered within forested habitats, including Eastern Wood Pewee (*Contopus virens*), Red-eyed Vireo (*Vireo olivaceus*), Yellow-green Vireo (*V. flavoviridis*), Swainson's Thrush (*Catharus ustulatus*), Gray-cheeked Thrush (*C. minimus*), and Scarlet Tanager (*Piranga olivacea*). During our inventory, high water levels may have lowered the abundance and diversity of migrant shorebirds in Actiamë and Remoyacu.

Reproduction

We observed little breeding activity during the inventory. Some insectivorous passerines were accompanied by older juveniles, and overall levels of singing were low, suggesting that the main breeding season had ended fairly recently. However, we did observe a few younger chicks, including dependent young of Starred Wood-Quail (*Odontophorus stellatus*), Black-fronted Nunbird (*Monasa nigrifrons*), White fronted Nunbird (*Monasa morphoeus*), and Plain-brown Woodcreeper (*Dendrocincla fuliginosa*). A handful of species were actively nesting. We found a Double-toothed Kite (*Harpagus bidentatus*) nest with large chicks at Actiamë. We found one nest each of Great Tinamou

(*Tinamus major*) and Blackish Nightjar (*Caprimulgus nigrescens*, Figure 8D) with eggs being incubated, at Itia Tëbu. A Fork-tailed Woodnymph (*Thalurania furcata*) was building a nest at Actiamë. We observed several parrots investigating nest holes at Actiamë, including Blue-and-yellow Macaw (*Ara ararauna*), Red-and-green Macaw (*Ara chloroptera*), Chestnut-fronted Macaw (*Ara severa*), Painted Parakeet (*Pyrrhura picta*), and White-bellied Parrot (*Pionites leucogaster*).

Biogeographic patterns

The proposed RC Matsés is relatively distant from major rivers or other barriers that could represent range boundaries for most Amazonian species. However, there are a handful of cases where allospecies replace one another within the region east of the Río Ucayali in Peru. For the most part, we found the more northerly of these species during our inventory. The allospecies included the following species pairs (more northerly species listed first and the species found during the Matsés inventory marked with an asterix): *Malacoptila rufa/semicineta**, *Galbalcyrhynchus leucotis/purusianus**, *Phaethornis bourcieri/philippii**, *Nonnula rubecula*/sclateri*, *Thamnomanes saturninus*/ardesiacus*, *Machaeropterus regulus*/pyrocephalus*, *Pipra filicauda*/fasciicauda*.

Surprisingly, at least 24 common, widespread Amazonian species were not recorded during either the Matsés or the Yavarí rapid inventory. All of these birds occur both east and west of the Yavarí drainage south of the Amazon, and are recorded both north and south of the Yavarí, so their gross distributional patterns suggest they should occur in the Yavarí drainage. This list includes Swallow-tailed Kite (*Elanoides forficatus*), Yellow-headed Caracara (*Milvago chimachima*), Pale-vented Pigeon (*Patagioenas cayennensis*), Blue Ground-Dove (*Claravis pretiosa*), Tui Parakeet (*Brotogeris sanctithomae*), Striped Cuckoo (*Tapera naevia*), Crested Owl (*Lophostrix cristatus*), Rufous-breasted Piculet (*Picumnus rufiventris*), Little Woodpecker (*Veniliornis passerinus*), Spot-throated Woodcreeper, (*Deconychura stictolaema*), Red-billed Scythebill (*Campylorhamphus trochilirostris*), Dark-breasted Spinetail (*Synallaxis*

albigularis), Short-billed Leaf-tosser (*Sclerurus ruficularis*), Sulphury Flycatcher (*Tyrannopsis sulphurea*), Boat-billed Flycatcher (*Megarynchus pitangua*), Pink-throated Becard (*Pachyramphus minor*), Spangled Cotinga (*Cotinga cayana*), Black-capped Mocking-thrush (*Donacobius atricapilla*), Hooded Tanager (*Nemosia pileata*), Orange-headed Tanager (*Thlypopsis sordida*), Masked Tanager (*Tangara nigrocincta*), Blue-black Grassquit (*Volatinia jacarina*), Red-rumped Cacique (*Cacicus haemorrhous*), and Oriole Blackbird (*Gymnomystax mexicanus*). Undoubtedly, some of these species will be recorded with further surveys along the Río Yavarí drainage in Peru. However, it is odd that a month of fieldwork by experienced ornithologists at six sites scattered within the Río Yavarí drainage did not uncover these species. If they are present, it is difficult to imagine that these species are as common in the Yavarí drainage as they are elsewhere in Amazonia.

At least some of these species are associated with human-disturbed habitats and this habitat type may be too scarce in the region, or they may not have dispersed to the relatively limited areas with appropriate habitat. Similarly, some of the species associated with rivers and associated habitats may be absent because of limited suitable habitat. But the absence of other species, such as *Elanoides forficatus*, *Lophostrix cristatus*, *Campylorhamphus trochilirostris*, *Pachyramphus minor* and *Cotinga cayana*, remains puzzling, and is not obviously related to habitat availability.

DISCUSSION

We estimate that ~550 species would be found in the region with more complete surveys, especially of the riverine habitats. Several riverine species found on the Yavarí inventory (Lane et al. 2003) probably occur within the proposed Reserva Comunal Matsés or the Comunidad Nativa Matsés. The white-sand forests near the boundary of the Río Gálvez basin and the Río Blanco basin that we surveyed at Itia Tëbu, if more completely surveyed, could uncover additional species, including potentially

undescribed ones. However, as this habitat is generally depauperate of birds, we would expect only a modest number of additional species to be found there.

Birds of white-sand forests (*varillal*)

White-sand forests are distributed patchily throughout Amazonia, with major areas in north-central Amazonian Brazil and northeastern Peru. The eastern complex of white-sand habitats has been studied by ornithologists since early ornithological surveys in Amazonia in the 1800s, and Oren (1981) has conducted the most recent comprehensive surveys. The white-sand areas west of Iquitos were ornithologically unknown until J. Álvarez began working there in the 1990s. Since that time, five species of birds new to science have been described from white-sand forests in Peru. Additionally, eight other species not previously known from Peru have been documented in these white-sand areas, as well as other species that appear to be associated primarily with these habitats (Álvarez 2002, Álvarez and Whitney 2003).

During this inventory, we did not find any of the species restricted to white-sand habitats elsewhere in Amazonia. Despite our failure to find any definite white-sand specialists, it is hard to imagine that there are none, given the wide expanse of white-sand forests in the region. The great distance separating the Río Ucayali and Río Amazonas suggests that the restricted range species discovered in the Iquitos area probably will not be found in the Matsés region. Wider-ranging specialists, like Barred Tinamou (*Crypturellus casiquiare*), Gray-legged Tinamou (*C. duidae*), and Saffron-crested Tyrant-Manakin (*Neopelma chrysocephalum*), which are found only north of the Río Amazonas, may also be unlikely. Instead, the white-sand forests near Itia Tëbu may harbor their own set of restricted-range species awaiting discovery. Most of the newly described species near Iquitos, and many of the more specialized widespread species, were only found after years of study on much smaller patches of white-sand forest (J. Álvarez, pers. comm.).

Comparison among sites

The three main camps shared 151 species. Actiamë was easily the most diverse camp, with 322 species, in large part because of its proximity to a large river. Actiamë also had the greatest number of unique species: 93. Of these, we recorded 38 (mainly riverine) species during our brief surveys of the Río Blanco and Remoyacu, making the number of unique species at Actiamë 55 if all five sites are considered. At Choncó we observed 30 species not seen at Actiamë or Itia Tëbu, while Itia Tëbu had 12 species restricted to that site, mostly species restricted to the white-sand forests. A substantial number of typically common and widespread forest species were not recorded at Itia Tëbu, including 67 common forest interior species that we observed at both Choncó and Actiamë.

Comparison with other rapid inventories in Loreto

In this section, we compare our observations in the Matsés region with those from two other rapid biological inventories recently conducted in terra firme forests in Loreto. The Yavarí inventory (Lane et al. 2003) sampled four sites within the Yavarí drainage, downriver from the Matsés inventory. The Ampiyacu, Apayacu, and Yaguas inventory (Stotz and Pequeño 2004) sampled three sites north of the Río Amazonas, within the Amazonas and Putumayo drainages. Many species are shared between these three inventories, but at least a third of the avifauna is unique to each.

Yavarí

The rapid biological inventory of Yavarí registered 400 species of birds (Lane et al. 2003) during April 2003, while we recorded 416 species in Matsés during October–November 2004. Species and abundance differences between sites principally reflect seasonal and habitat differences. Both inventories visited several unique habitats, and overall we were able to visit sites with greater habitat variation in the Matsés inventory than in Yavarí, as all the sites during the Yavarí inventory were along the main river channel. However, the Yavarí inventory did survey oxbow lakes, large

Mauritia palm swamps, and extensive *varzea*—all habitats that we did not visit in the Matsés region. With the exception of the white-sand forests, we suspect that the two regions overlap substantially in habitat types.

We registered 78 species in the Matsés inventory that were not found in Yavarí, and 60 species in the Yavarí inventory were not found in the Matsés region. Most of the species unique to Yavarí were associated with riverine habitats (29 species) or are migrants (13 species: eight austral and five boreal). We registered a diverse group of boreal migrants (19 species). Eleven of these species were not registered in Yavarí. We observed only one species of austral migrant. By the end of October, austral migrants should have returned to their breeding grounds, which likely explains their absence from this inventory. The differences in migrant composition between these two inventories almost certainly reflect seasonal differences rather than actual composition differences. Most of the migrants, both austral and boreal, probably occur in both areas at the appropriate season.

The riverine species observed uniquely during the Yavarí inventory, ranging from herons that use shallow waters to forage, to Amazonian Umbrellabirds (*Cephalopterus ornatus*) that live in tall *varzea* forests along the edges of major Amazonian rivers, reflect several unique riverine habitats sampled in Yavarí. Similarly, we registered 18 species in riverine habitats on the Matsés inventory (and three additional species in the Ucayali drainage at Río Blanco) that were not registered during the Yavarí inventory.

Two times we recorded a species in the Matsés inventory that geographically replaces a congeneric species recorded at Yavarí. These species replacements included Semicollared Puffbird (*Malacoptila semicineta*) instead of Rufous-necked Puffbird (*M. rufa*) and Chestnut-belted Gnateater (*Conopophaga aurita*) instead of Ash-throated Gnateater (*C. peruviana*). The puffbirds replace each other not only between our two inventories, but also along stretches of the Yavarí sampled during that inventory. The distribution of the two *Conopophaga* species is complex east of the Río Ucayali, and is not well understood.

Beyond differences in the species lists between the Yavarí and Matsés inventories, there were noticeable abundance differences in the avifauna. Obviously, the Yavarí inventory documented a richer riverine avifauna. However, even the riverine species that we did document at Actiamë were relatively uncommon compared to the Yavarí inventory. Similarly, the richer terra firme avifauna documented during the Matsés inventory reflected not only a greater number of terra firme species but also greater abundances of those species.

Ampiyacu, Apayacu, and Yaguas

In 2003, we participated in a rapid inventory in the Ampiyacu, Apayacu, and Yaguas region (AAY, Stotz and Pequeño 2004), an area north of the Río Amazonas. There, as in the Matsés inventory, terra firme species dominated the avifauna. Since the two regions are separated by the Río Amazonas, there are substantial compositional differences in their avifaunas. During the AAY inventory, we found 42 unique species, including 26 known not to cross south of the Río Amazonas or east of the Río Ucayali in Peru. Forty-five species of terra firme birds were recorded only in the Matsés region, including 33 only found south of the Amazonas in Peru. In 17 cases, related species replace each other on either side of the Río Amazonas. The differences between these two inventories in terra firme species, while substantial, are smaller than the differences between the AAY and Yavarí inventories (Stotz and Pequeño 2004).

Again, we sampled different habitats in the two inventories, and several of the compositional differences reflect these habitat differences. Overall, the Matsés inventory sites showcased much greater habitat diversity than our AAY inventory sites. Accordingly, the three inventory sites in the AAY inventory shared many more species and displayed a smaller range in diversity among sites (AAY: 242-302 species, Matsés: 187-323). The most important differences between these inventory sites, aside from their position on opposite sides of the Amazonas, are the white sands in the Matsés region and the high riverine habitat diversity sampled at Actiamë.

THREATS, OPPORTUNITIES, AND RECOMMENDATIONS

The principal threat for birds in the Matsés region is habitat destruction, especially deforestation, given the largely forest-based avifauna of the region. We observed evidence of logging activity near the Río Blanco, with several obvious tractor trails still evident within the white-sand forests. The riverine area there was quite disturbed. Most birds in this habitat are relatively tolerant of disturbance, but for some species including perhaps *Sakesphorus canadensis*, we need to ensure that relatively extensive areas of intact riverine habitats remain.

Given the high densities of game birds and the presence of some of the most sensitive species to hunting (*Crax* and *Psophia*), the introduction of significant hunting into the region could have noticeable impacts on the populations of these species. Continued subsistence-level hunting in the lands used by the native communities should not negatively impact the populations of these birds in the area we surveyed. We would expect that the greatest potential for negative impacts would be along the river courses that provide relatively easy access to parts of the region.

Recommendations

Protection and management

Currently, the area suggested for the Reserva Comunal Matsés extends west to the divide between the Río Yavarí drainage and the Río Ucayali drainage (Figure 2). It is clear that patches of the white-sand forest we surveyed near Itia Tëbu extend west into the Río Ucayali drainage. Extending the limit of the proposed Reserva Comunal west to the east bank of the Río Blanco (Figure 2) would protect more of this unique community. It would provide the area with a more clearly defined and easily protected boundary, and ensure the protection of some riverine habitats within the Río Ucayali drainage. This drainage has little area protected above its lower reaches. In general, the riverine areas within the region are most under pressure from human activity. We recommend protecting sections of some of the major rivers in the

areas, especially areas that currently have little or no human activity. This will provide protection to habitats and the fauna within them that are under pressure throughout the Amazon basin.

Inventories and Monitoring

The greatest priority for additional bird surveys are the white-sand forests that we briefly surveyed near Itia Tëbu. These forests, although likely poor in overall species richness (Figure 8E), could harbor undescribed species, since surveys in smaller areas of white-sand habitats near Iquitos have uncovered at least five species new to science. In addition, areas with large cochas within the Matsés region remain unsurveyed, and should be considered a priority. Finally, surveys of areas that are used heavily by the native community should be undertaken to understand how their resource use impacts the bird community. Such information could help in managing these areas for sustainable use by the human populations in the area. This would be a necessary precursor to long-term monitoring of the game birds that are exploited by the Matsés. These game birds should be monitored in areas that are actively hunted by the Matsés and in areas that are more isolated for comparison to direct management of this important forest resource.

Research

In the area east of the Ucayali, a number of allospecies replace one another, or species occur at the edges of their range, despite the lack of obvious barriers like broad rivers. Understanding these distribution patterns might help set natural boundaries for management areas, especially for forest-based species that may not be restricted to watersheds. Whether the extensive areas of white-sand forests together with associated agaujales and other low-lying wet areas limit movements of more typical forest species, and are acting as a geographic barrier, is worth investigating.

Investigating the genetic distinctiveness of populations of white-sand inhabiting species in the area, compared to other areas of white sands, would help in managing the populations of these specialized birds.

They occupy a naturally patchy environment, but it is one that has been relatively stable across long periods of time. Comparing their genetic structure to species in patchy environments that are ephemeral could help in understanding their evolution.

MEDIUM AND LARGE MAMMALS

Author/Participant: Jessica Amanzo

Conservation targets: One of the most diverse areas for mammals in Amazonia; extremely diverse primate community (14 species) with abundant, large species such as *Lagothrix lagothricha*, *Ateles paniscus* (Figure 9A) and *Alouatta seniculus*; presence of the giant armadillo (*Priodontes maximus*) listed as an endangered species (EN) on the World Conservation Union's (the IUCN) Red List; habitat specialists such as *Callimico goeldii* and *Cacajao calvus*, both of which are listed as Near Threatened (NT) on the IUCN Red List; abundance of large mammals that have suffered local extinctions in many parts of their natural distribution because of habitat loss or overhunting; intact, heterogeneous habitats that serve as a source of game species, especially in the headwaters of the Río Yaquerana and Río Gálvez

INTRODUCTION

The proposed Reserva Comunal Matsés is situated in the western Amazon, an area with an exceptional diversity of mammals, perhaps the greatest in the world (Emmons 1984, Voss and Emmons 1996, Valqui 2001). Several research studies of mammalian diversity have been carried out in and around the Matsés territory. Toward the north, Salovaara et al. (2003) registered 39 species in three sites in the upper Río Yavarí, and 49 species in Río Yavarí Mirín. Fleck and Harder (2000) conducted an intense study in the Río Gálvez watershed, within the Matsés territory, with the help of local inhabitants and registered 84 mammal species, 61 of which were medium and large mammals. Valqui (2001) registered 82 mammal species in the western portion of Reserva Comunal Tamshiyacu-Tahuayo, 44 of which were medium and large species.

In this rapid biological inventory, we evaluated the diversity of medium and large mammals in three sites characterized by different edaphic conditions and habitats types, within the proposed Reserva Comunal

Matsés. In this chapter we present our results, detail the diversity differences between the three evaluated sites (Figures 2; 3A, E, I), compare diversity of the three sites with other areas in Amazonia, highlight species of importance, and discuss management and conservation opportunities.

METHODS

We focused on medium and large mammal species (weighing more than 0.5 kg). We did not include small mammals because sampling methods (setting traps and nets) require more time than the rapid inventory allowed.

We sampled the trails established by the advance trail-cutting team, which varied between 1.2 and 11.1 km and covered most of the habitats present in the region. To register both diurnal and nocturnal species, we sampled the trails between 7:30 AM and 5:30 PM and again between 7:30 and 10:30 PM. We walked the trails at a velocity of ~1-1.5 km/h scanning the ground, the subcanopy, and the canopy to register terrestrial species as well as arboreal species. Every so often, we stopped to observe movements or listen to vocalizations. During most of the inventory, we worked with a local Matsés assistant.

We recorded large and medium-sized mammals using visual sightings as well as secondary clues such as tracks, vocalizations, food remains, scat, and watering holes. For each observation, we noted species information, number of individuals, sex (when possible), and distance from the trail. We also included mammal sightings by other members of the research team (D. Moskovits, C. Vriesendorp, T. Pequeño, D. Stotz, G. Knell, M. Gordo, J. Rojas, M. Hidalgo, I. Mesones and N. Dávila) and the Matsés assistants.

We interviewed members of the local Matsés communities that assisted us during our inventory and participants in the presentation of our preliminary rapid inventory results in Remoyacu/Buen Perú. We interviewed adult males since they are the primary hunters in the communities. In these interviews we used the plates in Emmons and Feer (1997) to identify species.

RESULTS

Using information from previous inventories and evaluations in areas close to the Matsés territory (Valqui 2001, Fleck and Harder 2000, Salovaara et al. 2003), we prepared a list of 65 expected medium and large mammal species (Appendix 6). During our inventory, we registered 43 species in the three inventory sites corresponding to 9 orders, 23 families, and 35 genera, and representing 66% of the expected species. After interviewing the Matsés, the number of species increased to 60, which represents 92% of the expected species. The final percentage demonstrates that the Matsés people are extremely knowledgeable about the mammal species present in their territory.

Similarities and differences among inventory sites

The number of registered species in Choncó, in the Río Gálvez watershed, and Actiamë, in the Río Yaquerana, was similar. We registered 35 species in each site, 29 of which (83%) were found in both sites. We found 25 mammal species in the white-sand forests of Itia Tëbu. The following paragraphs summarize our results at each inventory site.

Actiamë

Actiamë had the greatest number of edible fruits (Figure 3K) and the greatest abundance of the following species (which are also game species): *Agouti paca*, *Dasytus* spp., *Mazama gouazoubira*, *Priodontes maximus*, *Tapirus terrestris*, *Alouatta seniculus*, *Ateles paniscus* (Figure 9A), *Lagothrix lagothricha* and *Saimiri sciureus* (Table 2). This site had highly productive and heterogeneous soils and we frequently observed large primates and birds feeding in Moraceae and Sapotaceae trees and palms. We also observed different primate groups of the same species (primarily *Lagothrix lagothricha* and *Alouatta seniculus*) using areas very close to one another. In a small *aguajal* (palm swamp) we found many animal tracks, including tapir (*Tapirus terrestris*) and paca (*Agouti paca*) that had been feeding on *Mauritia flexuosa* fruits. These fruits are also an important resource for small mammals such as *Proechimys* spp. and *Oryzomys* spp. We also observed

many armadillo (*Priodontes maximus* and *Dasyopus* spp.) holes in a terrace next to the aguajal. Along some streams, we observed *Cabassous unicinctus* dens. In addition, this was the only sampled site where we registered the pink river dolphin (*Inia geoffrensis*) and the capybara (*Hydrochaeris hydrochaeris*) because it was the only area inventoried with easy access to a large river.

Choncó

Large mammal diversity and abundance was also great in Choncó. Here we observed 12 monkey species; in Actiamë we observed 11 species and in Itia Tëbu only eight. The pygmy marmoset (*Cebuella pygmaea*) was registered only in this site. With respect to the carnivores, we registered

six species from four families, two more species than in Actiamë and Itia Tëbu. Among the carnivores, the bush dog (*Speothos venaticus*), a very rare Amazonian canine, stands out. The most abundant species were *Myrmecophaga tridactyla*, *Panthera onca*, *Pecari tajacu* and *Callicebus cupreus*. The collared peccary (*Pecari tajacu*) was much more abundant here than in the other two sites, but as was the case in Actiamë, abundance of the white-lipped peccary (*Tayassu pecari*) was very low.

Itia Tëbu

White sands dominate Itia Tëbu, and because of their extremely low productivity, we found fewer species here than at the other two sites. Of the 25 species registered,

Table 2. Relative abundance of encounters (signs and observation) of large mammals in the three inventory sites.

Species	Common name	Relative abundance (Number of observations/km)		
		Itia Tëbu	Choncó	Actiamë
<i>Agouti paca</i>	paca	0.106	0.162	0.379
<i>Dasyprocta fuliginosa</i>	black agouti	–	0.054	–
<i>Dasyopus</i> spp.	armadillos	0.372	0.324	0.506
<i>Choloepus</i> sp.	two-toed sloth	0.053	0.027	0.032
<i>Mazama americana</i>	red brocket deer	–	0.297	0.253
<i>Mazama gouazoubira</i>	grey brocket deer	0.106	0.027	0.032
<i>Myrmecophaga tridactyla</i>	giant anteater	–	0.054	0.032
<i>Panthera onca</i>	jaguar	–	0.108	0.095
<i>Pecari tajacu</i>	collared peccary	0.106	0.811	0.632
<i>Priodontes maximus</i>	giant armadillo	0.213	0.162	0.316
<i>Tapirus terrestris</i>	lowland tapir	0.159	0.351	0.442
<i>Alouatta seniculus</i>	red howler monkey	–	–	0.081
<i>Ateles paniscus</i>	spider monkey	–	0.054	0.063
<i>Callicebus cupreus</i>	dusky titi monkey	0.053	0.081	0.063
<i>Cebus albifrons</i>	white-fronted capuchin monkey	–	0.054	–
<i>Lagothrix lagothricha</i>	common woolly monkey	–	0.081	0.284
<i>Pithecia monachus</i>	monk saki monkey	0.159	0.162	0.032
<i>Saguinus mystax</i>	black-chested mustached tamarin	0.213	–	0.032
<i>Saguinus fuscicollis</i>	saddleback tamarin	0.053	–	–
<i>Saimiri sciureus</i>	squirrel monkey	–	–	0.032
Number of all mammal encounters/km		1.593	2.809	3.306

many were also found in the other two sampled sites: 21 species found here were also found in Choncó (88%), and 23 species were also found in Actiamë (96%). Itia Tëbu's most abundant species include armadillos (*Dasypus* spp. and *Priodontes maximus*), the gray brocket deer (*Mazama gouazoubira*) and two species of tamarin monkeys (*Saguinus* spp.). While this site had lower abundance and richness overall, it is important to note that we did register both large felines here, the jaguar (*Panthera onca*) and puma (*Puma concolor*).

Species records

Most of the species registered are typical of the Amazon and are broadly distributed. All of the expected orders, except for Sirenia (river manatee), were represented in the inventory. The best-represented orders in the three sites were Xenarthrans, the primates, and the ungulates with 89%, 86%, and 100% of the expected species. The Amazonian manatee (*Trichechus inunguis*) was not registered in any of the sample sites and it was not recognized by any of the locals. In previous studies it has been considered as probable for the area. During overflights of the area, we observed many oxbow lakes close to the Gálvez and Yaquerana rivers (Figure 3L), therefore we continue to consider this species as potentially present.

We observed 12 of 14 expected primate species, and after including information gathered from interviews, recorded all 14 expected species. This is a high number of primates for a rapid inventory, and high for the Amazon in general. Goeldi's marmoset, (*Callimico goeldii*), and the red uakari monkey (*Cacajao calvus*), were not recorded in any of the three inventoried sites, but the Matsés recognized both of them during our interviews. The Matsés report that Goeldi's marmoset (*Callimico goeldii*) is rare.

We registered six ungulate species. The collared peccary (*Pecari tajacu*) was abundant in Choncó and common in Actiamë. We did not register evidence of large groups of white-lipped peccary (*Tayassu pecari*) in any site. The tapir (*Tapirus terrestris*) was present in each site; however, it was most abundant in Actiamë.

Armadillos were relatively common in Actiamë, and less common in Choncó and Itia Tëbu. The giant anteater (*Myrmecophaga tridactyla*) was abundant in Choncó and the southern tamandua (*Tamandua tetradactyla*) was abundant in Actiamë.

We registered a total of eight carnivore species (50% of the expected) representing all of the families of the order. The jaguar (*Panthera onca*) was the most abundantly recorded feline species. Based on tracks found along a stream in Actiamë we also registered an ocelot (*Leopardus pardalis*), but only once. During interviews, the local inhabitants identified all of the members of the feline family, and all but one—the greater grison (*Galictis vittata*)—of the expected species from the Carnivore order. The neotropical river otter (*Lontra longicaudis*) was observed only in Actiamë. It is likely that the giant otter (*Pteronura brasiliensis*) is present in Actiamë as well, because the Río Yaquerana is extensive, there are a large number of oxbow lakes, and fish resources are abundant (see Fishes, p. 184). In general, aquatic mammals were not well represented in this inventory because we only had access to one large river and one oxbow lake; however, local inhabitants confirmed that these mammals are indeed common and found throughout their territory.

We registered the pink river dolphin (*Inia geoffrensis*) in the Yaquerana (Figure 3L) in Actiamë. The gray dolphin (*Sotalia fluviatilis*) was registered after interviews with local inhabitants, who mentioned that this species is common in the majority of the area's rivers.

We inventoried 58% of the expected rodents and 33% of the expected marsupial species. The rodents belonged mostly to the Sciuridae, Agoutidae and Dasyproctidae families. The largest number of signs corresponded to the paca (*Agouti paca*). The pacarana (*Dinomys branickii*), uncommon in neotropical forests (Emmons and Feer 1997), was mentioned during interviews. In order to register more species from these orders, traps must be used.

During the nocturnal census, we also observed some small terrestrial mammals including a marsupial (*Marmosops* sp.) feeding on a cockroach, and the

rodents *Proechimys* spp. (probably more than one species) and *Oryzomys* spp. We observed two individuals of the genus *Proechimys* and one *Oryzomys* consuming *aguaje* (*Mauritia flexuosa*) fruit pulp in Actiamë.

Notable records

There was very little to no anthropogenic impact in the inventory sites, and as a result these areas support large mammal communities, notably large primates and ungulates most evident at Actiamë. Generally, hunters in tropical forests focus on primate and ungulate species because they provide more meat and hunters prefer the taste of these meats (Pacheco and Amanzo 2003). However, the large primates we observed did not flee in our presence, indicating that there is no or minimal hunting impact in these areas.

As mentioned above, we registered jaguars (*Panthera onca*) often, a species notable for occupying the highest trophic level. A jaguar was seen in the Choncó and Actiamë campsites. In Actiamë, one individual was observed by the Matsés assistants as it vocalized and roamed around the tents. In disturbed areas, jaguars are much more cautious and do not generally approach humans. In addition, in areas with hunting, there are fewer prey species for jaguars.

The monk saki (*Pithecia monachus*), common in the three sites, was observed in association with tamarins (*Saguinus mystax* and *S. fuscicollis*) in Itia Tëbu. *Pithecia monachus* feeds mostly on fruits, seeds, and leaves. Curiously enough, this species was seen with the two *Saguinus* species in the upper part of a tree that was being invaded by a swarm of raiding army ants. We assume that it was waiting for insects and small vertebrates that were climbing the tree to escape the ants.

G. Knell observed a female pink river dolphin (*Inia geoffrensis*) and her young for ~15 minutes at the mouth of a small tributary to the Río Yaquerana, and on two separate occasions (at night) one individual was seen in the Río Yaquerana itself. *Inia geoffrensis* is mostly a solitary species. They give birth during high water season (May and June) when more food is available

(Culik 2000). However, very little is known about its reproductive biology in Peru. Fish abundance in Río Yaquerana and adjacent oxbow lakes could provide many resources to the aquatic and semiaquatic mammal species.

Varillales and the transition zones between this habitat and high forests dominated Itia Tëbu. In the *varillales*, we observed that tips of the white-sand palm (*Euterpe catinga*, Figure 4J), a dominant species in this habitat, were being eaten by a rodent. We were unable to identify the species because of the short sample time and because we did not have the necessary traps to capture it. However, because the white-sand habitat is extensive, we suspect that it could be a species that has adapted to take advantage of these abundant palms. Identifying the species will require additional inventories.

Conservation targets

The Matsés territory supports diverse, intact communities of medium and large mammals. We registered a large number of species categorized as threatened by national and international institutions (Appendix 6). Of the 65 expected species, 21 are categorized as threatened on the IUCN's Red List (2004), 13 are categorized as threatened on INRENA's national list of threatened, and 36 are protected by the Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES, 2004).

Goeldi's marmoset (*Callimico goeldii*, Figure 9A) and the red uakari monkey (*Cacajao calvus*) are listed as Near Threatened (NT) by the IUCN, and Vulnerable according to INRENA (2004). *Callimico goeldii* is very rare throughout its distribution (Aquino and Encarnación 1994) and depends on bamboo habitats (Pook and Pook 1981, Aquino and Encarnación 1994). Most likely, it was not observed during this inventory because there were no bamboo habitats in the sites we evaluated. During the interviews, only a few Matsés people recognized the species.

C. calvus typically ranges over 150 km² areas (Emmons and Feer 1997) and it is threatened across its range. This species has disappeared altogether from many northeastern watersheds and in other areas, its

populations are diminishing progressively because of hunting and habitat destruction (Aquino and Encarnación 1994). Nonetheless, it is not protected in Peru.

Large monkey species like *Ateles paniscus* and *Lagothrix lagothricha* are considered as Vulnerable and Near Threatened respectively by INRENA (2004) and the tapir (*Tapirus terrestris*) is considered Vulnerable (VU) by both the IUCN (2004) and INRENA (2004). Tapir populations have been seriously reduced and have even suffered local extinctions because the species has a low reproductive rate, slow growth rate, and a long period of parental care, in addition to being a preferred game species, and suffering from reduced habitat (Bodmer et al. 1997).

It is important to stress that the Blanco and Tapiche rivers mark the distribution limits of the primates *Saimiri boliviensis peruviansis* and the subspecies of *Saguinus fuscicollis* (*S. f. nigrifrons*, *S. f. fuscicollis* and *S. f. illigeri*; Soini 1990, Aquino and Encarnación 1994), which could indicate that area is a speciation site for these groups and deserves strict protection.

The giant armadillo (*Priodontes maximus*) is widely distributed throughout the Amazon, listed as Endangered by the IUCN (2004), and very threatened by hunting. Its hollows, characteristic of its activity, were observed in all of the inventory sites. The giant anteater, uncommon in Amazonian forests, was observed twice during the inventory. Both the IUCN and INRENA (2004) list it as Vulnerable (VU).

Large carnivores are also affected by habitat loss and hunting, as well as overhunting of their prey species. Despite the short period of time for this inventory, we registered the Near Threatened (NT) jaguar (*Panthera onca*) and puma (*Puma concolor*) species, and the Vulnerable (VU) bush dog (*Speothos venaticus*; the IUCN 2004). During interviews, Matsés locals identified 15 of 16 expected carnivore species, including the giant otter (*Pteromura brasiliensis*) listed as Endangered by the IUCN (2004). Many of these species are protected in national parks in southern Peru, yet these species lack strict protection in the northern Amazon, an area that differs in both its ecology and mammal communities.

DISCUSSION

The three inventory sites displayed heterogeneous soils, and varied in productivity, flora, and availability of resources for mammals (see Landscape Processes: Geology, Hydrology, and Soils, p. 168; Flora and Vegetation, p. 174). Large mammals were most abundant in Actiamë; Choncó followed in abundance, and Itia Tëbu had the least abundance (Table 2). This abundance is related to the abundance of plants with edible fruits that provide food resources for herbivores (mostly primates, ungulates, and rodents), which are in turn an important source of protein for the Matsés communities.

Mammals in the varillales (white-sand forests)

The *varillales*, or white-sand forests, grow on poor soils with low productivity. As a result, mammal diversity and abundance were low in these habitats, since there are few food resources and little structural complexity (Janzen 1974, Emmons 1984, Hice 2003). Presence of varillal habitat specialists from other groups, such as plants, birds, and amphibians, has been documented (Janzen 1974, Alvarez 2002), but no mammal specialists are known for this habitat in Peru.

White-sand forests were dominated by a rare species of aguaje palm (*Mauritia carana*, Figures 3G, 12B); however, we did not observe any evidence of mammal consumption of their fruits (such as teeth marks in fruit and tracks near the plant). The paca (*Agouti paca*) was the only species observed within the *varillales*. All the others species were registered in the transition between varillal and taller forests, or in the taller forests.

Comparison with other Amazonian sites

The Matsés territory supports extremely high mammalian diversity. The 84 species registered by Fleck and Harder (2000) represent one of the highest diversity values in the entire Amazon. In Peru, this is the only region where 14 coexisting primate species have been reported. Within the Amazon, the most primate species are found between the Ucayali and Purús rivers, and depending on the site, there are between 9 and 14

Table 3. Number of medium and large mammal species registered in seven Peruvian Amazon sites and the proposed Reserva Comunal Matsés compared to richness in the entire northeastern Peruvian Amazon. Data are arranged by taxonomic order and the highest values are in bold.

Locality	Order									
	Marsupialia	Xenarthra	Primates	Carnivora	Cetacea	Sirenia	Perissodactyla	Artiodactyla	Rodentia	Lagomorpha
Cusco Amazónico (Pacheco et al. 1993)	6	7	13	17	0	0	1	6	12	1
Sierra del Divisor (Amanzo y Paredes 2001)	3	7	13	11	0	0	1	4	8	1
Ampiyacu, Apayacu, and Yaguas (Montenegro y Escobedo 2004)	3	5	10	7	2	1	1	4	6	0
Río Yavarí (Salovaara et al. 2003)	0	3	13	8	2	0	1	4	6	0
Río Yavarí Mirín (Salovaara et al. 2003)	0	8	13	13	2	1	1	4	7	0
Reserva Comunal Tamshiyacu-Tahuayo (Valqui 2001)	5	9	13	14	2	1	1	4	10	0
Río Gálvez (Fleck and Harder 2000)	4	9	14	16	2	0	1	4	11	0
Matsés (this study) expected	5	9	14	15	2	1	1	4	9	0
Matsés (this study) registered	2	8	12	8	1	0	1	4	7	0
Amazon forest, northeastern Peru	6	9	14	17	2	1	1	6	12	1

species recorded (Voss and Emmons 1996). Habitat diversity within the Matsés territory is great, and appears to determine the local distribution of mammals. Typically, regions with greater habitat heterogeneity are likely to have greater mammalian species diversity (Valqui 2001).

Mammalian species diversity is greatest in the western Amazon (Emmons 1984, Voss and Emmons 1996). In a comparison of mammal species richness in several Amazonian sites close to Matsés (Table 3), we find that our inventory of the proposed RC Matsés registered among the highest richness values for the orders Xenarthra and Primates. Other orders are also represented by many species in the RC Matsés, but not as many as in some other nearby sites.

Game species

It is important to highlight that some of these mammals are an important source of protein for the Matsés communities (Figure 10C). In interviews I conducted, as well as those conducted by the social inventory team, Matsés people mentioned that they preferred certain species over others. Larger, better tasting animals were

avored, such as armadillos (*Dasybus spp.* and *Cabassous unicinctus*), large monkeys (*Lagothrix lagothricha*, *Ateles paniscus*), peccaries (*Tayassu pecari* and *Pecari tajacu*), sloths (*Choloepus sp.* and *Bradypus variegatus*), tapir (*Tapirus terrestris*) and deer (*Mazama spp.*). Other important, but less favorable species are medium and large rodents including capybara (*Hydrochaeris hydrochaeris*), paca (*Agouti paca*) and black agouti (*Dasyprocta fuliginosa*). Of these, the last two are more abundant and therefore form an important part of the Matsés' diet.

Bows and arrows and shotguns are used for hunting. Young people are abandoning bows and arrows, but do not always have money for shotgun shells. Overall, the Matsés promote hunting with bow and arrow. Most of the hunting is for subsistence and to maintain family bonds since the meat is shared with family members. On rare occasions, bush meat is sold in the town of Requena, which is three days from the Matsés communities on foot. During the inventory, we heard of one case in which a Matsés native was hired to hunt for someone else, for commercial purposes.

Preferred species are becoming less abundant in some of the small villages, while in others they remain

common. Mammals sensitive to hunting, like the tapir (*Tapirus terrestris*) and large primates (*Lagothrix* and *Ateles*), have characteristics that cause rapid population declines and slow recoveries, including long gestation periods, slow development and growth, and sensitivity to disturbances (Mittermeier 1987, Collins 1999, Alverson et al. 2000, Pacheco and Amanzo 2003). As a result, these are usually the first species to disappear from areas near human populations.

Peccaries are extremely important to local communities. The collared peccary (*Pecari tajacu*) was much more abundant in Choncó than in the other study sites. Tracks and small natural salt licks were frequent. However, white-lipped peccary (*Tayassu pecari*) was only recorded as uncommon, and was absent from some sites. According to local inhabitants, the white-lipped peccary used to be abundant around the communities over five years ago, but today they must venture farther into the forest to find large groups. Since this species travels within a large territory, we suspect that we would find large groups in a longer inventory that covers more ground. Another possible explanation for the near absence of white-lipped peccaries may reflect the natural cycles of abundance and extinction within the distribution range of this species (Fragoso 1997).

We did not observe great abundances of small primates in the evaluated sites. In disturbed areas where large primates have been extirpated by hunting, greater abundance of small primates can occur (Freese 1982). Because neotropical hunters prefer larger, better tasting game, generally these species are overhunted and populations decline. Then hunters are forced to go after less preferred species, which tend to be smaller (Robinson et al. 1997).

THREATS, OPPORTUNITIES, AND RECOMMENDATIONS

Principal threats

Within the Matsés territory, hunting is one of the greatest threats to medium and large mammal

populations near local communities. Actiamë and Choncó do not appear to be currently threatened by hunting, and are perhaps only visited by the occasional hunter. There was some evidence of hunting impact in Itia Tëbu, such as a farm plot, patches of secondary forests, and a collared peccary skull found next to the Río Blanco. *Mestizo* communities settled along this river may visit and hunt in these forests (Figure 10A).

Hunting, habitat loss and habitat deterioration will primarily affect large primates, the tapir, and the giant armadillo. Carnivores that require large ranges and compete with man for prey are also very vulnerable. However, within our inventory sites, all of these species were abundant and indicated minimal or no anthropogenic impact.

Because Matsés communities frequently relocate (Figure 13, p. 217), habitat within the Matsés region has remained almost entirely intact. Any habitat loss and deterioration would almost certainly most strongly impact habitat specialists, such as Goeldi's marmoset (*Callimico goeldii*) and the red uakari monkey (*Cacajao calvus*) whose populations are already vulnerable to extinction.

Conservation opportunities

This region supports one of the most diverse communities of mammals in the Amazon, probably a function of the great soil and habitat heterogeneity. The Matsés people are extremely knowledgeable about this diversity and their territory's resources. They identify with their forests; this is an advantage when it comes to working with local inhabitants on flora and fauna management.

The isolation of the Matsés territories, and the long travel distances from large cities and towns has greatly diminished the threat of commercialization of bush meat. Currently, almost all of the meat is used for subsistence consumption (Figure 10C). Given the great abundance of hunted mammal species in the region, it will be important to protect and zone certain areas to create a mosaic of sink and source populations.

Recommendations

Protection and Management

We recommend designing and implementing a faunal management plan in which agreements are made with the community for implementing sustainable hunting, monitoring, and collecting biological data on hunted species (productivity, density, habitat preference).

In addition, we recommend establishing a strictly protected area where hunting is prohibited; this would help areas adjacent to hunting areas recuperate their game populations.

Research

Further research is recommended to determine the area's alpha and beta diversity, and the potential presence of small, endemic mammals in the varillal habitat. As was previously mentioned, the Tapiche and Blanco rivers represent the northern distribution limit of some primate taxa, which could indicate that it is an important speciation area.

Cacajao calvus and *Callimico goeldii* appear to occur in the Matsés territory, but were not observed during our inventory. It will be important to conduct longer, more elaborate inventories to understand their distributions within the area, and patterns of habitat use.

History of the Region and Its Peoples

TERRITORIAL HISTORY OF THE MATSÉS

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INTRODUCTION

The Comunidad Nativa Matsés possesses important assets that will facilitate their management of a protected area. In this chapter, we will focus on the territorial history of the Matsés and discuss how these assets have developed and evolved in the last 30 years. We will reveal how their past history of population resettlement and social organization relates to the management of natural resources, and influences their present political organization.

In 1970, anthropologist Luis Calixto began his long-term stay with the Comunidad Nativa Matsés in Peru. Since then, he has produced several documents that describe the modes of production and consumption, geographic resettlement, kinship ties, and political organization of the Matsés in the last 34 years. Although most of the information provided in this chapter reflects the social inventory team's direct observations of the present situation and conversations with members of the community, much of the context is provided by the ongoing work of Luis Calixto.

BEFORE CONTACT

Responding to pressures from the *shiringueros* (rubber tappers), many Matsés resettled in various sites within Amazonia, until they reached the Río Yaquerana around 1905. During this time, the groups likely settled along riversides to harvest resources found near the water, such as the *taricayas*, or river turtles. Using birth dates and abandoned *purmas* (fallow lands), we can estimate that since 1905, the Matsés have relocated every three to five years to start a new *chacra* (plot of cultivated land) and find new hunting grounds when medium-size animals became scarce. More sudden relocations occurred when an important relative died or other people, including other Matsés groups, threatened the Matsés.

PERIOD FROM 1969-1979

From August 1969 to August 1970, extended families of Peruvian Matsés lived in two general areas: one where contact was made in 1969, downriver from the present settlement of Puerto Alegre along the Río Yaquerana; another close to the right bank, upriver along the Quebrada Añushicayu (Figure 13).

On August 30, 1969, two representatives of the *Instituto Lingüístico de Verano* (ILV, Summer Institute of Linguistics) made their first contact with the Matsés on the Río Yaquerana and later (1970) on the left riverbank of the *Acte Dada* (big stream in Matsés), near the right bank of the Quebrada Añushiyacu. This settlement was known as “Yaquerana”. The ILV built an airplane runway by the Río Yaquerana, where they decided to settle. After the construction of the runway, several large Matsés families who had previously lived farther away began to concentrate near the ILV, staying there longer than the norm for those times. In 1973, the Ministry of Agriculture of Peru reserved 344,687 ha of land for the Matsés—the first time the group was granted land rights by the Peruvian government.

The Yaquerana group remained near the ILV site for almost 11 years, drawn to the Institute’s gospel and educational projects. During those years, a Major Chief—known as *Chuiquid tapa*—served as the link among the various individual family chiefs. The *Chuiquid tapa* determined the activities that affected the whole group. Since then, Luis Calixto has documented how the Matsés adjust their social organization in response to interactions with the external society.

By the end of the 1970s, this group consisted of around 500 to 600 people, divided into about 22 large families, each with its own family chief and large house or *maloca*. Before the end of the decade, some of these families started to move to other places: southeast, to the Quebrada Santa Sofía, a tributary of the Yaquerana Medio; while others, known as the Dunú group, went northwest, to the Río Gálvez, establishing the settlements of Buen Perú and Remoyacu.

The groups of large families who settled along the Quebrada Santa Sofía and others who appeared in

the Bajo Yaquerana (San José) by the end of the 70s made contact with a second missionary group known as *El Faro*. At that time, the Ministry of Education helped *El Faro* hire *mestizo* evangelical teachers to encourage educating the Matsés only in Spanish. Due to the influence of these evangelical teachers, the three settlements were named Santa Sofía, San Juan and San José.

PERIOD FROM 1980-2004

Due to several internal as well as external factors, the four above-mentioned residential groups began to relocate in 1980. These are the Yaquerana group, Dunú group, Santa Sofía and San José, some of whom settled along the Quebrada Chobayacu, and others on both sides of the Río Gálvez. Some common causes for their migration include conflicts with relatives, death of relatives, conflicts with Brazilian communities, search for game animals, pressures by traders, surveillance/control along the border with Brazil and commercial dealings with foreigners.

In February 1981, part of the Yaquerana group decided to move to the lowest part of the left side of the Quebrada *Cute Nēnete*, naming the new place *Chëshēmpi* (meaning “black” in the Matsés language) for its black waters. *Chëshēmpi*, a settlement with high population density, remained in that location for only three years, possibly because it proved impossible to build an airport for the ILV. During that same year, another part of the Yaquerana group settled in the neighboring Quebrada Chobayacu, naming the place *Matied Chuca*. After another airport was built at that location, the settlement became known as Buenas Lomas, and then Buenas Lomas Antigua.

The *Chëshēmpi* group founded the settlements of Buenas Lomas Antigua, Buenas Lomas Nueva, Estirón, and Santa Rosa; the Santa Sofía group founded the villages of Paujil and Nuevo San Juan; and the San José group founded San José de Añushi and Nueva Choba (the latter eventually moved to the Río Ucayali). Conflicts within the Remoyacu group, one of the groups that reached the Río Gálvez in 1979, motivated a subset of families to colonize settlements in Siete de Junio.

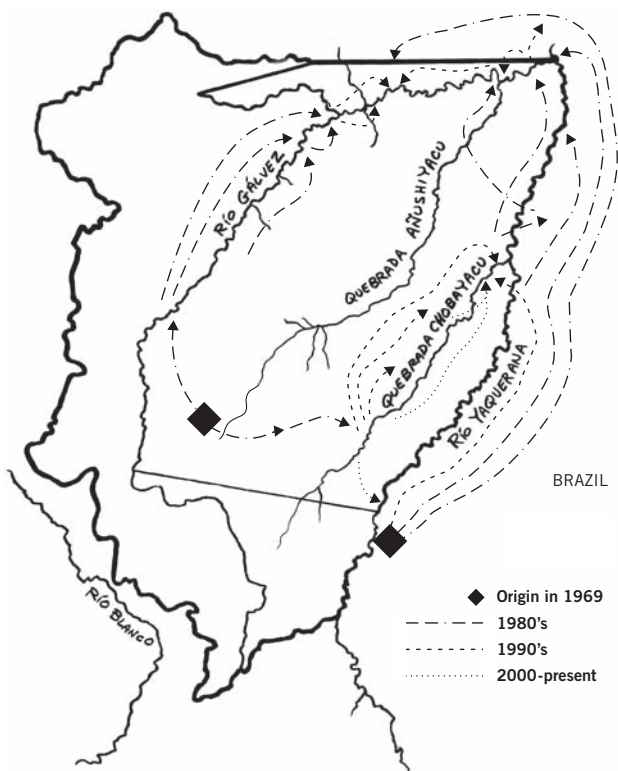
These groups were later incorporated into the Buen Perú group and eventually into Jorge Chávez and San Mateo. The Jorge Chávez group was formed as a result of a familiar split in the settlement of San José de Añushi between the former members of the old village of Siete de Junio who had settled in Buen Perú. All the groups mentioned are settled within the communal territory, except for the settlements of Las Malvinas and Fray Pedro, which are located along the upper Yavarí river.

RESETTLEMENT PATTERNS

The map below identifies the movements, sequence, and geographic routes of the known Matsés resettlements (Figure 13). These resettlement patterns are important as a context for how the Matsés currently organize themselves.

Although in the 70s there were eight migration movements, the map highlights the migration waves that correspond to three periods: the 80s, the 90s and the

Figure 13. Map of movements of Matsés groups since 1969. Data compiled by L. Calixto M.



early years of 2000. The 80s were the years with the most movement and resettlement of the Matsés groups —with 14 different relocations, followed by seven relocations in the 90s and only three between 2000 and 2004. As the Matsés families moved from central forested areas to the riverside, groups in riverside settlements in turn relocated to areas between the riverbanks. The frequency of Matsés resettlement has steadily decreased. Most settlements, known currently as *Anexos* within the new Matsés governance structure, have remained at their present location for at least seven and up to 26 years, which is a much longer period than the 3-5 year resettlement frequency common before contact with the ILV. The permanence of the *Anexos* may be related to the construction of more permanent school buildings built with cement, although this is likely not the only factor underlying their greater permanence in a single location. For example, in Santa Rosa, although the *Anexo* remained in a single location for 15 years, they abandoned the site in 2004 following the death of several family members, despite the construction of permanent school structures.

Matsés migration patterns have contributed to the protection of natural resources within the Comunidad Nativa Matsés, particularly near the Río Gálvez. Since the early 80s, the Matsés presence near the Río Gálvez has formed a protective barrier against negative impacts on natural resources by *mestizos* from the nearby villages of Colonia Angamos and Requena. The need for the Matsés to safeguard their resources within the Comunidad Nativa may be another factor underlying the permanence of the *Anexos*, particularly on the riverbanks of the Río Gálvez.

Over time, the number of Matsés settlements has increased. Before 1980, only two Matsés groups were known. They were composed of several large families that, as we have mentioned, may have remained together because of the presence of missionaries. Today, there are 13 *Anexos* within the communal territory, a fourteenth one applying for *Anexo* status, and two additional groups, Las Malvinas and Fray Pedro, close to the district capital, Colonia Angamos.

Changes in the community's social organization have accompanied the resettlement patterns described above. The resettlement patterns of the 80s, for example, may have initiated a trend of individualism in the decision-making processes about resource use. This trend was later reversed with the formation of the communal administration, known as the *Junta Directiva*. Despite numerous resettlements and the potential for isolation of the settlements, the groups have remained connected by strong kinship ties. The inter-group dialogue, forged on these kinship relationships, has played and continues to play an important role in resolving conflicts and making decisions about territory and resource management.

GROUNDS FOR ENTITLEMENT AND REORGANIZATION OF THE TERRITORY

Throughout their history, the Matsés lifestyle has revolved around small-scale subsistence resource use. Since the times when the Matsés and other indigenous groups were pushed deep into the Amazon forest by the *shiringeros* and other groups, the Matsés have relocated their communities in response to political, social, and economic pressures by outsiders.

Since the mid 1990s, timber dealers and traders have attempted to extract timber resources for commercial purposes within the Comunidad Nativa Matsés. In the same way that external forces motivated the Matsés to seek title to their land in 1973, these same forces have promoted efforts to create a social organization to confront these threats.

The Comunidad Nativa Matsés was granted legal title to its lands in 1993, with support from the Centro para el Desarrollo del Indígena Amazónico (CEDIA). In 1995, strong pressure by timber dealers and traders began to affect the community. For example, when the Matsés community members traveled to Colonia Angamos, the traders would take advantage of the opportunity to offer money or merchandise in exchange for permission from those Matsés individuals to enter the community and extract timber. When those individuals returned to their

settlements to consider those offers together with the rest of the Matsés, conflicts of interests arose regarding the use of the territory resources, especially as many felt decisions should not be made by only a few people.

In addition to outside pressures, there are internal pressures as well. Younger Matsés are increasingly interested in leaving the community to move to more populated centers such as Requena and Iquitos, in the hopes of improving their quality of life there. In the last 20 years, the Matsés have been learning how to manage internal and external forces that challenge their current lifestyle. In the last three years, they have formed the *Junta Directiva* and the CANIABO Youth Association to address these issues.

The *Junta Directiva* was created to administer community relations with outsiders and the CANIABO Youth Association was created to reinforce Matsés values and to train future leaders. These two social organizations form key assets in the communal decision-making processes and formal administration of the Matsés territory. With these legal, political, and social tools, the Comunidad Nativa Matsés faces the future with a solid aim towards ensuring the well-being of its members and its lifestyle (Figures 11A, D, F, G, I).

SOCIO-CULTURAL ASSETS OF THE COMUNIDAD NATIVA MATSÉS

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Assets and Conservation Targets: High organizational capacity for managing a protected area; economic activities and production methods of the type and scale that are compatible with conservation; in-depth cultural knowledge of the environment, including *varillales* (white-sand forests); commitment to value conservation and sustainably use natural resources; source areas of plants and animals highly important to the Matsés

INTRODUCTION

In this chapter, we would like to highlight those characteristics of the Comunidad Nativa Matsés that constitute the assets they have to manage a protected

area (PA). By describing the cultural values, socio-political organization, decision-making mechanisms, and vision for the future of the Matsés, we will be able to understand better how the community will manage its territory as a Reserva Comunal.

ASSET-MAPPING APPROACH

The principal objective of the socio-cultural inventory team, which included CEDIA, representatives of the Comunidad Nativa Matsés, and The Field Museum, was to identify the socio-cultural assets of the Comunidad Nativa Matsés.

What are socio-cultural assets? These can include, among other aspects:

- 01 Tangible indicators of people's capacity to organize; for example, the existence of civic organizations, modes of governance, and institutions such as schools, churches, etc.;
- 02 How the population organizes itself socially; for example, social kinship ties, marriage ties, friendships, and associations that exist not only within communities, but also between the community and outsiders; and
- 03 Attitudes and values that people have regarding natural resources and the use of those resources (Figures 10C; 11F, I).

These three aspects of the socio-cultural assets are intimately related, but it is important to remember that identifying assets is only the first step in a longer process of cultural changes and strengthening social relations. Simply identifying the socio-cultural assets is not enough in itself; it is important to understand how they function, and for what ends they have been—and can be—used. The assets approach is powerful when used to identify and strengthen the community's capacity to work toward conservation and sustainable use of its natural resources. An asset-based approach can identify existing tools with which a community can reach their objectives by further developing and

strengthening their existing leadership capacity, social organization, and channels of communication.

METHODS

The socio-cultural inventory of the Comunidad Nativa Matsés was carried out between October 25 and November 5 in seven of the 13 *Anexos* (human settlements inside the Comunidad Nativa; Figure 11E). The team conducted *Talleres de Información, Capacitación, y Consulta para el Establecimiento de un Área Natural Protegida* (Workshops focusing on Information, Training, and Consultation about the Creation of a Protected Area) in two of the seven *Anexos* that were visited. The workshops were carried out October 25-26 in San José de Añushi, situated along the Río Gálvez; and November 2-3 in Buenas Lomas Antigua, situated along the Quebrada Chobayacu.

The workshops were attended by community members from San José de Añushi and Buenas Lomas Antigua, community leaders and delegates from neighboring communities, bilingual professors, health practitioners, a representative from INRENA, a representative of the Regional Government of Loreto, and two representatives of ORAI, the regional AIDSESEP organization.

The workshops were carried out with the following objectives:

- 01 Explain the Rapid Biological Inventory process;
- 02 Provide information regarding the different categories of natural protected areas; and
- 03 Foment a reflective process that respects the time necessary for the Comunidad Nativa Matsés to make an informed decision regarding the most appropriate level of protection for the protected area.

The *Anexos* of San José de Añushi, Paujil, Jorge Chávez, Remoyacu, and Buen Perú were visited between October 25-31, and visits to Buenas Lomas Antigua and Buenas Lomas Nueva took place between November 2-5. During these visits, the team systematically

observed the daily life of the community, conducted structured interviews and informal conversations with community leaders and other key people, organized focal group meetings, attended community meetings, worked with community members in developing resource use maps, and visited community members' homes and *chacras* (agricultural plots). As a whole, these efforts sketched a preliminary portrait of the socio-economic assets of the Comunidad Nativa Matsés.

RESULTS

Demographic information

The Comunidad Nativa Matsés has an estimated population of 1,700 people distributed among 13 *Anexos* (Appendix 7; Figure 11E). These *Anexos* originated from previous settlements formed in the course of the last 30 years. In 2001, 12 settlements existed, and by 2003, a new settlement, Puerto Alegre, was created.

The *Anexos* we visited share several general settlement patterns—almost all have 20-50 rectangular houses that are elevated above the ground and built completely from forest resources, and include an indoor or outdoor kitchen. The homes tend to be clustered, sometimes with only a few meters between them (Figure 11E). The majority of the *Anexos* have cement sidewalks and a cement sports field. Other shared physical characteristics of the *Anexos* include soccer fields; cement schools, ports, and landing docks along the rivers; rafts made of part wood and part metal; and covered bridges.

Socio-cultural assets of the Matsés native community

Assets consist of the socio-cultural characteristics of a community that are compatible with conservation and sustainable use of natural resources, such as the organizational capacity to manage a natural protected area, and particular attitudes and cultural values that encourage sustainable use of natural resources. During our inventory, we identified—together with members of the Matsés community—five principal assets, including: political organization, low impact of

production activities on natural resources, strong kinship ties, substantial traditional knowledge of the forest, and a strong desire to maintain their Matsés identity. In the following paragraphs, we highlight each asset and explain how they coincide with conservation and sustainable use objectives.

1. Political organization

The Comunidad Nativa Matsés has invested tremendous efforts in recent years towards constructing a new governance structure, one that is best suited to meet the needs of each *Anexo* as well as those of the represent the community as a whole. The result has been the creation of three key organizations: i) the *Junta Directiva* (Board of Directors); ii) the *Juntas de Administración* (Administrative Boards), and iii) the CANIABO Association.

The first *Junta Directiva*, elected in 2001, was created to represent the community as a whole, including all of its *Anexos*, or settlements. In its first four years, the *Junta Directiva* has concentrated its efforts not only in addressing issues internal to the community, but also to addressing external conflicts pertaining to the commercialization of natural resources (such as timber, and the fishes *paiche* and *arahuana*) from within the Comunidad Nativa Matsés by outsiders. The current *Junta Directiva* has a Chief, Sub-Chief, Secretary, Treasurer, and two assistants, and its *Estatutos*, or Statutes, define the roles and responsibilities of the *Junta Directiva* members.

The *Juntas de Administración* were created to represent each individual *Anexo*, and the roles of each *Jefe de Anexo*, or settlement Chief, are described in the *Reglamento Interno*, known to the Matsés as *Nuqui Natequid Nabanaid* (our way of governing). This Reglamento defines the way new authorities are chosen, the institutional relations between *Anexos* via their *Juntas de Administración*, and their interactions with the *Junta Directiva* of the community and vice versa.

It is important to recognize the tremendous effort that the Matsés have put towards re-structuring their governance system; the process itself, described

below, demonstrates the community's capacity to face changing circumstances while continuing to transmit the values that sustain their lifestyle through their own norms and traditional customs.

The political re-structuring process started in 2000 with a joint initiative by the Matsés and CEDIA. In previous years, Luis Calixto Méndez, an anthropologist with CEDIA, had started the process of training secondary school students from various Río Gálvez schools on issues such as legal frameworks applicable to native communities, environmental education, Amazonian socio-linguistics panorama for Peru; and community building. These trainings incorporated social and physical sciences within the environmental curriculum. During these training sessions, the most interested students were recruited to participate in the second phase of the political re-structuring. These committed students initially became known in the community as *monitores*.

Once trained in community governance issues, the seven young men assumed the role of *promotores* during the second phase, and with subsequent help from each settlement's school teachers and the CEDIA social promotor (a Matsés), they translated and transmitted the contents of the new governance model—the Reglamento Interno—with the goal of presenting preliminary draft proposals to each *Anexo*. During meetings held at each *Anexo*, the articles of the Reglamento Interno were presented, and members of each *Anexo* analyzed and discussed the contents before approving the wording. After the school teachers and *promotores* obtained approved drafts of the proposed Reglamento from each *Anexo*, they met with all community leaders in San José de Añushi, where they confirmed each *Anexo's* approved texts in the *Libros de Actas de Asambleas Locales*.

Once the Reglamento Interno was approved, each *Anexo* began to elect their first Junta de Administración as well as its delegates—according to the percentage of qualified community members in each *Anexo*—before the *Asamblea General de Delegados* of the community. Once elected, the delegates gathered in Remoyacu during three days in August 2001 to discuss and subsequently approve a draft *Estatuto de la*

Comunidad. With the Estatuto approved, members of the first *Junta Directiva* were elected. From that moment on, two “popular versions” of the Reglamento Interno were written, without numbered articles and using commonly used Spanish and Matsés terminology. Only after this final analysis and revision was the Reglamento Interno approved.

Our description of the political re-structuring process highlights the participatory mechanisms that were respected at each phase. Not only were all members of each settlement consulted regarding the new organizational structure, but the local communication norms were respected to ensure a thorough understanding of the Reglamento Interno and Estatuto by all Matsés. With the new organizational structure, the community can now rely not only on a governance model that functions at the level of each *Anexo* to resolve issues that affect each settlement, but also rely on a macro structure that functions at the community-level to manage interactions between the Matsés and loggers, traders, and other groups.

There are two decision-making mechanisms that function at the level of each *Anexo*. The first is traditional, in which kinship and marriage ties come into play when deciding to carry out specific activities such as hunting and use of agricultural areas. The second involves the participation of all the members of a given *Anexo* through discussions that lead to consensus regarding use and management of natural resources, construction of homes and community buildings, the cleaning/clearing of paths in residential areas, opening of family agricultural plots, immigration control, and community rights and responsibilities. The leaders of the *Anexos*, known throughout the community as *Chuiquid*, interact with the population of their *Anexo* not only through daily family gatherings, but also at least once per month for scheduled assemblies.

Issues that are of importance to the entire community are discussed in a general assembly of delegates, which is convened by the community chief, *Chuiquid tapa*, three times per year. During the first three

years of this organization, issues of great importance have been discussed in these gatherings. For example, the delegates have addressed issues of expansion of their territory, creation of a natural protected area, community organization, legal instruments regarding indigenous communities, natural resource management (particularly fauna and forest resources), *Reglamento Interno* (community rules and regulations), community statutes, strategic development plan, and personal identification documents.

With the recent creation of this new political organization, the Comunidad Nativa Matsés is becoming familiar with the social and legal tools necessary to promote their cultural, political, and economic interests. Such is the case with control over commercial forest resources (such as the timber trees *cedro* and *caoba*). For example, in order to respond to local groups and foreign traders that harass local authorities with the aim of fostering illegal extraction of forest resources, the *Chuiquid tapa* have organized to meet with each other to develop a strategy, instead of each one responding separately. In addition, they meet to discuss other issues that affect many or all *Anexos*. Community members know that a participatory process needs to be undertaken in order to gain knowledge about the potential of their forest before extracting forest resources. The community is also conscious that young Matsés have to be trained as leaders, in order to preserve cultural, political and economic values.

The third newly created organization in the Comunidad Nativa Matsés is the youth association known as CANIABO (“young people” in Matsés). According to its statutes, the main objective of this association is the training and capacity building of young people so that they can comprehend and contribute to the cultural and social development of the Matsés. The association’s members, normally youth aged between 15-30 years, share the following objectives:

- 01 Build leadership and organizational capacity of youth,
- 02 Promote the development of the individual and the Matsés community,

- 03 Teach and reinforce the Matsés cultural values, and
- 04 Actively contribute to the formation of the indigenous identity.

Although the Association was formed in 2002, its judicial recognition was not approved until 2004. In developing a set of statutes for the Association, the founding youth translated the statutes into a popular language, as was the case with the development of the *Junta Directiva* norms, with the aim of reaching out and gaining new members that share the goals.

With these three new organizations—the *Junta Directiva*, the Juntas de Administración, and the Youth Association (CANIABO)—the Comunidad Nativa Matsés is prepared to not only manage a protected area, but also ensure the participation of all members in their decision-making processes.

2. Low impact on natural resources: settlement pattern and modes of use

Although settlement patterns for the Matsés have changed over the years, small groups still maintain a low impact on the natural resources of the region, and this constitutes an important socio-cultural asset. As was explained in the section *Territorial History of the Matsés* (see p. 213), the Matsés maintained small settlements of 30-60 people per *maloca* (large houses separated from one another by varying distances) for many generations. The existence of small group sizes has been documented since 1969 by Luis Calixto and corroborated by other reports (Bodmer and Puertas 2003).

A second aspect of the settlement pattern that constitutes an asset pertains to the frequency with which each human settlement relocates, and their reasons for doing so. The relocations of the Matsés populations in the last 30 years can be seen in Figure 13 (p. 217). Although the principal motives for the relocation of the settlements has not been a lack of animals to hunt, it should be noted that the fact that they have not remained in one place very long has contributed to the regeneration of soil and repopulation of the wildlife

species hunted in the region. Therefore, if the Matsés population is able to remain stable as it has during the last 30 years, this aspect of their lifestyle will continue to be a great asset.

Although at present it is not possible to estimate the future duration of each settlement (Figure 13), it is important to note that the period of settlement that occurs today does differ from the pre-1969 period. The difference in this estimate is not based on the causes of relocations—which may remain similar to previous times—but rather to various factors that groups take into consideration when deciding to move slowly or abruptly. For example, the presence of basic services such as schools, clinics, community buildings, sports fields, bridges, radio antennas, churches, etc., may affect these decisions. To illustrate the variations of Matsés resettlement patterns, we may compare the relocations of the group that came from the Yaquerana with the resettlement of the group that came from the Río Gálvez.

The Yaquerana group took on the name *Chëshëmpi* (meaning black) in 1980 upon moving to the stream that contained blackwater, where they remained for only three years; the Yaquerana relocated in 1983 to another zone that they called *Matied Chuca*, and subsequently Buenas Lomas. In 1994, 14 years later, part of that group relocated and gave rise to the settlements of Buenas Lomas Nueva and Santa Sofía Nueva, and members of the original group that remained in Buenas Lomas changed their settlement's name to Buenas Lomas Antigua. Only eight years later, in 2002, a second segment of Buenas Lomas Antigua relocated again to the Yaquerana, referring to their settlement as Puerto Alegre. In this example, we can note the high frequency with which the group has relocated for various reasons in the past three decades. In contrast, the group from San José de Añushi relocated in 1979 from the Yaquerana to the Gálvez, and still continues to live there after 25 years. What might these differences in resettlement patterns be attributed to?

The first group mentioned above, which claimed (at different times) the names of Yaquerana-*Chëshëmpi*-Buenas Lomas, constituted a large population of over

500 people, and had they not resettled as frequently as they did, the wildlife resources may have been overused. The group from San José de Añushi, on the other hand, has only 67 people at present. The population dispersion of the groups and the number of houses is understandable because they have originated from the division of extended families, some of which have resettled to previously-settled areas, as was the case with the old *Chëshëmpi* that gave birth to the settlement of Buenas Lomas, and subsequently Buenas Lomas Nueva, Estirón, Santa Rosa, Puerto Alegre, Buen Perú and Remoyacu.

The population growth in these groups may be estimated by the amount of group names that can today be found along the Yaquerana, Gálvez and Yavarí rivers, as well as the Quebrada Chobayacu. However, it could also be considered that this expansion of families seeks only to recuperate historic sites that allow them to satisfy vital needs and continue to practice their subsistence lifestyle. A future study of the reconstruction of extended families and how frequently they return to previously populated areas may confirm this hypothesis. Beyond the frequency of their resettlements, it is also important to recognize that their methods of natural resource extraction are compatible with sustaining those resources.

In each *Anexo* of the community, members live to a large extent on meats from forest animals and some agricultural products, such as corn, manioc, and plantains. The Matsés still maintain their traditional knowledge of hunting with bow and arrow, and teach their children how to hunt beginning at two years of age. This method, apart from being beneficial to them because of relying solely on forest resources as opposed to monetary resources for the purchase of bullets and rifles, tends to accompany a low scale of resource consumption. When a member of the Matsés community goes hunting with a bow and arrow, he tends to take only 3-5 arrows. In addition, since the method is very silent, particularly when compared to the sound of a rifle, the use of bows and arrows does not scare the remaining wildlife away, thereby allowing them to continue having animals living in close proximity to each *Anexo*. It is important to mention that although this benefit of using a bow and

arrow could be interpreted by some as accompanying higher scales of consumption due to the silence and convenience of the method, this is not the case with the Matsés because they value a more rational use of their natural resources as a means to satisfy their hunting needs for subsistence consumption or local market trade. It is clear, therefore, that the reduced size of some of the *Anexos* as well as the hunting methods help to maintain a low impact of the human Matsés community on the natural resources of the region.

3. Strong maintenance of kinship relations

Kinship ties represent two important assets of the Comunidad Nativa Matsés (Figure 1). The first exists at the community-wide level, as the ties between the different *Anexos* serve as channels of communication and conflict resolution; kinship ties strengthen the Matsés' new social organization, maintaining the *Anexos* connected in spite of their geographic distribution (Figure 13, p. 217 in Territorial History of the Matsés).

The second asset exists at the level of each *Anexo*, as kinship ties between families facilitate the redistribution of wildlife meat, which implies an effective and efficient use of the resource and therefore contributes to the low impact over the natural resources. For example, during our visit to San José de Añushi, the meat from a caiman fed not only a few families, but also members of the social inventory team. In general, when an animal is hunted, the meat can be shared with the closest relatives. If family members did not share meat in this way, it is likely that wildlife resources would not be used as efficiently due to lack of storage capacity. In addition, other family members who didn't receive a share of the meat supply would face the need to hunt more frequently.

In closing, it is important to recognize that in spite of the sedentarization process that the Matsés have experienced, with settlements now remaining in one place for longer periods of time (7-26 years) than before contact by missionaries (3-5 years), kinship ties continue to be important channels of communication and redistribution of resources. The permanence of these

assets illustrates some of the capacities and resilience that the Matsés have of maintaining family and economic values even during times of important cultural changes.

4. Knowledge and use of the forest

The Matsés have always traveled across their territory in search of natural resources. Even today, every large family walks along its paths to gather resources and in this way obtains information about the present state of the forest. After countless generations of living with the forest, the Matsés have developed a detailed knowledge of the natural resources located within the boundaries of their territory (Figures 10C; 11E, I).

Since the Matsés have settled down on the banks of rivers and streams, their use and management of resources has guided their itinerary upstream or downstream as they have searched for animal and plant resources in the forest. Animals like the collared peccary, or *sajino*, and the white-lipped peccary, or *huangana*, which are species used for food and local trade, tend to be far from the villages for most groups, and in those cases the hunting can take from one to several days, depending on the prey. When parents wish to feed their children they can choose to go hunting for a short period, but in the case of commercial hunting, they move to *colpas* (clay licks) that are far away and it can take them five to ten days to obtain meat.

It is clear that, due to the permanent contact of the Matsés with the environment and the accumulated knowledge that has been handed down from one generation to the other, current members of the community know their territory very well. Indeed, when the team of the biological inventory presented with enthusiasm the features of the territory, like the fragile *varillales* (white sand forests) of a high biological value, a community elder present at that presentation revealed that his grandparents had always warned not to work in the "white sands" because productivity and fauna abundance were low. This example highlights ways in which scientific and indigenous knowledge can complement each other well, contributing to an in-depth understanding of the natural resources of a given area.

5. *Desire to keep the Matsés identity and a vision of the future*

Since the Matsés began their permanent contact with the external society in 1969, they have struggled to maintain the use of their language in the face of pressures to speak Spanish. They were advised by the *Instituto Lingüístico de Verano* (ILV), which trained the first teachers that were then acknowledged by the educational sector, to establish a bilingual educational system. Today, all the schools within the community are bilingual and the Matsés language is spoken more than Spanish in all the *Anexas*. In more isolated *Anexas* that have less interaction with external society, like the groups living in the Quebrada Chobayacu and the Alto and Bajo Yaquerana, only a few speak Spanish; unlike the settlers of Gálvez and Alto Yavarí rivers that use this language in their commercial dealings with the mestizo population of Colonia Angamos.

The language itself has cultural value since it features the Matsés as a unique ethnic group (Figures 11A, D). However, the importance of the language beyond the benefits of cultural diversity pertains to the above-mentioned environmental knowledge that is encapsulated in Matsés words. For this reason, the Matsés language is a matter of importance for the protection of the environment as it contains the knowledge of generations of community members regarding the natural resources and their use (Shiva 2000). The demonstrated interest by the Matsés in maintaining their language can therefore be recognized as highly valuable for the sustainability of their environmental resources.

THREATS, OPPORTUNITIES, AND RECOMMENDATIONS

Threats and challenges

Since the 90s, the Matsés youth—eager to know more about the external world—have left the community in search of jobs to live in populated centers such as Soplín-Curinga, Requena, and Iquitos. In addition, the professors that work in the Comunidad Nativa Matsés spend their vacations in those populated

centers, particularly in the city of Iquitos. These experiences that take place out of the community constitute a high degree of vulnerability to the Matsés, since their values that are compatible with a sustainable future are exposed to the pressures of material consumption and offers of important levels of extraction of their natural resources. Where does this vulnerability come from?

When the Matsés young people leave the community and find a job in a more populated center, traders and timber dealers who are continually seeking sources of suitable natural resources for their commercial extraction easily identify them. Since 1993, when the Ministry of Agriculture granted the possession of the territory to the Comunidad Nativa Matsés, these lands have been known in the region as a major source of wood to be exploited. Commercial loggers have tried in numerous occasions to enter the Comunidad Nativa Matsés to extract timber resources, and each time they have been expelled by the Matsés leaders who consider that these offers are not prudent; the Matsés lifestyle depends on forest resources, as well as their knowledge of the requirements imposed by the Peruvian government for its exploitation and commercialization.

In this way, timber dealers who offer them money in exchange for an informal “permit” to extract the community’s timber resources constantly tempt the Matsés who go to the mestizo centers of population. Some of these offers have advanced more than others, but they have always been intercepted in time to prevent foreigners from exploiting the community resources illegally.

When young people, who see the difficult reality of the external society, return to the community, they begin to appreciate the Matsés lifestyle in new ways. The difficulties they have to go through in the cities—working schedules, job hierarchies, increasing workload, food and housing expenses, lack of social ties and the sterile urban landscape—usually represent an important change for youth who reach the conclusion that they would be better in the community. However, upon returning, they usually refer to their experiences in the external world in an absolutely positive way,

without commenting on the difficulties they had to overcome. This one-sided reflection of a complex experience leads other young people to think that life is better outside, nurturing in this way their aspirations to leave in search of something more.

In the future, population growth into and out of the community will aggravate pressure for natural resources and will deepen their vulnerability. With more commercial loggers pressing young people for permission to enter the community for illegal timber extraction, the extraction of natural resources is likely to increase. Matsés population growth will intensify the impact on natural resources, which may mean that more young people will be going to the mestizo centers of population, thus increasing the probabilities of collaborating with commercial loggers. For these reasons, controlling population growth will represent an important challenge for the Matsés. However, if the population of the Comunidad Nativa Matsés remains relatively stable, as it has been for the last 30 years, and their members continue reinforcing the cultural values that confer dignity to the low consumption of natural resources, future Matsés generations will be able to continue living off of the forest resources and ensuring their well-being according to their own quality of life standards.

Recommendations

Taking into account the strengths identified in our fieldwork, the socio-cultural inventory team recommends:

Support to the communal organizations

In order to counterbalance the pressures that we have already mentioned, the Matsés will need financing for the logistic and communication expenses incurred by the Junta Directiva and the CANIABO Association. It might be possible to obtain an income from the sale of handmade items in the mestizo centers. Another possibility could be to reduce the need of buying goods when they could be produced in the community.

Several women have expressed their wish to revitalize the production of handmade crafts as an

explicit way of reducing the trade of wildlife hides in order to cover their consumption needs. This desire can be seen as a wish to keep their customs and identity, together with a small scale economy, giving at the same time support to the *Junta Directiva* of the Comunidad Nativa Matsés.

Therefore, we recommend

- Continue strengthening the organization of the community and its *Anexos*.
- Ensure financing for their activities and logistics (at first from international funding sources and by the development of their own activities, such as handmade crafts).

Ensure that the Matsés administrate the protected area

- Involve the Jefe and the *Junta Directiva* of the Comunidad Nativa Matsés in the creation and management of the protected area.
- Incorporate the tradition of walking their forests as a means of protecting the protected area, so that they continue walking their territory in the same way they have been doing for generations.
- Involve youth in the management of the protected area through the CANIABO Association.

To continue the development of educational programs

- Incorporate knowledge of the forest to the educational materials used in the Matsés *Anexos*
- Prepare educational materials in Matsés about the results of the inventory and their forest resources.
- Reinforce the education of both teachers and students regarding traditional knowledge, and exchange with elders in order to reduce the division between formal school education and informal indigenous knowledge.
- Strengthen similar initiatives to the ones encouraged by professor Noyda Isuiza Guerra, by systematizing her methodology to be established in schools in the long term.

To monitor and reduce the impact of pressures by external society

- Establish a Matsés house in Iquitos for teachers and members of the community to stay in to reduce the pressure they feel from commercial loggers and traders during their visits to the city, and
- Train teachers so that they can give support to the *Junta Directiva*

To strategically plan the management of natural resources

Develop a natural resource management plan in the Comunidad Nativa Matsés with the support of the WCS and other committed institutions, so that the use of their resources and the Matsés subsistence lifestyle are sustained (Figures 11A, D, F, G, H, I).

