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PARTICIPANTS

FIELD TEAM

Roberto Aguinda L. (field logistics, social inventory)
Fundación para la Sobrevivencia del Pueblo Cofan
Dureno, Ecuador
robertotsampi@yahoo.com

William S. Alversen (herbarium)
Environment, Culture and Conservation
The Field Museum, Chicago, IL, USA
walverson@fieldmuseum.org

Elizabeth P. Anderson (social inventory, fishes)
Environment, Culture and Conservation
The Field Museum, Chicago, IL, USA
eanderson@fieldmuseum.org

Randall Borman A. (large mammals)
Fundación para la Sobrevivencia del Pueblo Cofan
Federación Indígena de la Nacionalidad Cofan del Ecuador
Quito, Ecuador
randy@cofan.org

Ángel Chimbo P. (field support)
Fundación para la Sobrevivencia del Pueblo Cofan
Dureno, Ecuador

Ángel Criollo L. (field support)
Fundación para la Sobrevivencia del Pueblo Cofan
Dureno, Ecuador

Álvaro del Campo (field logistics, photography)
Environment, Culture and Conservation
The Field Museum, Chicago, IL, USA
adelcampo@fieldmuseum.org

Florencio Delgado E. (archeology)
Universidad San Francisco de Quito
Quito, Ecuador
fdelgado@usfq.edu.ec

Sebastián Descanse U. (field logistics, plants)
Comunidad Cofan Chania Na’e
Sucumbíos, Ecuador

Freddy Espinosa (general logistics, social inventory)
Fundación para la Sobrevivencia del Pueblo Cofan
Quito, Ecuador
freddy@cofan.org

Robin B. Foster (herbarium)
Environment, Culture and Conservation
The Field Museum, Chicago, IL, USA
rfoster@fieldmuseum.org

Christopher James (social inventory)
Fundación Jatun Sacha
Quito, Ecuador
courses@jatunsacha.org

Bolívar Lucitante (cook)
Comunidad Cofan Zábalo
Sucumbíos, Ecuador

Laura Cristina Lucitante C. (plants)
Comunidad Cofan Chania Na’e
Sucumbíos, Ecuador

Javier A. Maldonado O. (fishes)
Instituto de Investigación de Recursos Biológicos Alexander von Humboldt
Villa de Leyva, Colombia
gymnopez@gmail.com

Jonathan A. Markel (cartography)
Environment, Culture and Conservation
The Field Museum, Chicago, IL, USA
jmarkel@fieldmuseum.org
Patricio Mena Valenzuela (birds)
Museo Ecuatoriano de Ciencias Naturales
Quito, Ecuador
pmenavenezuela@yahoo.es

Humberto Mendoza S. (plants)
Instituto de Investigación de Recursos Biológicos
Alexander von Humboldt
Villa de Leyva, Colombia
hummendoza@gmail.com

Norma Mendúa (cook)
Comunidad Cofan Zábalo
Sucumbíos, Ecuador

Debra K. Moskovits (coordination, birds)
Environment, Culture and Conservation
The Field Museum, Chicago, IL, USA
dmoskovits@fieldmuseum.org

Jonh J. Mueses-Cisneros (amphibians and reptiles)
Universidad Nacional de Colombia
Bogotá, Colombia
jjmueses@gmail.com

Luis Narváez (social inventory)
Federación Indígena de la Nacionalidad Cofán del Ecuador
Lago Agrio, Ecuador
luis.narvaez.feince@gmail.com

Stephanie Paladino (social inventory)
El Colegio de la Frontera Sur
San Cristóbal de las Casas
Chiapas, Mexico
macypal@gmail.com

Patricia Pilco O. (social inventory)
Corporación Grupo Randi Randi
Quito, Ecuador
patypilc@yahoo.es

Susan Poats (social inventory)
Corporación Grupo Randi Randi
Quito, Ecuador
spoats@interactive.net.ec

Amelia Quenamá Q. (natural history)
Fundación para la Sobrevivencia del Pueblo Cofán
Federación Indígena de la Nacionalidad Cofán del Ecuador
Quito, Ecuador

Ángel Quenamá O. (field support)
Fundación para la Sobrevivencia del Pueblo Cofán
Dureno, Ecuador

diego.reyes_jurado@yahoo.com

Thomas J. Saunders (geology, soils, and water)
Environment, Culture and Conservation
The Field Museum, Chicago, IL, USA
tomsaun@gmail.com

Douglas F. Stotz (birds)
Environment, Culture and Conservation
The Field Museum, Chicago, IL, USA
dstotz@fieldmuseum.org

Antonio Torres N. (fishes)
Universidad de Guayaquil
Guayaquil, Ecuador
atorresnoboa@hotmail.com
COLLABORATORS

Cofan Communities of Chandia Na’e, Dureno, and Zábalo
Sucumbíos, Ecuador

Ejército Ecuatoriano
Ecuador

Helicópteros Ícaro
Ecuador

Parroquias Huaca, Julio Andrade, and Monte Olivo
Carchi, Ecuador

Parroquias La Sofía, Playón de San Francisco, and Rosa Florida
Sucumbíos, Ecuador

Sectors La Barquilla and Paraíso
Sucumbíos, Ecuador

Gorky Villa M. (plants)
Finding Species
Washington DC, USA
gfvilla@gmail.com

Corine Vriesendorp (plants)
Environment, Culture and Conservation
The Field Museum, Chicago, IL, USA
cvriesendorp@fieldmuseum.org

Tyana Wachter (general logistics)
Environment, Culture and Conservation
The Field Museum, Chicago, IL, USA
twachter@fieldmuseum.org

Alaka Wali (social inventory)
Environment, Culture and Conservation
The Field Museum, Chicago, IL, USA
awali@fieldmuseum.org

Mario Yánez-Muñoz (amphibians and reptiles)
Museo Ecuatoriano de Ciencias Naturales
Quito, Ecuador
m.yanez@mecn.gov.ec
The Field Museum

The Field Museum is a collections-based research and educational institution devoted to natural and cultural diversity. Combining the fields of Anthropology, Botany, Geology, Zoology, and Conservation Biology, museum scientists research issues in evolution, environmental biology, and cultural anthropology. One division of the Museum — Environment, Culture, and Conservation (ECCo) — is dedicated to translating science into action that creates and supports lasting conservation of biological and cultural diversity. ECCo works closely with local communities to ensure 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, and innovative education programs — to the immediate needs of conservation at local, national, and international levels.

The Field Museum
1400 South Lake Shore Drive
Chicago, Illinois 60605-2496, USA
312.922.9410 tel
www.fieldmuseum.org

Fundación para la Sobrevivencia del Pueblo Cofan

The Fundación para la Sobrevivencia del Pueblo Cofan (FSC) is a non-profit organization dedicated to conserving the indigenous culture of the Cofan and the Amazonian forests that sustain them. Together with its international counterpart, the Cofan Survival Fund, the foundation supports conservation and development programs in seven Cofan communities in eastern Ecuador. Their programs focus on research and the conservation of biodiversity, protecting and titling Cofan ancestral territories, developing economic and ecological alternatives, and education opportunities for young Cofan.

Fundación para la Sobrevivencia del Pueblo Cofan
Casilla 17-11-6089
Quito, Ecuador
593.2.247.0946 tel/fax, 593.2.247.4763 tel
www.cofan.org
FEINCE, the “Indigenous Federation of the Cofan Nation in Ecuador” is the political arm of the Ecuadorian Cofan, representing the five legalized communities in the country—Chandia Na’e, Dureno, Dovuno, Sinangoe, and Zábalо—at the national level. FEINCE works to defend the human rights of the Ecuadorian Cofan as a member of the larger umbrella groups that support indigenous groups in Ecuador: the Confederation of the Indigenous Nationalities of Ecuador (CONAIE) and the Confederation of the Indigenous Nationalities of the Ecuadorian Amazon (CONFENIAE). FEINCE is directed by a board of officers elected by the Cofan community every three years.

Federación Indígena de la Nacionalidad Cofan del Ecuador
Lago Agrio, Ecuador
593.62.831200 tel

**Ministerio del Ambiente del Ecuador**

The Ministerio del Ambiente del Ecuador (MAE) is the national environmental agency responsible for sustainable development and natural resource management. It is the highest authority for issuance and coordination of national policies, rules, and regulations, including basic guidelines for organizing and implementing environmental management. MAE develops environmental policies and coordinates strategies, projects, and programs for the protection of ecosystems and for sustainable use of natural resources. MAE sets regulations necessary for environmental quality associated with conservation-based development and the appropriate use of natural resources.

Ministerio del Ambiente, República del Ecuador
Avenida Eloy Alfaro y Amazonas
Quito, Ecuador
593.2.256.3429, 593.2.256.3430 tel
www.ambiente.gov.ec
mma@ambiente.gov.ec
The Museo Ecuatoriano de Ciencias Naturales (MECN) is a public entity established on 18 August 1977 by government decree 1777-C, in Quito, Ecuador, as a technical, scientific, and public institution. MECN is the only state institution whose objectives are to inventory, classify, conserve, exhibit, and disseminate understanding of the country’s biodiversity. The institution offers assistance, cooperation, and guidance to scientific institutions, educational organizations, and state offices on issues related to conservation research, natural resource conservation, and Ecuador’s biodiversity. It also provides technical support for designing and establishing national protected areas.

Museo Ecuatoriano de Ciencias Naturales
Rumipamba 341 y Av. De los Shyris
Casilla Postal: 17-07-8976
Quito, Ecuador
593.2.244.9825 tel/fax

The Herbario Nacional de Ecuador (QCNE) is a section of the Museo Ecuatoriano de Ciencias Naturales that carries out programs of inventory, research and conservation of the Ecuadorian flora and vegetation. It houses a collection of 160,000 plant specimens and a botanical library of 2,000 volumes. The Herbarium serves as the national center for information on the flora and vegetation of Ecuador, with broad public access, and is among the principal scientific and cultural institutions of the country. It constitutes a public service to scientists, natural resource managers, and students, and makes its voice heard in nationwide forums dealing with environmental and biodiversity issues. In the past two decades the Herbarium has provided training for hundreds of young Ecuadorian botanists, and carried out dozens of intensive botanical inventories throughout Ecuador.

Herbario Nacional del Ecuador
Casilla Postal 17-21-1787
Avenida Río Coca E6-115 e Isla Fernandina
Quito, Ecuador
593.2.244.1592 tel/fax
qcne@q.ecua.net.ec
Instituto de Investigación de Recursos Biológicos Alexander von Humboldt

Instituto de Investigación de Recursos Biológicos Alexander von Humboldt (IAvH) is a private, civil, non-profit corporation linked to the Ministerio del Ambiente, Vivienda y Desarrollo Territorial in Colombia. It was created by law #99-1993, was constituted on 20 January 1995, and it is part of the Sistema Nacional Ambiental (SINA). IAvH is responsible for developing basic and applied research on genetic resources of Colombia’s flora and fauna, and for conducting scientific inventories of biodiversity throughout the entire nation.

Instituto de Investigación de Recursos Biológicos Alexander von Humboldt
Claustro de San Agustín, Villa de Leyva
Boyacá, Colombia
578.732.0164, 578.732.0169 tel
www.humboldt.org.co

Gobierno Municipal del Cantón Sucumbíos

The headquarters of the Gobierno Municipal del Cantón Sucumbíos (GMCS) are located in the community of La Bonita. GMCS was created by legislative decree on 31 October 1955, and published in the official registry #196 of 26 April 1957 (which regulates the juridical and institutional life of the municipality). The Cantón Sucumbíos is located in the northwestern corner of the Sucumbíos Province in northern Ecuador, on the border with Colombia. The Cantón (County) is the oldest in the province and was established in 1920.

Gobierno Municipal del Cantón Sucumbíos
La Bonita, Sucumbíos, Ecuador
593.6.263.0063, 593.6.263.0069 tel
Corporación Grupo Randi Randi

Corporación Grupo Randi Randi (CGRR) is a private, non-profit, Ecuadorian corporation. It was created in 2000 with a mission to encourage the conservation of natural resources, sustainable development, and social and gender equity. It promotes research and technical assistance to communities and organizations located in threatened ecosystems. The Group adopted the expression Randi Randi—“giving and giving” in the Kichwa language—because it expresses the sense of reciprocity that drives their work: they offer their knowledge, support, and experience knowing that it will be well received and returned in one form or another.

Corporación Grupo Randi Randi
Calle Burgeois N34-389 y Abelardo Moncayo
Quito, Ecuador
593.2.243.4164, 593.2.243.1557

Fundación Jatun Sacha

The Jatun Sacha Foundation is a non-profit Ecuadorian organization that has been working since 1985 to conserve the country’s biological diversity and promote the sustainable development of its peoples. The Foundation protects a variety of unique forest, aquatic, and paramo (high mountain grassland) ecosystems, all of which are under threat due to burning, deforestation, pollution, and other destructive activities. It has been a pioneer in the creation of private reserves as bases of operation to carry out various conservation activities, including research, ecosystem restoration, environmental education, and the development of sustainable alternatives for the communities in the local area. These reserves are found from sea level up to over 13,000 feet in altitude, and in environments as diverse as the Galapagos, the Amazon, dry-forest, and the high Andes.

Fundación Jatun Sacha
Pasaje Eugenio de Santillán N34-248 y Maurián
Urbanización Rumipamba
Quito, Ecuador
593.2.243.2240, 593.2.331.8191 tel
www.jattensacha.org
Nearly nine years ago, we singled out the Cabeceras Cofanes-Chingual as a significant conservation priority during one of our previous inventories in the northern Andes. The entire team is grateful for the opportunity to survey these rugged mountains and the communities that live nearby. Our effort builds on years of invaluable work in this area by conservation groups, the Cofan, and local authorities, and would not have been possible without the generous help of many collaborators and colleagues.

We would like to extend our gratitude to the Cofan nation, especially the Federación Indígena de la Nacionalidad Cofan del Ecuador (FEINCE), the Cofan Survival Fund (FSC), all of our Cofan guides and counterparts, and the Cofan communities of Chandia Na’e, Dureno, and Zábaló.

Following the inventory, a working group was formed to pursue legal protected status for the area. We are incredibly grateful to this group of dedicated individuals, as their efforts led to the sectional resolution declaring the Área Ecológica de Conservación La Bonita-Cofanes-Chingual (AECBCC). At the time of the report, the proposal is still being evaluated at the national level. We would like to acknowledge the many people who have provided support to this process, among those Mayra Abad, Diego Aragón, Elizabeth Anderson, Wilson Arevalo, Paulina Arroyo, Margarita Benavides, Emerson Bravo, Diana Calero, Gerardo Canacuán, Tatiana Castillo, Byron Coronel, Gerardo Cuesta, Hugo Encalada, Mateo Espinosa, Segundo Fuentes, Chris James, Irene Lloré, Pedro Loyo, Manuel Mesías, Luis Naranjo, Luis Narváez, Angel Onofa, Patricia Pilco, Susan Poats, Ana María Regalado, Guillermo Rodríguez, Orfa Rodríguez, Edgar Rosero, Esteban Saltos, Sadie Siviter, Luis Tatamues, and René Yandun.

We are deeply grateful to the Ministerio del Ambiente del Ecuador for their support, both nationally and regionally. We would like to extend special recognition to the minister of the environment, Dr. Marcela Aguinaga Vallejo, and our colleagues at the Dirección Nacional de Biodiversidad: Wilson Rojas, Laura Altamirano, Gabriela Montoya, and Elvita Díaz. Regionally, we are indebted to Fausto González, Dr. Orfa Rodríguez, and Dr. Águedo Onofa.

The Ministerio de Defensa Nacional, especially the minister of defense, Javier Ponce Cevallos, facilitated logistical support. In the Ejército Ecuatoriano, we are grateful to Mayor Nicolás Ricuarte, Mayor Freddy Ruano, Sargento Abraham Chicaiza, General de División Fabián Varela Moncayo, General de División Luis Gonzales Villarreal, Coronel Wilson Carrillo, Mayor Iván Gutiérrez, Mayor Marroquin, Capitán Carrasco, and Sargento Kliever Espinosa. In the Aero Policial, we extend our thanks to Mayor Guillermo Ortega and Teniente J. Pozo. For helping with logistics, we thank Dr. Juan Martines of Plan Ecuador.

We received important strategic support from Coronel Dario “Apache” Hurtado Cárdenas of the Peruvian National Police, as well as Daniel Schuur, and Coronel Jorge Pastor in Quito.

We were privileged to spend time in some incredible, isolated sites in the high Andes. None of this would have been possible without the support we received from Icaro S. A., and their fantastic pilots and staff: Capitán Mario Acosta, May Daza, Capitán Jácome, and Capitan Esteban Saltos.

This inventory demanded substantial logistical wizardry, and as always, we are very fortunate to have Álvaro del Campo leading the effort. He was supported by the incredible team of Roberto Aguinda, Carlos Menéndez and Cesar Lucitante, who supervised all of the food and equipment logistics for the advance and rapid inventory teams. We are very grateful to all of them.

We give our deepest thanks to our fabulous cooks, Bolívar Lucitante and Norma Mendía. Their transformation of camp staples into delicious meals was extraordinary.

The community members of our advance team deserve enormous credit for the success of the inventory. In Monte Olivo, we are grateful to José Beltrán, Paul Carabajal, Pablo Cuamaca, René Erazo, Amable Flores, Carlos Flores, Marcos Flores, Segundo Flores, Armando Hernández, German Hernández, Edwin Huera, Homero Lucero, Rubén Lucero, Aníbal Martínez, Dario Martínez, Ramiro Martínez, Miguel Mejía, Germán Mená, Juan Narváez, Manuel Pasquel, José Portilla, Enrique Reascos, Fernando Robles, Marcelo Rosero, Daniel Yaguapaz, Fernando Yaguapaz, and Osvaldo Yaguapaz.

In La Bonita and El Playón de San Francisco we are deeply grateful to Johnny Acosta, Gener Aus, Ramiro Bolanos, Gerardo Calpa, Dario Cárdenas, Diego Cárdenas, Mario Cárdenas, Vicente Ceballos, Danny Chapi, Vincio Chapi, Faber Cuastumal, Fabio Escobar, Patricio Fuertes, Ermel García, José Guerrero, Arturo Guerríón, Felipe Guerrión, Remigio Hernández, Gelo Jurado, Jimmy Jurado, Carlos Maynaguer, Lisandro Mena,

While the inventory team was in the field, Freddy Espinosa and María Luisa López did a brilliant job coordinating efforts from Quito. In addition, from the Cofán Survival Fund (FSC) office in Quito, Sadie Siviter, Hugo Lucitante, Mateo Espinosa, Juan Carlos González, Víctor Andrango and Lorena Sánchez expedited logistics before, during, and after the inventory, while Elena Arroba and Nivaldo Yiyoguaje did the same from the FSC office in Lago Agrio. Similarly, Luis Narváez and FEINCE were critical in planning and executing logistics, for both the social and the advance teams.

The social team would like to extend its deepest thanks to all of the people in Sucumbíos and Carchi who shared their time, knowledge, experience, and hospitality. It was truly a privilege to spend time with all of you, and we regret that we cannot list every single person here.

We would like to thank certain individuals for going above and beyond during our work in the communities. In San Pedro de Huaca, we would like to thank Oliva Rueda, Unidad de Ambiente, Producción y Turismo; Nilo Reascos, Alcalde; and Oscar Muñoz, Secretario Municipal. In the Universidad Técnica del Norte, extensión Huaca, we thank Erika Guerraón, academic coordinator; Ing. Geovanny Suquillo, INIAP and mathematics professor Julio Aguilar; Luis Unigarro, Ing. Agropecuario, and receptionist Amanda Padilla. In Mariscal Sucre, we are grateful to Don Félix Loma and his wife, Doña Teri, experimental agriculturalists; Martha Muñoz, member of the Club Ecológico de Mariscal Sucre; Jadira Rosero, secretary-treasurer of the Junta Parroquial de Mariscal Sucre; Piedad Mafra, president of the Club Ecológico de Mariscal Sucre; and José Cando, Responsable de la Estación Biológica Guandera.

In San Gabriel, we are grateful to Emerson Bravo, director of the Unidad Ambiental Municipal, UNAM, Municipio de Montufar; Guadalupe Pozo; Irene Lloré, Escuela Superior Politécnica de la Amazonía (ESPEA); Fernando Ponce, coordinator of the Asamblea de Unidad Cantonal de Montufar; and Gerardo Canacuán, administrator of the Sistema de Riego Montufar.

In Monte Olivo and Palmar Grande, we thank Fausto Omero, president of the Cabildo de Palmar Grande; Hanibal Martínez, president of the Asociación de Palmar Grande (grupo de turismo); Homero Lucero Armas, president of the Comunidad de Palmar Grande; Elmer Robles, Palmar Grande; Osvaldo Mejía, Palmar Grande; Don Segundo Salazar, long-term resident of Monte Olivo; Edita Pozo, secretary of the Colegio de Monte Olivo; Guido Villarreal, director of the Colegio de Monte Olivo; Santos Quilco, president of the Junta Parroquial de Monte Olivo; Franklin Osejas, Teniente Político; Germán Mena, president of the Junta de Agua Potable; Eulália Mueses; Marujita Cuasquier; and Wilmer Villarreal, MIDUVI-Tulcán.

In Paraíso, we are grateful to Sr. Peregrino Realpe, president of the Junta de la Comunidad, and the Maestra Nancy. In La Barquilla, we thank Mariana Recalde and her husband, José Tenganán; Lucía Iva; Rosa Villa; and Sr. Abiatar Rodríguez, president of the Junta de la Comunidad. In Rosa Florida, we are indebted to Germán Tulcán, president of the Junta Parroquial, and José Burbano.

In La Bonita, we are grateful to Luis Armando Naranjo, mayor of the Gobierno Municipal del Cantón Sucumbíos; and Ing. Byron Coronel T., director of Medio Ambiente y Turismo, Gobierno Municipal del Cantón Sucumbíos; with a special recognition to Doña Rosa Zúñiga, who shared not only the history of La Bonita but also several beautiful songs of the region.

In La Sofía, we are grateful to Antonio Paspuel, president of the Junta Parroquial; Daniel Rayo, secretary-treasurer of the Junta Parroquial; the family of Sr. Carmen Arteaga and Juan Narváez; Lorenzo Narváez, Narciso Narváez, and Vasalia Narváez Arteaga. We are also grateful to Carlos Rosero, Ramiro Benavidez, and Rodrigo Rosero, our guides for our trip to La Sofía.

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Although they are both recognized above, we would like to give a special thanks to Paulina Arroyo, The Nature Conservancy, for her helpful suggestions and providing key historical context;
and to Chris James for his fantastic work coordinating and planning the presentations in Ibarra and in Quito.

All of the biologists are grateful to the museums and herbaria in Quito, with special thanks to David Neill and the Herbario Nacional, and to Marco Altamirano of the Museo Ecuatoriano de Ciencias Naturales, for facilitating export permits and work in the collections. Jonh Jairo Mueses would like to thank Cecilia Tobar, for her help during his stay in Quito. The ichthyologists thank Ermel García, José Guerrero, and their driver Lucía for their support while collecting near La Bonita, as well as Jonathan Valdivieso and Juan Francisco Rivadeneira for help with specimens. The botany team would like to acknowledge all of the staff at the Herbario Nacional for facilitating their visit, as well as Lorena Endara, Mario Blanco, James Luteyn, Lucia Kawasaki, Nancy Hensold, and Jose Manzanares for valuable help identifying specimens.

Jonathan Markel prepared excellent maps for the advance team, inventory team, and for the final report. In addition, he stepped in whenever necessary during the writing and presentation process, even serving soup to the participants. We are grateful to Dan Brinkmeier and Nathan Strait for producing great visual materials for the work in local communities by the social team.

As always, Tyana Wachter played a fundamental role, stepping in to solve problems whenever and wherever necessary in Chicago, Quito, Ibarra, Puerto Libre, and La Bonita. Rob McMillan and Dawn Martin worked their usual magic to solve problems from Chicago.

Funds for this inventory were provided by generous support from The John D. and Catherine T. MacArthur Foundation, The Boeing Company, Exelon Corporation, and The Field Museum.
The goal of rapid inventories—biological and social—is to catalyze effective action for conservation in threatened regions of high biological diversity and uniqueness.

**Approach**

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

During social asset inventories, scientists and local communities collaborate to identify patterns of social organization and opportunities for capacity building. The teams use participant observation and semi-structured interviews to evaluate quickly the assets of these communities that can serve as points of engagement for long-term participation in conservation.

In-country scientists are central to the field teams. The experience of local experts is crucial for understanding areas with little or no history of scientific exploration. After the inventories, protection of natural communities and engagement of social networks rely on initiatives from host-country scientists and conservationists.

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

| **Dates of field work** | Biological team: 15–31 October 2008  
Social team: 8–30 October 2008 |
|-------------------------|--------------------------------------------------------------------------------|
| **Region**              | Northern Ecuador, forested slopes covering elevations from 650–4,100 m on the  
eastern flank of the Andes. The Cabeceras Cofanes-Chingual spans Sucumbíos, Carchi  
and Imbabura provinces, sheltering the confluence of two major watersheds (Cofanes  
and Chingual), which drain into the Amazon basin, as well as the headwaters of a  
western-slope drainage (Chota), which flows to the Pacific Ocean. |
| **Sites inventoried**   | The biological team visited three sites:  
01 Laguna Negra, paramo at 3,400–4,100 m, 15–19 October 2008  
02 Alto La Bonita, upper montane forest at 2,600–3,000 m, 23–26 October 2008  
03 Río Verde, lower montane forest at 650–1,200 m, 26–31 October 2008  
Only the mammal and advance teams visited a fourth site, Ccuttopoé, which is unburned  
paramo at 3,350–3,900 m.  
The social team visited 22 communities. In the following nine focal communities they  
conducted intensive interviews, workshops, and informational meetings:  
01 La Barquilla, El Paraíso, and Rosa Florida—Parroquia (parish of) Rosa Florida,  
Cantón (county of) Sucumbíos, Provincia (province of) Sucumbíos  
02 La Bonita, La Sofía, and El Playón de San Francisco—Cantón Sucumbíos,  
Provincia Sucumbíos  
03 Mariscal Sucre—Cantón Huaca, Provincia Carchi  
04 Monte Olivo and Palmar Grande—Parroquia Monte Olivo, Cantón Bolivar,  
Provincia Carchi  
In 13 additional communities, the team interviewed authorities and other key actors,  
conducted visual surveys of land use patterns, and briefly interviewed residents. These  
included Santa Barbara, Santa Rosa, Las Minas, and Cocha Seca (in Provincia  
Sucumbíos); and Huaca, Túcán, San Gabriel, Miraflor, Raigrass, El Aguacate,  
Manzanal, Motilón, and Pueblo Nuevo (in Provincia Carchi). |
| **Biological focus**    | Geology, hydrology, soils, vascular plants, fishes, reptiles and amphibians, birds, and  
large mammals |
| **Social focus**        | Social and cultural strengths, natural-resource use, community management practices,  
and archeology (historical human settlement in the region) |
### Principal biological results

<table>
<thead>
<tr>
<th>Organism group</th>
<th>Laguna Negra 3,500–4,100 m</th>
<th>Alto La Bonita 2,600–3,000 m</th>
<th>Río Verde 650–1,200 m</th>
<th>Total registered 650–4,100 m</th>
<th>Total estimated 650–4,100 m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vascular plants</td>
<td>~250</td>
<td>~300</td>
<td>~350</td>
<td>~850</td>
<td>3,000–4,000</td>
</tr>
<tr>
<td>Fishes</td>
<td><em>*</em></td>
<td>1**</td>
<td>12</td>
<td>19*</td>
<td>25–30</td>
</tr>
<tr>
<td>Amphibians</td>
<td>6</td>
<td>10</td>
<td>22</td>
<td>36</td>
<td>72</td>
</tr>
<tr>
<td>Reptiles</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>6</td>
<td>38</td>
</tr>
<tr>
<td>Birds</td>
<td>74</td>
<td>111</td>
<td>214</td>
<td>364</td>
<td>650</td>
</tr>
<tr>
<td>Medium and large mammals</td>
<td>13***</td>
<td>15</td>
<td>29</td>
<td>40</td>
<td>50</td>
</tr>
</tbody>
</table>

* Ichthyologists did not sample Laguna Negra but instead visited an additional site, Bajo La Bonita, where they registered 11 species. They encountered an additional 12 species at lower elevations outside the proposed reserve, at sampling stations 017 and 018.

** *Oncorhynchus mykiss* (trout), a non-native, introduced species

*** 12 species were recorded at the other high-altitude site, Ccuttopoé.

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**Geology, hydrology, and soils:** Fourteen million years and massive energy built the Andes from a seafloor into a towering, geologically complex, dynamic mountain range. Cabeceras Cofanes-Chingual is the result of this large-scale folding, faulting, and uplift; the rise and slow cooling of deep subsurface plumes of magma; and volcanic eruptions, deposition of magma and ash, and massive mud and rock slides. These geological processes continue today. The steep mountains rise from the floodplain of the Aguarico River, at an elevation of 650 m, to high-altitude lakes and paramo at more than 4,000 m. This dramatic rise occurs over a distance of 35 km and divides the Pacific and Amazon basins. During the last ice age (10,000 years ago), glaciers carved U-shaped valleys from the highest mountains. Powerful rivers continue to carve deeper into the lower valleys and deliver sediments and nutrients from the Andes to the Amazon River. Moisture-laden air masses from the Amazon Basin cool as they rise up the Andes, causing condensation and precipitation that maintain wet environments year-round at higher elevations. The paramos capture much of this moisture, channeling it to the rivers and streams that provide water to nearby human settlements and agricultural areas. The steep slopes that dominate the watersheds of Cabeceras Cofanes-Chingual are highly sensitive to erosion, induced by both natural and anthropogenic perturbations. A protected area in the region is essential to avoid deforestation and protect the water resources that arise in the paramo and Andean forests.

**Vascular plants:** The botanists encountered approximately 850 vascular plants during fieldwork—with essentially no overlap among the sites sampled—of which 569 have been identified to species, genus, or family. The rugged terrain and exceedingly wet conditions create dramatic small-scale differences in vegetation and plant composition. We estimate that the region harbors 3,000–4,000 plant species. Endemism is high and many species are restricted to the few remaining forests of northern Ecuador and southern Colombia. We found signs of logging, with *Polylepis* (Rosaceae) and *Podocarpus* (Podacarpaceae) extracted for local use and commercial markets. In contrast to heavily
deforested Andean forests elsewhere, Cabeceras Cofanes-Chingual offers the rare opportunity to protect a diverse, intact gradient from rainforest to alpine grasslands.

**Fishes:** The ichthyologists registered 19 species in the three sites surveyed—Alto La Bonita, Bajo La Bonita, and Río Verde—one of them being the introduced trout (*Oncorhynchus mykiss*) in the higher elevations of the Cofanes-Chingual watershed, and the Sucio River. Of the species collected, four (in the genera *Characidium*, *Astroblepus*, *Hemibrycon*, and *Chaetostoma*) are likely new to science. The team registered an additional 13 species at lower elevations, to 480 m. We estimate 25–30 species in the 500–3,000 m altitudinal range of the region, a normal species-richness for this elevational gradient on the eastern slopes of the Andes. Typical of Andean foothill streams in Ecuador, Peru, and Colombia, the two most species-rich and abundant orders were Characiformes and Siluriformes, encompassing 55% and 36% of the species registered. Three families—Characidae (31%), Loricariidae (19%), and Astroblepidae (16%)—had the majority of species. Most abundant were the species of Astroblepidae and Loricariidae that show special adaptations to the rushing torrents of the Andean foothills, such as mouths modified with suction cups and interopercular teeth for clinging to rocks, and small or medium-sized bodies with reduced swimming bladders adapted for swimming along the bottom where currents are weaker.

**Amphibians and reptiles:** The herpetologists found 36 species of amphibians and 6 of reptiles (12 families, 19 genera) in 170 hours of effort. We estimate 72 amphibians and 38 reptiles for the region. With the exception of *Pristimantis chloronotus* frogs (found in two of the three sites), there was no overlap of species among the sites sampled, indicating three distinct herpetofaunas. The fauna at Laguna Negra, typical of paramo, had few species, most with localized, small ranges. Our methodology of searching in dead *Espeletia* and puya bromeliads confirmed the abundance of two frogs (*Osornophryne bufoniformis* and *Hypodactylus brunneus*) that are considered rare in the literature. Alto La Bonita’s high-montane herpetofauna was dominated by *Pristimantis* frogs, including the first record of *P. colonensis* for Ecuador and a range extension for *P. ortizi*. *Osornophryne guacamayo*, a rare endemic, was abundant here; this would be a good site to learn about the species and what might protect it. The herpetofauna at Río Verde had Amazonian elements mixed with Andean foothill species. We recorded a latitudinal range extension for the frog *Cochranella puyoensis*—known previously only from the central portions of Ecuador’s Oriente—and an altitudinal range extension for the frog *Rhinella dapsilis* (700–800 m), previously known only from Amazon lowlands below 300 m.

**Birds:** The ornithologists registered 364 species of birds during the inventory and estimate 500 for the three sites surveyed. Including the entire elevational range in the region—from 650 m to paramo—increases the estimate to 650 species. The forest avifauna is diverse, and we recorded relatively few species of other habitats. Aquatic
species were poorly represented; we observed a few species in rushing streams and occasional migrants at paramo lakes. The open paramo is species poor; most birds use the patches of isolated forest. The avifaunas were markedly distinct at each site surveyed, with essentially no overlap between Río Verde and the two high elevation sites, and only a quarter of the species in common between the paramo site at Laguna Negra and Alto La Bonita. Within each site, the avifauna varied greatly in association with changing elevation and topography. We registered one endangered species (Bicolored Antpitta), four vulnerable species (Wattled Guan, Military Macaw, Coppery-chested Jacamar, and Masked Mountain-Tanager), and nine near-threatened species; most species of conservation concern were at Río Verde. We recorded 14 range-restricted species: 9 are restricted to eastern Andean slopes, and 5 are in paramo. Although Ecuador is south of the main wintering grounds for migrants from North America, we found 17 species of migrants, including 4 (Swainson’s Thrush, plus Blackburnian, Cerulean, and Canada warblers) that winter almost entirely in the humid Andes.

Medium and large mammals: The mammalogists used visual observations, scat, tracks, feeding evidence, smell, vocalizations, and interviews with local people to confirm the presence of 40 species (18 families, 8 orders) of the 50 species they estimate for the region. Our most important finding is intact populations of mountain tapir (Tapirus pinchaque) in two of our four sites (both above 3,000 m). Spectacled bear (Tremarctos ornatus) was present in healthy numbers at all four sites. Both species are considered vulnerable or endangered (UICN 2008), and threatened with extinction (CITES 2008), through most of their range. We observed abundant tracks and feeding sites of the little-known mountain paca (Cuniculus [Agouti] taczanowski), olive coatimundi (Nasuella olivacea), and an unidentified species of Coendu porcupine. At lower elevations around 1,500 m, populations of Lagothrix lagothricha, Ateles belzebuth, and Alouatta seniculus still exist. The protection of contiguous forests covering altitudinal ranges for each of these animals is critical for their conservation. Interviews with local people led us to one of the most interesting animals in the region: a giant pocket gopher (Orthogeomys sp.) that workers uncovered 4 m underground during excavations for the new road between La Bonita and La Sofía.

Principal social and archeological results

Past cultural landscape: The region has a rich and wide variety of archeological evidence that indicates it is an anthropogenic landscape formed during centuries, if not millennia. We found materials indicating the presence of early humans in two of the three areas sampled. In the lowlands of upper Amazonia (our Río Verde site) we found a small riverside occupation. In the Andean foothills we found a large settlement at the modern town of La Bonita, with evidence of a complex form of social organization, and transformation of the landscape through mound building and terracing. Although we found no evidence of human presence in the caves of Laguna Negra (in the paramo), these caves may have been occupied at the end of the Ice age.
Principal social and archeological results (continued)

**Present-day cultural landscape:** Cantón Sucumbios (county of Sucumbios), in Provincia Sucumbios, was settled during waves of natural resource extraction, starting with rubber-tapping at the end of the nineteenth century. Population in the cantón was 2,868 in 2001. The entire county has electricity and piped water, all communities have elementary schools and distance-learning secondary schools, and La Bonita and El Playon have high schools. La Bonita and El Playon have health clinics; the other communities have medical and first-aid supplies and trained personnel. Economic activities include salaried jobs (especially for the municipality and other governmental work), farming and tending livestock, and logging. Communities along the “Interoceanic Highway” are intimately tied with the market economy—regional, national, and with Colombia—while more isolated La Sofia maintains a largely self-sufficient economy. The greatest assets in this cantón are (1) strong support for protection of forests and watersheds, (2) a dedicated search for alternatives to illegal logging, and (3) capacity to organize around public projects, such as the successful juntas de agua potable (management groups for potable water). Residents showed great interest in participating in emerging governmental programs for payment of ecological services, such as the Socio Bosque program of MAE (the environmental ministry). This interest in conservation stems from stricter regulations on illegal logging, fear of droughts, and the possibility of revenues through ecotourism or payment for ecological services. Another major asset in the region is that residents recognize that despite economic difficulties they have a good quality of life because their forests and waters are still healthy and their soils fertile. In February 2008 the municipal government created a protected area approved at the county level, the Reserva Municipal La Bonita (Figs. 2A, 2B, 10J, 12B). In addition, La Sofia is developing a strategic plan to protect its forests, reduce commercial mining activities, and maintain its communal identity and strong link with its environment.

In Provincia Carchi, the social inventory team focused on institutional players in cantones Huaca and Montúfar, which neighbor Cantón Sucumbios. Carchi is more heavily populated than Sucumbios. Today residents engage in farming (primarily potatoes) and dairy production. Illegal logging and charcoal production using forest trees still persist, with markets in Quito and Ibarra. Nonetheless, Huaca and Montúfar are developing conservation policies to protect the Andean highlands. Institutional assets in the region also include the Estación Biológica Guandera (part of the NGO Jatun Sacha) and the new extension of the Universidad Técnica del Norte, based in Huaca. Residents of Parroquia Monte Olivo (parish of Monte Olivo, including Palmar Grande, which we studied in more detail) are very enthusiastic for ecotourism and conservation of their forests and paramos. Monte Olivo was more successful than other towns we visited in forming cooperatives (asociaciones) for economic activities, especially women’s cooperatives.
### Principal threats

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<tbody>
<tr>
<td>01</td>
<td>Mining</td>
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<tr>
<td>02</td>
<td>Logging</td>
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<tr>
<td>03</td>
<td>Deforestation and subsequent erosion, especially in headwater regions</td>
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<tr>
<td></td>
<td>(with subsequent effects on human and wildlife populations that depend on streams for</td>
</tr>
<tr>
<td></td>
<td>their water supply)</td>
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<tr>
<td>04</td>
<td>Expansion of the agricultural frontier</td>
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<td>05</td>
<td>New roads and trails into intact habitat or sensitive archeological sites</td>
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<tr>
<td>06</td>
<td>Excessive burning of paramos</td>
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<tr>
<td>07</td>
<td>Introduction of non-native species (especially trout)</td>
</tr>
<tr>
<td>08</td>
<td>Water-use conflicts because of diversions for irrigation (Carchi)</td>
</tr>
<tr>
<td>09</td>
<td>For archeological sites, introduction of dairy cows (which disturb the soil) and</td>
</tr>
<tr>
<td></td>
<td>raiding of valuable objects from ancient sites</td>
</tr>
</tbody>
</table>

### Opportunities and targets for conservation

The rugged Cabeceras Cofanes-Chingual is one of the last remote, intact mountainous regions in Ecuador. Encompassing more than 100,000 ha of unbroken habitats, with altitudinal ranges from 650 meters at the mouth of the Chingual River to more than 4,100 meters on the meadows of the highest ridges, this mountainous landscape is the most important remaining refuge for endangered, range-restricted flora and fauna of the Ecuadorian Andes. Spectacular orchids, highly adapted fishes, brightly colored tanagers, and the mountain tapir are among the more conspicuous conservation targets at Cofanes-Chingual. So is the source of water that supplies the entire region. The invaluable, unbroken altitudinal gradient allows movement of plants and animals up and down the slopes and provides crucial buffer for global climate change.

Specific conservation targets appear in the chapter for each taxonomic group. Below we list the broader conservation targets in the region:

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<tbody>
<tr>
<td>01</td>
<td>Ecosystem services of freshwater production in paramos, serving the entire region</td>
</tr>
<tr>
<td>02</td>
<td>A broad elevational gradient of intact forest, critical in allowing migration, especially in response to climate change</td>
</tr>
<tr>
<td>03</td>
<td>Diverse and endemic flora of the Northern Andes, a region largely deforested in other parts of Colombia and Ecuador</td>
</tr>
<tr>
<td>04</td>
<td>Highly endemic Andean and paramo fauna between 650 and 4,100 m</td>
</tr>
<tr>
<td>05</td>
<td>Distinct granite- and volcanic-rock-based, high-altitude glacial valleys and lakes</td>
</tr>
</tbody>
</table>
REPORT AT A GLANCE

Opportunities and targets for conservation
(continued)

06 Hydrologic connectivity between rivers in both the Cofanes and Chingual watersheds
07 Aquatic ecosystems with little human impact (except introduction of trout)
08 Healthy populations of montane forest timber species (e.g., *Polylepis*, *Podocarpus*, *Humiriastrum*)
09 Diverse forest avifauna across an entire, montane elevational gradient
10 Endangered species that are common at the sites inventoried

Principal recommendations

These integrated recommendations use the strengths we encountered in the region to combat the threats that could fragment and destroy the remaining forest, an area vitally important for three provinces and globally valuable for its biodiversity:

01 Grant formal conservation status for the continuous vegetation along the entire altitudinal range from lowland forest to Andean paramos. This is a critical refuge for diverse habitats and water sources crucial for the region.

02 Seize the opportunity to catalyze and implement a new conservation model — a municipal reserve. The Reserva Municipal La Bonita should be supported by a Ministerial Decree from the national environmental authorities, and should integrally involve the local government and indigenous populations.

03 Develop and implement participatory management plans for proposed and existing conservation areas: Reserva Municipal La Bonita, Territorio Ancestral Cofan, and others.

04 Form strategic alliances — among indigenous organizations, campesino associations, and municipalities — founded on a shared vision for protecting intact forests. These alliances will become a local complement to the Ministerio del Ambiente.

05 Reinforce and expand alliances among Carchi, Sucumbíos, and Imbabura provinces, strengthening existing links. Evaluate the unique opportunities to conserve the globally important, intact forests and headwaters in Carchi and Imbabura, especially mechanisms that halt the advance of the agricultural frontier and join forces to protect water sources.

06 Pursue binational collaborations for coordinated management of existing and potential conservation areas in Colombia.

Current conservation status

Presentation of our preliminary results to the provincial governments and regional organizations generated a spirited discussion that resulted in a declaration — signed by all authorities present — to support the Reserva Municipal La Bonita and to create
similar reserves in the two neighboring provinces that still have a narrow band of forest shielding the headwaters of a third important river, the Chota (Figs. 2B, 12B).

Since the start of 2009, The Field Museum has facilitated several meetings in northern Ecuador with local government organizations, NGOs, and local scientists and residents. The goal of this Work Group (Grupo de Trabajo) is to secure immediate legal protection for the roughly 70,000 ha that we inventoried in October 2008, along an intact elevational gradient. Neighboring provinces (Carchi and Imbabura) have requested continued support from the Work Group to protect the two adjacent forest remnants, for an additional 18,450 hectares.

At the time of printing of this report, plans were moving forward for the official declaration of the Área Ecológica de Conservación La Bonita-Cofanes-Chingual (AECBCC) to protect the 70,000 hectares envisioned initially as a municipal reserve. The technical proposal for the area received initial approval by the Ministerio del Ambiente in July 2009. The Work Group continues to follow the declaration process closely, and will start developing a management plan for the AECBCC.
Why Cabeceras Cofanes-Chingual?

Following the tracks of a mountain tapir, one can descend from the surreal, windswept paramos* of Cabeceras Cofanes-Chingual through the precipitous slopes of cloud forests dripping with mist and orchids all the way down to tall Amazon forests in the lowlands. The conservation complex proposed in this report will protect the headwaters of two important rivers in the region, the Cofanes and Chingual, and will conserve water resources critical to human populations and to a rich assemblage of wild species. The complex will safeguard the forested slopes from 650 to 4,100 meters in elevation, one of the last intact altitudinal gradients remaining in Ecuador. Contiguous with Cofan ancestral lands and the Reserva Ecológica Cayambe-Coca, this new reserve will provide a key piece in the region’s conservation puzzle, resulting in a corridor of more than 550,000 hectares of highly diverse forests.

The streams that drain the region are the sources of the Aguarico-Napo river system, one of the most important fluvial systems of western Amazonia. The Cofanes and Chingual rivers, which join to form the Aguarico, are some of the last unfragmented mountain rivers in Ecuador and provide crucial habitat for aquatic biota. Paramos and forests filter rainwater and modulate river flow in these headwaters, protecting critical sources of water for domestic and agricultural uses.

Habitat variation is striking and the distribution of species is narrow and markedly patchy: species on one ridge are often not on the next, nor are they found at lower or higher elevations. The intact vegetation of Cabeceras Cofanes-Chingual allows free movement of bears, tapirs, macaws, and other wide-ranging species up and down the mountains in search of food, mates, and nesting sites. The forested slopes buffer the effects of climate change because they allow species to migrate in response to hotter, wetter, or drier conditions.

Human history in the area spans thousands of years and has left a strong imprint on the environment. Accelerating deforestation and unsustainable mining and agricultural practices now endanger both wilderness and humans, and local residents are mobilizing to retain the forests that surround them. Three provinces—Sucumbíos, Carchi, and Imbabura—have joined forces to create a conservation complex that will ensure the long-term survival of this spectacular and diverse landscape.

* High-altitude grasslands.
We envision Cabeceras Cofanes-Chingual as a conservation complex that protects diverse Andean forests for the long term and sustains the quality of life in neighboring towns and villages. Implementation of this vision will depend on a network of government and non-government organizations, public officials, scientists, local residents (including indigenous groups), and a strong scientific foundation. Below we highlight ecosystems, habitats, species, and human practices important for conservation of the area. Some of the conservation targets occur only in this region; others are rare, threatened, or vulnerable in other parts of the Amazon or Andes. Some are crucial for local residents; others play critical roles in ecosystem function; and still others are critical for the long-term health of the area.

**Landscapes and ecosystem services**

- A broad elevational gradient (650–4,100 m) of intact forest, critical in allowing migration in response to climate change
- High-altitude glacial valleys and lakes, including a rare glacially carved valley surrounded by solid granite walls
- Intact forests that provide natural protection from erosion in rugged mountain landscapes
- Forests that store globally important reserves of carbon
- High-gradient rivers and streams that ensure water supply for the entire region
- Hydrological connectivity between the headwaters and downstream areas throughout the Cofanes-Chingual basin, important for aquatic and human communities

**Vascular plants**

- A well-conserved sample of the diverse and endemic flora of the northern Andes, a region largely deforested in other parts of Ecuador and neighboring Colombia
- Healthy populations of timber species in upper and lower montane forests (e.g., *Polylepis*, *Podocarpus*, *Weinmannia*, *Humiriastrum*)
Conservation Targets (continued)

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vascular Plants (continued)</td>
<td>Tremendous diversity of orchids, including possibly some of the highest local richness of genera such as <em>Masdevallia</em></td>
</tr>
<tr>
<td>Fishes</td>
<td>Highly endemic, poorly studied, Andean fish assemblages located between altitudes of 500 and 3,500 m</td>
</tr>
<tr>
<td></td>
<td>Ecological integrity of aquatic communities, including fishes as a principal component</td>
</tr>
<tr>
<td>Amphibians and reptiles</td>
<td>Endemic species of the eastern foothills of northern Ecuador and southern Colombia classified as endangered, including <em>Cochranella puyoensis</em>, <em>Gastrotheca orophylax</em>, and <em>Hypodactylus brunneus</em></td>
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<td></td>
<td>Amphibians whose reproductive strategies have been affected by climate change and epidemiologic factors in the Ecuadorian and Colombian Andes (<em>Hyloscirtus larinopygion</em>, <em>Cochranella puyoensis</em>, <em>Gastrotheca orophylax</em>)</td>
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<tr>
<td></td>
<td>Species with restricted distributions associated with paramo microhabitats, which are threatened by excessive burning by humans (<em>Osornophryne bufoniformis</em>, <em>Hypodactylus brunneus</em>, <em>Riama simoterus</em>, and <em>Stenocercus angel</em>)</td>
</tr>
<tr>
<td></td>
<td>Endemic species categorized as Data Deficient with restricted distributions in northern Ecuador and southern Colombia (<em>Pristimantis ortizi</em>, <em>P. delius</em>, and <em>P. colonensis</em>)</td>
</tr>
<tr>
<td>Birds</td>
<td>Endangered birds, including Bicolored Antpitta (<em>Grallaria rufocinerea</em>)</td>
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<td>Threatened birds, including Wattled Guan (<em>Aburria aburri</em>), Military Macaw (<em>Ara militaris</em>), Coppery-chested Jacamar (<em>Galbula pastazae</em>), and Masked Mountain-Tanager (<em>Buthraupis wetmorei</em>)</td>
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</tbody>
</table>
- Fourteen range-restricted species of Andean slopes and paramo
- Diverse forest avifauna across an entire montane elevational gradient

**Mammals**
- Healthy populations of mountain tapir (*Tapirus pinchaque*) and Andean bear (*Tremarctos ornatus*)
- Abundant populations of *Nasuella olivacea*, *Agouti taczanowskii*, and other montane species
- Important predators, including puma (*Puma concolor*) and jaguar (*Panthera onca*)
- Intact populations of woolly monkey (*Lagothrix lagothricha*) and white-bellied spider monkey (*Ateles belzebuth*) at mid-level altitudes
- Intact altitudinal ranges for all these species, especially mountain tapir and Andean bear

**Archeological and historical artifacts**
- A pre-Columbian settlement at La Bonita, made up of mounds and other modifications of the environment
- A pre-Columbian settlement at Río Verde, at the confluence of the Verde and Cofanes rivers
- Other archaeological artifacts and earthworks, an invaluable historical record of pre-Colombian settlements in the region, some of which are known to local residents

**Human communities**
- Organic farms using traditional methods and crops and small-scale production (e.g., artisanal cheeses)
- Local ecological knowledge, including use of native medicinal plants
- Artisanal gold mining operations and technology, including apparently premodern sites that could become tourism opportunities
Human communities (continued)

- Access roads for horseback or pedestrian travel, such as the road from La Bonita to La Sofía and the road to La Estación Biológica Guandera (as opposed to bigger thoroughfares that expose the area to colonization and large-scale extraction of natural resources)

- The “Eastern Road” (Camino del Oriente), a historical path linking Monte Olivo and La Sofía, which could complement community efforts in ecological and historical tourism
RECOMMENDATIONS

The rugged headwaters of the Cofanes, Chingual, and Chota rivers (including the latter’s tributaries: Apaquí, Escudillas, and Sataqui) represent one of the last opportunities to conserve the distinct biological communities along an altitudinal gradient from 650–4,100 m. This mountainous area is the most important remaining block of forests providing refuge for unique and threatened species in the Andes, as well as essential water sources for human populations in Carchi, Imbabura, and Sucumbíos.

One portion of the forested block already is an established conservation area, Territorio Ancestral Cofan (30,700 ha). To the north is the proposed Reserva Municipal La Bonita* (70,000 ha; Figs. 2A, 2B), a conservation initiative originating within Provincia Sucumbíos. The western fringe indicated with a dotted line in Fig. 2B offers a unique opportunity to protect water sources and the few remaining forests and paramos in the provinces of Carchi and Imbabura.

Below we list our principal recommendations. These recommendations mobilize the strengths we encountered in the region to mitigate the threats that could fragment and destroy the remaining block of forest, an area vitally important for three provinces and globally valuable in its biodiversity.

| Protection and management                                                                 | 01 Grant formal conservation status to the entire altitudinal range, from lowland forest to Andean paramos, which harbors unique biological communities and water sources for the region. |
|                                                                                           | • We recommend that the Instituto Nacional de Desarrollo Agrario (INDA, the national institute for agrarian development), conduct an evaluation to designate the area as appropriate for the conservation of natural resources. Steep cliffs, vertical slopes, and frequent landslides create highly unfavorable conditions for agriculture in the mountains. |
|                                                                                           | • Delimit specific conservation areas to protect the integrity of watersheds, (especially the headwaters) and a continuous range of intact habitats; coordinate the management of these areas as an integrated network. |
|                                                                                           | • Strengthen inter-institutional links among the Secretaría Nacional del Agua (SENAGUA, the national water authority), the Ministerio del Ambiente (MAE, the ministry of the environment), local governments, and community water organizations, among others. |
|                                                                                           | • Support and strengthen local conservation interests within the integrated network of protected areas (e.g., the Guandera Biological Station and a new conservation area in Monte Olivo, among others). |
|                                                                                           | 02 Seize the opportunity to catalyze and implement a new conservation model—a municipal reserve (la Reserva Municipal La Bonita), with integral participation from parishes (parroquias) and indigenous populations, and the approval of the national environmental authorities with a Ministerial Decree. |

* The proposed municipal reserve is now being protected as the Área Ecológica de Conservación La Bonita-Cofanes-Chingual (AECBCC).
03 Develop and implement participatory management plans for proposed and existing conservation areas: Reserva Municipal La Bonita and the Territorio Ancestral Cofan, and others.

- Form a work group that includes the department of environment of the Sucumbíos municipal government (Departamento del Medio Ambiente del Gobierno Municipal Cantón Sucumbíos, GMCS), the mayor of GMCS, representatives of the parish (parroquia) boards of Rosa Florida and La Sofía, members of the Cofan Survival Fund (FSC), and the Cofan indigenous federation (Federación Indígena de la Nacionalidad Cofan del Ecuador, FEINCE), and other key actors.

- Together with local landholders, adjust the limits of the proposed La Bonita municipal reserve.

- Zone each conservation area, defining strict protection areas, areas of traditional use, and management areas.

- Identify critical access points for establishing control posts, using the La Bonita–La Sofía highway as a patrol route—with sentry huts at points of access to the highway—and halt land trafficking along the length of the road.

- Manage excessive burning in the paramos, hunting levels, and exotic species (e.g., trout, grasses, cattle).

- Restrict unsustainable fishing practices in the lowlands (e.g., use of dynamite and barbasco fish-poison).

- Implement initiatives (e.g., agroforestry) to reduce and ultimately eliminate timber extraction from conservation areas.

- Research alternatives to harmful agrochemicals and promote development of water treatment projects to preserve water quality.

- Implement a participatory comité de gestión (“management committee”) that involves residents living in and around the conservation areas in the development of management plans and the administration of the areas.

- Conduct an “environmental flows assessment” and use appropriate technologies to minimize the ecological impact of the proposed hydroelectric plant in La Sofía.

- Coordinate management among the neighboring conservation areas.

- Reinforce management plans with municipal ordinances.

04 Build strategic alliances—among indigenous organizations, campesino associations, and municipalities—founded on a shared vision for protecting intact forests. These alliances will provide a crucial local complement to the activities of the Ministerio del Medio Ambiente. Build on existing successful models, e.g., Cofan conservation management and park guard systems, and Reserva Ecológica El Ángel.
RECOMMENDATIONS

05 Reinforce and expand alliances among Carchi, Sucumbíos, and Imbabura provinces, strengthening existing links. Evaluate the unique opportunities to conserve globally important intact forests and headwaters in Carchi and Imbabura, especially mechanisms that halt the advance of the agricultural frontier; join forces to protect water sources.

06 Develop financial mechanisms for the protected areas through the national and provincial governments.

07 Elaborate a strategic development plan for responsible land use, especially soil management, in the surrounding conservation areas and provide technical support for suitable aquaculture practices.
   - Strengthen and improve existing programs, including the Centro de Investigación y Servicios Agrícolas para Sucumbíos (CISAS, the Sucumbíos agricultural research and services center) and municipal initiatives in Sucumbíos, Carchi, and Imbabura, improving follow-up with agriculturalists.
   - Pursue opportunities to collaborate with other private and public entities, e.g., the national agrofisheries research institute (Instituto Nacional Autónomo de Investigaciones Agropecuarias) and local extensions of various universities, including the Escuela Superior Politécnica Ecológica Amazónica (ESPEA) and the Universidad Técnica del Norte – Extensión Huaca.

08 Consider economic alternatives that are ecologically compatible with the area, such as local handicrafts, and orchid and bromeliad cultivation, using successful models in Ecuador and other countries (e.g., micropropagation of orchids).

09 Carefully define possible financial mechanisms that could support environmental services, manage expectations, and base development of ecotourism on existing experiences (e.g., the “Y” in the Laguna de Mache Chindul, and the Red Indígena de Comunidades del Alto Napo para la Convivencia Intercultural y el Ecoturismo [RICANCI]).

10 Expand successful training programs for teachers in environmental education, and distribute identification guides for native species and other materials to existing programs (e.g., the “Green Notebook” (Cuaderno Verde) curriculum developed by the environmental education department in Sucumbíos.)

11 Pursue binational collaborations with Colombia in contiguous conservation areas.

12 Conduct feasibility studies for an avoided-deforestation project in the Cofanes-Chingual region.

Research

01 Determine the distribution of the introduced rainbow trout in the Cofanes-Chingual basin and evaluate its impacts on the aquatic ecosystem and native fish species.
## Research (continued)

02 **Conduct cost-benefit studies of rainbow trout cultivation** to determine whether or not this “alternative economic development activity” is financially feasible.

03 **Study population dynamics and ecology of threatened species** (e.g., amphibians, macaws, mountain tapirs, spectacled bears), in particular, seasonal movements, home ranges, and key food and reproductive resources.

## Additional inventories

1. **We recommend additional inventories targeting elevations we did not sample** (i.e., 1,100–2,500 m and 3,000–3,500 m) and focused on the isolated massif to the east of La Sofía, the upper Condué valley, the Ccuttopoé paramo, the upper Cofanes drainage, and the forested areas on the western flanks in Carchi province. For aquatic communities, we recommend additional inventories in the Cofanes and Chingual rivers and their main tributaries, beginning near La Sofía.

2. **Conduct inventories to understand the size and extent of the Bicolored Antpitta population**. Given the deforestation in Colombia, the populations in Cabeceras Cofanes-Chingual are likely among the largest within its range and critical for long-term conservation of this rare species.

3. **Inventory other paramo sites for Masked Mountain-Tanager**, which seems to be negatively impacted by burning of the paramo. Ccuttopoé is especially important because it lacks human-generated fires.

4. **Inventory appropriate habitat for locally distributed, near-threatened species**, including Black-thighed Puffleg, Coppery-chested Jacamar, and White-rimmed Brush-Finch.

## Monitoring and surveillance

1. **Train a local corps of forest wardens, guides, and scientists to support the monitoring, surveillance, research, and inventory work for the complex of conservation areas in Cabeceras Cofanes-Chingual.**

2. **Monitor deforestation in the buffer zone**, to understand and eventually mitigate its causes.

3. **Monitor water quality, especially in the Chingual River**, which drains deforested lands to the north and east of its course, to create an early-alert mechanism to mitigate sources of pollution.
OVERVIEW OF REGION AND INVENTORY SITES

Authors: Corine Vriesendorp, Randall Borman, and Stephanie Paladino

Cabeceras Cofanes-Chingual (“Cofanes-Chingual”) is a rugged and remote wilderness in northern Ecuador—a vast expanse of diverse, intact forests covering the eastern flank of the Andean cordillera. These forests grow on the youngest extension of the Andes, part of the volcanic chain running south from Colombia into Ecuador.

The area is named for the two rivers—the Cofanes and the Chingual—which originate high within its paramos (Andean wet meadows). These two rivers and their many tributaries drain the northern, central, and eastern portions of the area into the Amazon basin (Figs. 2A, 12B). A thin band of the westernmost edge of the area comprises the upper headwaters of the Mira-Chota river drainage, which eventually feeds into the Pacific.

Cofanes-Chingual covers over 100,000 ha and spans two provinces, Carchi and Sucumbíos; the majority of the area rests within Sucumbíos. Few people live on the Sucumbíos side, but the neighboring valley in Carchi harbors a substantial and growing human population. Sucumbíos and Carchi share a common interest in the area because headwater streams in Cofanes-Chingual provide water for human settlements in both provinces.

Current conservation plans envision two adjacent pieces: a municipal reserve (reserva municipal)* covering the central and northern portions, and an indigenous territory (Territorio Río Cofanes) in the south. In September 2007, the Ecuadorian government granted the Cofan indigenous people title to a 30,700-ha block of ancestral territories along the Cofanes River (Figs. 2A, 2B, 10J). The Cofan already manage other parts of their territories along the Aguarico River, and have extended their park-guard system and patrolling efforts into the southern portion of the Cofanes-Chingual.

Residents in the central and northern portions of Cofanes-Chingual are very interested in creating a municipal reserve of approximately 70,000 ha. In 2008, the municipal government of Cantón Sucumbíos, headquartered at La Bonita, took an important step towards protecting the area, passing a near-unanimous resolution to

* At the time of printing of this report, plans were moving forward for the official declaration of the Área Ecológico de Conservación La Bonita-Cofanes-Chingual (AECBCC).
create the reserve. The next step—the creation of a valid legal framework and management plan for the municipal reserve—is still pending.

Cofanes-Chingual shares its southern border with the Reserva Ecológica Cayambe-Coca (403,103 ha). And, across the Río Chingual to the east lies the Reserva Ecológica Cofan-Bermejo (53,451 ha). Combined, these three areas would create a reserve of more than 550,000 ha, conserving a complete elevational range of Andean forests, which are some of the most critically endangered habitats in South America.

Our rapid inventory of Cofanes-Chingual supports conservation planning and implementation in the region by means of a survey of the biological value of the area and the social strengths and aspirations in surrounding villages and towns.

In the technical reports that follow, scientists discuss their findings on the geology, hydrology, flora, vegetation, fishes, amphibians, reptiles, birds, mammals, archeology, and social assets of the region. Below we provide a brief context for those reports, describing the sites surveyed by the biological team, and the human communities visited by the social team.

**BIOLOGICAL INVENTORY**
*(15–31 OCTOBER 2008)*

A highly heterogeneous jumble of soils and rocks—ranging from uplifted ancient geologic formations to young volcanic material and more recently altered metamorphic rocks—underlies Cabeceras Cofanes-Chingual. The landscape is terrifically dynamic, reflecting historical and ongoing processes of earthquakes, volcanic eruptions, glaciers, and landslides.

The nearest meteorological measurements, taken at the Guandera Biological Station on the western slopes of the inventory area, indicate an annual rainfall average of 1,700 mm. This number likely underestimates actual conditions in Cofanes-Chingual because of unmeasured condensation inputs from moisture-laden winds and near-constant cloud cover most of the year.

Spanning more than 3,500 m of elevational change, Cofanes-Chingual is bounded at its lowest point at 650 m (in the southeast) and extends over steep slopes and jagged peaks to reach its highest points over 4,200 m (in the northwest). Above 3,600 m, wet meadows, known as “paramos” (páramos in Spanish), form a large, discontinuous rim around the northern and western edges of the area. With the exception of some isolated terraces, a few flat crests, and the occasional glacially formed valley, there are remarkably few flat areas. The steepest slopes are on the southern edge of the isolated massif east of the town of La Sofia.

Using satellite imagery and a June 2008 helicopter overflight of the northern part of Cofanes-Chingual, we chose four sites: two within the Cofan ancestral lands and two within the proposed municipal reserve. Sites were selected to represent a broad altitudinal range (650–4,000 m) and the greatest diversity of habitats in the two proposed conservation areas.

Logistically, access to the area was extremely challenging, and we used a combination of horses, hiking, and helicopters to reach our sites. We traveled counterclockwise around the area, beginning in the northwest and ending in the northeast. Weather and helicopter availability prevented us from reaching Ccuttopoé, our southwestern site, despite three days of attempts.

Below we describe the three inventory sites visited by the biological team from 15 to 31 October, and include some information about the fourth site, Ccuttopoé, visited only by our advance team and our mammalogist (R. Borman) during early reconnaissance trips to the area. Our ichthyological team sampled streams at two additional sites near the towns of La Bonita and Puerto Libre; these habitats are described in their technical report (p. 187).

**Laguna Negra** *(15–19 October 2008, 00º36’44.1” N, 77º40’12.5” W, 3,400–4,100 m)*

This was our highest-elevation site. We camped midway along a kilometer-long valley, on a low rise at the base of a 25-m tall waterfall. Glaciers formed the valley, creating a U-shaped trough and leaving behind a series of rounded hills at the trough’s lower end. The waterfall separates the valley into two sections, and both the upper and lower sections have a flat area amidst the hills. In the lower valley, a small lake, Laguna Negra, fills the flat...
valley bottom and is visible on the satellite image. In the upper valley the area is swampy, apparently a former lake slowly filling with eroded soil and vegetation.

Tussock-grass paramo dominates the landscape, dotted with stems of *Espeletia pycnophylla*, known locally as *frailejones* (Figs. 1, 3A). Only the steepest slopes of the valley support patches of forest, which vary in size from small clumps of trees and shrubs to larger expanses of a hectare or more (Fig. 1).

We established 12 km of trails and explored the valley in which we camped, as well as two valleys to the west and one to the east. One of our trails descended to 3,400 m on an east-facing slope, where it entered much wetter forests. Because the paramo is open grassland, we could blaze across the landscape and not restrict ourselves to existing trails.

To reach the site, we hiked for two hours along a horse trail used frequently by residents of El Playón de San Francisco, a town only 6 km away. The town has initiated a tourism project near Laguna Negra, and residents are stockpiling wooden planks to build an inn and seeding the lake with trout (an exotic species). Currently people hunt and fish in the paramo, extract some timber for fuelwood, and set fires to the grasslands. Their trails criss-cross the paramo, as do occasional trails of spectacled bear.

**Río Verde** (22–26 October 2008, 00º14′13.9″ N, 77º34′34.7″ W, 650–1,200 m)

We flew by helicopter from the town of Puerto Libre to our lowest-elevation site, in the southeastern corner of Cofanes-Chingual. This site was closest to the diverse forests of Amazonia, and the only one where we found strong evidence of recent human settlement.

We camped on a high terrace, in a clearing at the edge of a sheer drop-off 50 m above the fast-flowing, ~30-m-wide Cofanes River. In the last year, Cofan park guards have established a guard post here, building a small house and creating a small garden of plantains, sugar cane, and corn. This is one of two areas within the Río Cofanes ancestral territory where the Cofan are establishing control posts; the other is on the western slopes in Carchi several kilometers upstream from Monte Olivo.

We explored 14 km of trails that traversed the high terrace where we camped, the ridge to the north of our camp, and forests on the other side of the Cofanes and Verde rivers. Many of the trails scrambled up steep faces; the few flat areas were restricted to ridges and the saddles between them. A network of small streams drains each of the hilltops, cutting through heterogeneous substrates to feed the Cofanes River and its tributaries.

Both the Cofanes and Verde rivers cut deep ravines and no true floodplain is evident along the inner meanders. All of the rivers had high water levels during our stay, and were rough and fast flowing. River levels created challenging sampling conditions for the ichthyologists, and, because fording the rivers was dangerous, we established cables to traverse the wider rivers using harnesses and pulleys.

We observed remnants of a mining camp along the Cofanes River, downstream from our camp. For the last three decades, illegal miners have been an ongoing presence in the area, with the most intense period of activity in the 1980s.

**Alto La Bonita** (26–31 October 2008, 00º29′18.0″ N, 77º35′12″ W, 2,600–3,000 m)

We flew by helicopter directly from the Río Verde site to Alto La Bonita—a spectacular flight up the Cofanes River drainage, flanked by forested peaks—and landed along the upper reaches of the Sucio River on a grassy bluff at the end of a massive landslide.

The landslide is recent, having occurred in the last four years, and apparently deposited enough material to dam the Sucio River temporarily. When the dam burst, the large pulse of water flooded expanses of pasture and agricultural lands near La Bonita. The landslide covers tens of hectares in its entirety but is ~50 m wide at its base at the river’s edge.

We explored 13 km of demanding trails, including (1) a long trail along the Sucio and over a large hillcrest to La Bonita, the nearest town, 6 km downstream; (2) a trail upriver along the Sucio and along a tributary to two side-by-side waterfalls; (3) a loop through montane forest growing on the slopes southwest of our camp; and (4) a long trail that traveled up the ridge north of our camp, descended into a glacial valley, traversed...
a series of Andean bogs, and reached the base of the granite cliffs that ring the valley.

The Sucio River was ~10-m-wide during our stay, and rose and fell dramatically with rainfall. Three years ago, the Sucio was stocked with trout (*Oncorhynchus mykiss*), a non-native species. The Amarillo River, a tributary of the Sucio that dissects the glacial valley, is currently devoid of trout, however, barring physical barriers, trout will almost certainly expand within the drainage.

Some small-scale logging is occurring in the area, mainly of *Podocarpus* trees, both for local use and commercial markets.

We reached this site by following an old, abandoned trail created by residents of La Bonita. The trail is now well established, and our campsite could provide an ideal location for a park guard post to monitor and stem hunting excursions and timber extraction from the area.

*Ccuttopoé* (00°19’57.6” N, 77°48’54.5” W, 3,350–3,900 m)

The biological team was not able to reach Ccuttopoé during the inventory. However, mammalogist Randy Borman visited the site twice before the inventory. Ccuttopoé is a Cofan word meaning “place of the mists.”

In contrast to Laguna Negra, few people have visited this site, and it appears to be one of the few remaining wild paramos in Ecuador.

From Monte Olivo, a town on the western slopes at 2,400 m, a trail leads steeply upwards through a mix of pastures and relatively intact montane forest until it reaches a small, oval lake ~1,400 m² in size (Fig. 3A). More than 30 years ago the lake was stocked with trout, and local residents are keen to develop tourism here.

Beyond this first lake, signs of human activity vanish, and bear and tapir tracks are abundant. A new trail established by the Cofan rises sharply from the trout-stocked lake through heavily forested sections of the valley, continuing up to tussock-grass- *Espeletia* paramos to the windswept and virtually bare ridge of the continental divide. From the divide downward, the Ccuttopoé camp comes into view, located at the headwaters of the Condué River, alongside a small lake at 3,600 m. Here, heavily forested hillside alternate with paramo meadows down the Condue valley to the confluence of the Condué and Agnoequi rivers at 3,200 m.

SOCIAL INVENTORY
(8 – 30 OCTOBER 2008)

The social team visited communities within and surrounding Cabeceras Cofanes-Chingual to identify the main patterns of natural-resource use of these communities (Figs. 2A, 12B), their potential interactions with and aspirations for the proposed conservation areas, and existing community and regional assets for participating in conservation planning.

The team visited 22 communities. In 9 focal communities, scientists conducted intensive interviews, community workshops, and informational meetings. We visited 13 additional communities to interview representatives of local and regional governments and other key actors, conduct visual surveys of land-use patterns, and briefly interview residents.

Although the communities visited are in the two provinces of Sucumbíos and Carchi, conceptually they can be grouped into three categories according to their sociohistorical patterns and regional contexts.

The first group of communities includes Paraíso, La Barquilla, Rosa Florida, La Bonita, and La Sofía. Here, forested areas dominate the landscape, ranging in elevation from 800 to 2,500 m. Communities are linked by (1) the Chingual River and its tributaries; (2) historical relations of settlement, kinship, migration, and economy; and (3) a highway (which connects them to Lago Agrio, the provincial seat of Sucumbíos, to the south, and Provincia Carchi to the north). In addition, communities share a common set of agricultural- and natural-resource use patterns, with local variations reflecting timing of settlement, altitude, microclimate, and geography. While sharing many of these characteristics, the community of La Sofía is distinctive because (1) it is located in a valley deep within the proposed municipal reserve, close to the Río Cofanes ancestral territory; (2) it still has no direct highway access; and (3) it is on the Laurel River, a tributary of the Cofanes River.

The second group comprises communities situated along the northern extent of the proposed municipal
reserve. Some are in the northernmost extension of Cantón Sucumbíos (in Provincia Sucumbíos), and the rest fall within Provincia Carchi. While these Sucumbíos communities have some historical and economic ties with the communities discussed above, they are economically, geographically, and ecologically most like their Carchi neighbors. The focal community visited was El Playón de San Francisco. However, observations and interviews with key institutional actors were carried out in Santa Barbara, Santa Rosa, Las Minas, and Cocha Seca (Sucumbíos); and Tulcán, Huaca, San Gabriel, and Mariscal Sucre (Carchi). These communities fall within an altitudinal range of 3,000–3,800 m. In this region, a patchwork of potato fields and cattle pastures surrounds human settlements, with the agricultural frontier gradually giving way to forested areas on hill crests just below the paramo. These forests protect water sources for several communities in both Sucumbíos and Carchi provinces.

The third group of communities inventoried is in Cantón Bolívar, at the southernmost tip of Provincia Carchi, bordering Sucumbíos and Imbabura provinces. Monte Olivo and Palmar Grande were our focal communities. We conducted observations and brief visits in nearby Miraflores, Raigrass, Aguacate, Manzanal, and Motilón villages, perched on the flanks of the surrounding mountains that drain into the Carmen and Escudillas rivers. The social team also briefly visited Pueblo Nuevo, a community a few kilometers downstream from Monte Olivo, established when some Monte Olivo residents relocated after a massive 1972 landslide. These settlements are at approximately 1,900–3,100 m and share historical links and a common struggle to adapt production systems to the demanding conditions of mountain microclimates, steep topography, and periods of water scarcity. The region provides irrigation water for downstream farming communities.

A core social team (Alaka Wali and Stephanie Paladino) was present throughout the inventory and was joined by additional members during different phases. Details and discussion of the natural-resource use practices and social assets of the communities within and adjacent to Cabeceras Cofanes-Chingual appear in the last chapter of the technical report (see pages 230–248).

**GEOLOGY, HYDROLOGY, AND SOILS:**
Landscape properties and processes

**Author/Participant:** Thomas J. Saunders

**Conservation targets:** High-altitude glacial valleys and lakes; a rare glacially-carved valley surrounded by solid granite walls; high-gradient rivers and streams; valuable ecosystem services of water capture and supply; and intact forests that provide natural protection from erosion in high gradient mountains

**INTRODUCTION**

The geological template of Cabeceras Cofanes-Chingual is among the most complex and dynamic on the planet. Outcrops of solidified volcanic debris, walls of solid granite, and a mixture of sedimentary and metamorphic rocks break the surface along an altitudinal gradient rising from 650 to over 4,000 meters in elevation. Rock ages range from geologically young volcanic deposits to slates whose original material was deposited well over a hundred million years ago. Steep, forested slopes, long sinuous ridgelines, and high-gradient rivers link high-altitude paramos (alpine grasslands) to the depositional floodplain of the Aguarico River. The region receives large quantities of rain and condensation, and water plays a huge role in shaping the landscape via erosion, landslides, and the constant export of sediments from the Andes to the Amazon.

During the last ice age, glaciers carved into the volcanic deposits and granite outcrops near these mountain summits to create deep glacial valleys bounded by steep rock cliffs. The Soche volcano shaped the landscape through its past eruptions and the resulting deposits of ash and rock throughout the region. Volcanic fire met glacial ice when Soche reportedly erupted ~10,000 years ago (Hall et al. 2008), creating huge mud and lava flows (“lahars”), again reshaping the landscape. Continually punctuated by change, the Andes of Cabeceras Cofanes-Chingual are still subject to major geological events. The Chingual-La Sofía fault line crosses directly through the middle of the inventory region (Eguez et al. 2003). This fault system has been very active over the past 10,000 years. Ego et al. (1996) estimate that an earthquake of 7.0–7.5 magnitude can be expected along this fault line every 400 (+/-440) years.
This 70-km fault line is just one indication of the active geology in the region: Significant eruptions of the nearby volcanoes Cayambe, Reventador, and Soche would also affect Cabeceras Cofanes-Chingual.

Less-dramatic landslides triggered by small storms and soil creep (the slow, downslope movement of soil due to gravity) occur across the landscape and exemplify the variety of temporal scales over which the mountains are shaped. Highly variable rock types and the high incidence of landslides result in a truly heterogeneous and dynamic arrangement of young soils. Despite this variability, a large-scale trend in soil conditions emerges: Regardless of underlying rock type, organic matter accumulation increases with altitude as the temperature drops and moisture levels rise in the soils. The physical and chemical properties of water also change as a function of altitude and geological variability but generally exhibit elevated pH and conductivity levels characteristic of whitewater Andean rivers. Small high-altitude lakes and marshes are common in the paramo landscape, and have their own unique physical and chemical properties.

Cabeceras Cofanes-Chingual dramatically influences regional meteorological and hydrological cycles by capturing much of the moisture held in the air masses blowing in from the Amazon Basin. An “orographic effect” wrings moisture from warm moist air forced up the eastern Andean slopes by the prevailing winds. With increasing altitude, dropping temperature gradually decreases the saturation point of these air masses and forces condensation of water molecules into droplets. Condensation accumulates on plant leaves, drains into the soil, and eventually drains through the subsoil and into streams and rivers. However, if vegetation cover decreases (i.e., via deforestation), so will the amount of condensation collected. With its intact forest cover and paramo, Cabeceras Cofanes-Chingual performs a monumental environmental service by capturing freshwater for human uses and environmental services.

Intact forests also prevent erosion and deter landslides that would otherwise occur on the steep mountainsides. Slopes in the region range from low-gradient terraces to vertical cliffs, and many of the slopes observed at the camps were at angles greater than 45°. The potential for erosion increases as a slope increases because the rain that falls on it travels faster and can carry more sediment. While the soils themselves may be fertile—especially in areas with a strong volcanic influence—clearing the forest for agriculture will result in a rapid loss of fertility because the heavy rainfall in the region quickly erodes bare soil. While it is possible to farm a steep hillside for a short period of time, erosion rates eventually become so high as to quickly exhaust the fertility of the soils. Also common in steep landscapes like the Cofanes-Chingual are large landslides that can endanger human habitations or cause temporary, natural dams along small rivers and streams that drain the steep valleys; these natural dams cause significant flooding downstream.

METHODS

I evaluated the landscape, soils, water bodies, and geological past of the region based on observations made while hiking the established trails in each camp, using aerial photos taken on overflights and during helicopter transport to each camp, and via existing data derived from satellite images (Aster, Landsat) and topographic information (SRTM 90-m resolution; IGN 1:50,000 scale maps). I assessed rock types along existing outcrops and in riverbeds to understand the dominant underlying bedrock at each camp. I used a Dutch Auger to sample soils to a depth of approximately 1.4 m within different landforms. I noted differences in soil color, texture, and horizonation in association with different landforms and along topographic gradients. Finally, I measured conductivity, pH, temperature, and dissolved oxygen in water bodies using a YSI Professional Plus datalogger and sensor assembly. I combined observations of geology, soil, hydrology, and water quality to form a landscape history at each site and to provide a physical context to the biological work completed during the inventory. References to soil taxonomy follow that of the USDA Soil Survey Staff (2006).

RESULTS

Data for the conductivity, dissolved oxygen, oxidation/reduction potential, pH, and temperature of water bodies are given in Appendix 1.
Laguna Negra

Geology and landscape processes

Laguna Negra sits at the base of a long, glacially carved valley bounded by a combination of sheer rock walls and steep hillsides. The relatively flat valley bottom is segmented by two waterfalls, which drop 10–25 m. Streams and small rivers near Laguna Negra slowly meander over a bedrock that tells of an explosive past. Volcanic breccia, the bedrock dominating the entirety of the Laguna Negra camp trail system, is formed when rocks created by volcanic eruptions (basalt, rhyolite, andesite, and pumice) are mixed with lava, water, and ash in violent torrents (“lahars”). This heterogeneous mix of rock and water eventually hardens into a solid rock mass containing inclusions of various rock types. After glaciers cut into this rock, the resulting valleys were again filled with lahars and landslides that occurred following the glacial retreat.

The valley of Laguna Negra resembles other, glacially carved headwater valleys that I observed nearby at similar elevations along the trail system. The glacial and volcanic landscape that originally formed by a violent combination of fire and ice continues to be transformed by slow but persistent geomorphic and pedogenic processes. Plant growth, organic matter deposition, and sediment slowly fill the hollows of the valley bottoms and convert lakes into wetlands by creating deep, soft deposits of organic matter, fine sand, and silt. Small landslides descend from the steep hillsides, burying old soil surfaces with fresh organic and mineral material, and adding to the hummocky topography in the valley. Small streams meander around these landslide surfaces, slowly cutting into the valley bottom.

Soils

Owing to its high elevation, Laguna Negra is characterized by cold and wet conditions that dramatically slow the decomposition of organic matter. Grasslands produce large amounts of organic matter, which then accumulate into thick organic deposits. (Notably, paramo soils act as considerable storehouses for carbon.) Surface horizons, rich in organic matter, often exceeded 1 m in depth, especially in relatively flat areas of the landscape. Steep hillsides alternate between exposed bedrock covered by lichens and mosses to those covered by a shallow organic-rich soil over bedrock. Textures are often much sandier on hillsides because weathered bedrock from above mixes with the surface soil. Where Andean forests are present in patches, thick mats of moss (up to 60-cm thick in places) occur on the surface of shallow soils. The soils dominating this region fall under the soil order of Andisols (using USDA taxonomy) due to the presence of volcanic materials within 50 cm of the soil surface. Limited expanses of Histosols, those soils dominated by organic matter, are especially prevalent in the saturated valley bottoms and wetlands.

Water

Lakes, streams, bogs (pantános), and small pools were common throughout the wet, high-elevation paramo. Temperatures were consistently <10 °C in all water bodies, but small exposed pools had temperatures up to 12 °C during day. The pH of streams and rivers was affected by the concentration of base cations (Ca, Mg, K, Na) commonly associated with volcanic rocks, leading to higher pH values (>6.3) compared to water in wetlands (often <5.0) maintained by organic acids derived from the dead plant material with which they are in direct contact. In effect, the thick organic deposits disconnect the stagnant or slow moving water from the influence of the bedrock, resulting in a dominantly organic chemical signature (low pH, low conductivity). Regardless of relatively minor variation in the chemical signatures of its waters, the paramo plays a significant role in the region’s hydrological cycling and freshwater production through its consistent production of potable freshwater resources via condensation.

Alto La Bonita

Geology and landscape processes

Rock composition at Alto La Bonita is the most heterogeneous of the entire inventory. As at Laguna Negra, a massive glacier carved a valley out of the landscape. However, at Alto La Bonita, the glacier slowly cut through an outcrop of solid granite (Fig. 3B),
breaking the rock and mixing it with volcanic debris that was then deposited into two large and notable lateral moraines (essentially plow rows of the glacier). Along a landslide on one lateral moraine, large cobbles and boulders of granite were found high on the hillside, mixed with sand and gravel-size pieces of pumice, rhyolite, and basalt. Lower in the valley, at an elevation of approximately 2,600 m, the lateral moraines terminate and a steep V-shaped, river-carved valley dominates the landscape. The bed material of the Sucio River mainly consists of granite from the upper valley, however, many metamorphic rocks (including schist and gneiss) were also common. Easily broken and eroded lightweight volcanic rocks are quickly transported down the steep river gradient of this lower, V-shaped valley, leaving only a few traces of rock with volcanic origins in the sands and small gravels of the riverbed.

Soils
Like Laguna Negra, Alto La Bonita is a high-elevation, low-temperature site where organic matter degradation is slowed and accumulations of thick organic horizons are common. Thick root mats (often 1 m or more thick) blanket the steep hillslopes and valley bottoms, making it difficult to walk. Mirroring its geologic complexity, the soils of Alto La Bonita are extremely heterogeneous because they form over distinct rock types across a variety of dynamically changing landforms. Landslides transport huge masses of mineral and organic material tangled with tree trunks, large boulders and cobbles to the valley floor or onto abandoned river terraces. Soils here are extremely complex, heterogeneous, and often just beginning to form on fresh deposits, with few diagnostic horizons. In general, soils are of the order “Inceptisol,” i.e., soils that are just beginning the process of forming distinct horizons. Similar to Laguna Negra, Histosols predominate the wetland areas of the flat valley bottoms where organic matter has accumulated in thick deposits.

Water
Water bodies in Alto La Bonita are high-gradient, high-energy rivers and streams that transport huge volumes of stone, tree trunks, root balls, and suspended sediment from the high valleys to the lowlands. The meandering stream that drains the low-gradient, glacially carved valley of the Amarillo River is the lone exception. The channel substrate consists of smaller gravels and cobbles that contrast the boulder-choked channel of the Sucio River. Iron, after being dissolved from the surrounding, flat, water-saturated valley, drains to this river and is oxidized (rusted) by bacteria in the water and growing on the rocks. This imparts a yellowish-orange color to the river rock and the water itself. In rivers throughout the Sucio River’s headwaters, the pH is generally high, but the varied composition of granite and volcanics balances the pH toward 7.

Río Verde
Geology and landscape processes
The geology and soils of Río Verde, the lowest elevation camp, are distinct from our other camps. The bedrock underlying the Río Verde inventory area is no longer dominated by the granites, gneiss, and schist found in the upper catchment but instead consists of sedimentary, meta-sedimentary, and metamorphic rocks derived from former sedimentary deposits. The dominant rock at the base of the Río Verde region is a dark black slate, a metamorphic rock that began its formation well over 14 million years ago (before the Andes began to rise in Ecuador) as thick deposits of organic matter and clay.

As the Andes formed, rivers that once drained toward the western edge of South America began to drain eastward, where they formed large pools. Their organic matter and fine sediment continued to accumulate at the base of the young Andes. As the mountain range continued to grow, so did the particle size of the sediments arriving in its floodplains, grading from clays into silts and sands. Organisms growing in the waters created calcium carbonate shells that accumulated in some areas to form limestone. Pressure built and the soft deposits were compressed into a hard stone known as shale. As the pressure of mountain building continued to influence this area, the shale was further compressed (metamorphosed) into the dense-layered black slate found today. Overlying these slates are mudstone and limestone that underwent varying degrees of compression and
metamorphism. Intrusions of magma from below caused localized melting and re-cooling of these rocks, creating a gradient of rock types derived from the same original sedimentary material, each melted and resolidified to varying degrees. Durable, hard cherts also are common in the area and formed when mudstones were exposed to high concentrations of dissolved silica that then precipitated within the mudstone matrix. Hard silica-rich cherts are often used by humans for tool making.

Finally, the Cofanes River transported the granite, schist, and gneiss from the upper catchment and deposited them along the river’s edge in the form of terraces, meanwhile dumping large boulders and cobbles into the tributary rivers during massive floods. Abandoned river terraces high above today’s riverbed still contain fragments of these rounded stones. As a result, the soils formed on these old terraces contain a mixture of rocks from the entire Cabeceras Cofanes-Chingual region. The rivers of the area continue to cut into the deep bottoms of the steep V-shaped canyons.

Soils
The conditions at Río Verde were similar to those encountered at Alto La Bonita in that landslides and erosion maintain a young and heterogeneous set of soils, constantly evolving within the landscape. However, one major difference between Río Verde and our higher camps is the content of organic matter in the soil. At Río Verde, warm temperatures contribute to faster decomposition of soil organic matter. Soils are firm and easy to walk on, and thick root mats like those covering Alto La Bonita were not present. The deepest soils were found on river terraces, and soils were generally shallow on steep slopes and even on the narrow, high ridges. Sand content was higher in the shallow soils of the steep slopes because rock material was mixed with the upper soil during landslides. The majority of soils at Río Verde would again be classified as Inceptisols due to their youth and limited differentiation into horizons.

Water and water bodies
Upstream from its union with the Cofanes River, the bed substrate of the Verde River changes from large, well-rounded granite and metamorphic boulders and cobbles deposited by the Cofanes to the slate and mudstone cobbles drawn from local formations. Due to mixed outcrops of slate, mudstone, and limestone, the chemical properties of the small streams feeding the Verde River are variable. One stream in particular had an elevated pH (8.13) and the highest conductivity (107.7 µS) recorded during the inventory, suggesting the presence of a surface or shallow subsurface deposit of calcium or magnesium carbonate. During the inventory I also noted that the Verde River responded dramatically to rainfall events: Its water level rose and fell substantially over a two day period. High levels of erosion were notable on the hillsides (landslides) as well as by a change in color when suspended sediments filled the river channel following rainstorms. Any further deforestation in the system would quickly lead to elevated rates of erosion.

THREATS AND OPPORTUNITIES
High-altitude Andean forests and paramo are known for their production of large volumes of high-quality freshwater. This intact ecosystem service has immense value and should be protected by preventing deforestation of local watersheds. The steep slopes of Cabeceras Cofanes-Chingual are held in place by the plant communities growing on them. These precarious slopes are already sensitive to natural landslides originating from earthquakes and intense rain events. Anthropogenic deforestation in the region would dramatically increase rates of landslides and erosion and cause further slope instability. The cold and wet soils of high-elevation habitats of the inventory region are major storehouses for carbon in the form of soil organic matter. The extent and significance of these carbon stores need to be quantified and considered when making decisions regarding land use.

The tremendous value of ecosystem services of water production, slope stabilization, and carbon storage in Cabeceras Cofanes-Chingual present clear opportunities to justify and perhaps provide a source of stable funding for conservation in the region.
RECOMMENDATIONS

- Retain forest cover on all slopes to ensure the production of clean water and limit the loss of soil and organic matter.
- Limit destructive human activities (mining, roads, agriculture, cattle grazing, excessive burning) in forested and paramo landscapes to protect water quantity and quality.
- Conduct studies of carbon storage in high-altitude areas of the Cofanes-Chingual region.

FLORA AND VEGETATION

Authors/Participants: Corine Vriesendorp, Humberto Mendoza, Diego Reyes, Gorky Villa, Sebastián Descanse, and Laura Cristina Lucitante

Conservation targets: The diverse and endemic flora of the northern Andes, a region largely deforested in other parts of Colombia and Ecuador; healthy populations of timber species in upper and lower montane forests (e.g., *Polylepis*, *Podocarpus*, *Weinmannia*, *Humiriastrium*); tremendous diversity of orchids, including possibly some of the highest local richness of genera such as *Masdevallia*; and a broad elevational gradient of intact forest, critical in allowing migration in response to climate change.

INTRODUCTION

Cabeceras Cofanes-Chingual ("Cofanes-Chingual") comprises the forested slopes on the eastern flank of the Andes in northern Ecuador. The area has been largely unexplored by botanists, and we know little about the local flora. Currently, our best approximation comes from plant collections at elevations above 1,000 m in eastern Carchi and western Sucumbios provinces, representing ~2,200 species (TROPICOS 2008; D. Neill pers. com.). Nearly all of these collections come from areas along or near the Pan-American highway and other major roads that encircle Cofanes-Chingual.

In addition, three nearby reserves share plant species with some elevations of Cofanes-Chingual: the paramo of Reserva Ecológica El Angel (Foster et al. 2001), elevations between 600 and 4,200 m in Reserva Ecológica Cayambe-Coca, and areas above 600 m in the Reserva Ecológica Cofan-Bermejo (Foster et al. 2002). In nearby Colombia, floristic records exist for a 25-ha plot, La Planada (Vallejo et al. 2004), and although La Planada is on the western slopes of the Andes and covers a small elevational range (1,718–1,844 m), there is some floristic overlap with Cofanes-Chingual.

METHODS

From 15–31 October 2008, we surveyed flora and vegetation in paramo (3,400–4,200 m), upper montane forest (2,600–3,000 m), and lower montane forest (650–1,200 m) in sites in the northern, eastern, and southern parts of Cofanes-Chingual. At each of our three sites, we covered as much ground as possible, collecting fertile species and noting gross differences in habitat types. In the field, H. Mendoza, D. Reyes, and C. Vriesendorp took more than 2,500 photographs of plants, mostly in fertile condition. A selection of the best of these photographs will be freely available on the web at http://fm2.fieldmuseum.org/plantguides/.

Our estimates of relative differences in diversity are approximations; we made no quantitative measurements of plant diversity. Using our collection records and observations of well-known species, we generated a preliminary list of the flora of the Cofanes-Chingual (Appendix 2). We matched these data with records from the Red Book of Endemic Plants of Ecuador (Valencia et al. 2000) to determine the endemic status of plants recorded during the inventory.

We collected 843 specimens during the inventory. R. Foster and W. Alverson spent a combined twenty days pressing, drying, and identifying specimens at the Herbario Nacional (QCNE) in Quito, Ecuador, joined for six days by H. Mendoza, D. Reyes, and G. Villa. These collections are deposited at QCNE, with duplicate specimens at The Field Museum (F) in Chicago, USA, and the Herbario Federico Medem Bogotá (FMB) of the Instituto Alejandro von Humboldt, Bogotá, Colombia. Any additional specimens were sent to specialists or distributed to Ecuadorian herbaria.
FLORISTIC RICHNESS AND COMPOSITION

During the inventory we encountered approximately 850 species of vascular plants—with almost no overlap among our three sites—of which 569 have been identified to species, genus, or family (Appendix 2). We estimate Cofanes-Chingual harbors 3,000–4,000 plant species. This estimate reflects our sense that within the ~2,200 collections known from the region, forests in the middle elevations (1,500–3,000 m) are under-represented and likely harbor 800–1,800 additional species. In addition, regional endemism is high, with many species likely restricted to the remaining forests in northern Ecuador and southern Colombia.

In order of increasing elevation, we registered approximately 350 species at Río Verde (650–1,200 m), 300 species at Alto La Bonita (2,600–3,000 m), and 250 species in Laguna Negra (3,400–4,100 m). Conservatively, we estimate that 1,000–1,200 species occur at Río Verde, 700–800 at Alto La Bonita, and 300–350 species at Laguna Negra.

Certain families and genera were particularly diverse and abundant. At Laguna Negra, our paramo site, the most species-rich families were Ericaceae, Asteraceae, and Poaceae. Generic diversity in Ericaceae at Laguna Negra was especially high, with many species of *Ceratostema*, *Disterigma*, *Gaultheria*, *Macleania*, *Pernettya*, *Plutarция*, *Themistoclesia*, *Thibaudia*, and *Vaccinium*. At Alto La Bonita, in the upper montane forests, we found great diversity of Asteraceae, Melastomataceae, and particularly Orchidaceae. At the generic level, we registered at least 5 species of *Masdevallia* (Orchidaceae). At Río Verde, our lowest elevation site, we had more lowland species and greater rates of disturbance. Piperaceae, Melastomataceae, and Rubiaceae were the most species-rich families, with the genus *Piper* (Piperaceae) particularly species rich. Generic diversity in Rubiaceae was spectacular, with species representing 16 genera: *Coussarea*, *Faraema*, *Guetarda*, *Hamelia*, *Hippotis*, *Hoffmannia*, *Joosia*, *Macbrideina*, *Manetta*, *Notopleura*, *Palicourea*, *Pentagonia*, *Psychotria*, *Schradera*, *Sphinctanthus*, and *Warszewiczia*.

In these wet montane forests, epiphytes are an important element of the flora. The dominance and richness of orchids at Alto La Bonita was particularly impressive, ranging from big showy species (e.g., *Maxillaria*, *Masdevallia*) to many tiny orchids (e.g., *Lepanthes*, *Stelis*). Overall, bromeliads and hemi-epiphytes were abundant, but not particularly diverse.

VEGETATION TYPES AND HABITAT DIVERSITY

Rugged terrain and exceedingly wet conditions create dramatic small-scale differences in vegetation and plant composition. Below we briefly describe the plant communities we encountered at each site.

**Laguna Negra** (3,400–4,200 m)

At Laguna Negra we surveyed two habitats: tussock-grass paramo and forest patches growing on wet, steep slopes. Neither of these habitats is very diverse; however both harbor species endemic to high-elevation Andean forests and grasslands.

The major landscape-level disturbances are landslides and fires, with paramo vegetation representing one of the first successional phases in the recolonization of disturbed areas. Some of the disturbances are mediated by local residents, who set fires in the paramo and extract trees (especially *Polylepis*, Rosaceae; *Escallonia*, Grossulariaceae; *Weinmannia*, Cunoniaceae) for fuelwood or fence-building.

**Paramo**

Despite natural and anthropogenic disturbance, the paramo flora at Laguna Negra is rich and similar to paramo in nearby areas (e.g., Reserva Ecológica El Angel and the Guandera Biological Station). The grass *Calamagrostis intermedia* (Poaceae) dominates the landscape, which is punctuated by stems of *Espeletia pycnophylla* (Asteraceae), known locally as *frailejón*. A predictable suite of other species—*Calceolaria* cf. *crenata* (Scrophulariaceae), *Halenia weddelliana* (Gentianaceae), *Hypericum laricifolium* and *H. lanceoloides* (Clusiaceae), *Brachytomum lindenii* (Melastomataceae), *Chuquiraga jussieui* (Asteraceae), and numerous other Asteraceae—are scattered throughout the grasslands. *Puya hamata* (Bromeliaceae) was only moderately common, and only a few individuals had inflorescences;
however, spectacled bears appear to be eating both their tufted, white seeds and inner core.

The paramo in the upper valley has a broad flat bottom, without *Espeletia*. The soils here are waterlogged, spongy, and covered in yellow and white-flowered rosettes of *Hypochaeris* (Asteraceae). A handful of species of Rubiaceae form scrambling carpets across wetter areas, including *Arcytophyllum setosum* (with small white flowers), *Galium hypopcarpium* (with tiny orange fruits), and *Nertera granadensis* (with small red fruits). The cushion plants that often dominate wetter areas in Colombian paramos are surprisingly scarce or absent here.

**Remnant forests**

A few forest patches on the steepest cliff faces grow on moss mats heavy with moisture, creating areas so waterlogged that they resemble vertical swamps. Tree composition did not appear different from other areas, but, growing amidst the forest, we observed greater densities of terrestrial orchids, *Fuchsia* (Onagraceae), and *Castilleja* (Scrophulariaceae).

The majority of forest patches grow on steep slopes without extensive moss mats. The most common trees are *Gaiadendron punctatum* (Loranthaceae), visible from afar with rusty orange leaves and yellow inflorescences; *Escallonia myrtilloides* (Grossulariaceae) with tiny leaves; *Baccharis* sp. (Asteraceae) with grayish-white lanceolate leaves; *Gynoxys* (Asteraceae) with appressed terminal leaflets; and *Weinmannia pinnata* (Cunoniaceae) with flat-topped canopies. In addition, two trees in different families, *Ilex colombiana* (Aquifoliaceae) and *Cybianthus marginatus* (Myrsinaceae), are common and have a similar morphology of tiny, spiralled, densely packed leaves that give their branches a tower-like aspect.

The only regeneration of forest species we observed in the paramo were substantial numbers of *Gaiadendron punctatum*, and an occasional *Weinmannia pinnata*. Current hypotheses regarding factors that determine treelines suggest that cold night-time temperatures, coupled with high solar radiation, may inhibit photosynthesis of forest species in open areas, preventing their invasion of paramo at higher altitudes (Bader 2007). We speculate that *G. punctatum* either has less stringent physiological constraints, is reproducing clonally, or may be parasitizing roots (given that it a member of the largely parasitic family Loranthaceae).

In forest canopies, the long, red, erect tubular flowers of *Tristerix longebracteatus* (Loranthaceae) stand out, as well as the emergent inflorescences of the common climber *Pentacalia* (Asteraceae). Evolutionary convergence is common. For example, the red flowers of the common vine, *Ceratostema alatum* (Ericaceae) are pendulous but superficially similar to the erect flowers of *Psittacanthus*. Trees and shrubs in many families have converged on an “ericoid” habit, with small, sclerophyllous leaves.

*Clusia flaviflora* (Clusiaceae) was not present in forest patches, however we did observe this species along ridges at lower elevations. This species, known locally as *guandera*, is extracted for fuelwood, especially on the western slopes of Cofanes-Chingual in Provincia Carchi.

**Older paramo on landslides**

As mentioned above, we found limited regeneration of forest species in the wide and open paramo that dominates the area. However, older paramo was being invaded by forest species on an east-facing slope with several landslides. The oldest landslides were covered in high grasses, giant *Espeletia* (>5-m tall), and many forest species. Our working hypothesis is that areas colonized after landslides are small enough that forests can recolonize, not only because of the proximity of seeds, roots, and rhizomes, but also because the microclimatic conditions in smaller clearings may be less stringent than in bigger, open areas. However, perhaps east-facing slopes receive more moisture and are therefore less subject to burns.

Compared to other areas we sampled at Laguna Negra, this east-facing slope was lower (~3,400 m) and much wetter, with greater moss mats growing on trees, and many more orchids. This was the only place we saw *Podocarpus* (Podocarpaceae). The forest on this slope was dominated by *Cybianthus marginatus*, *Escallonia myrtilloides*, and a Melastomataceae with domatia (small structures typically inhabited by mites or ants) on the underside of the leaf.
Alto La Bonita (2,600–3,000 m)

Compared to other sites at 2,600 m, Alto La Bonita appears to have more in common with higher-elevation areas, perhaps because it is a river valley isolated from lower areas by constricted canyons and waterfalls, and because it is surrounded by higher elevation peaks. Although we had only a few dozen plants shared among our inventory sites, the few species overlaps that did occur were between Alto La Bonita and Laguna Negra, despite these sites not having overlapping elevational ranges. A very similar pattern was detected with birds during the inventory; see that chapter of this technical report.

We encountered a diverse upper-montane forest assemblage, with a mix of older, well-established forests and successional habitats. We coarsely define habitats as ranging from montane forests growing on slopes and ridges, successional forests in the glacial valley, and ephemeral communities along river edges and in andean bogs. Cold temperatures and the amount of water (especially in the waterlogged glacial valley) appear to determine which species can make a living here.

Orchid diversity was incredibly high. In these montane forests, up to half of the diversity can be concentrated in epiphytes, and the majority of that richness rests within the Orchidaceae. We recorded numerous genera, including Encyclia, Masdevallia, Maxillaria, and Stelis. Many of our collections remain unidentified, and we suspect that several of these species are restricted to this area or to Ecuador, as 33% of the 4,011 species endemic to Ecuador are orchids (Valencia et al. 2000).

Montane forests on slopes and ridges

The most common tree locally is Hedyosmum translucidum (Chloranthaceae), with white fruits, present near the Río Sucio and extending up onto nearby ridges. We observed substantial populations of Podocarpus macrostachys (Podocarpaceae), known locally as pino, reported to be logged selectively in the area. Other important elements of the arboreal flora include a Styrax (Styracaceae, with deep purple fruits and fuzzy leaves), Weinmannia pinnata (Cunoniaceae), a Saurauia (Actinidiaceae, with white flowers), an Ocotea (Lauraceae, with golden leaves and ripe black fruits), Ilex laurina (Aquifoliaceae, with coriaceous leaves and flower buds), and Clusia flaviflora (Clusiaceae, the same species we observed in forests below our paramo site in Laguna Negra). Similar to Laguna Negra, Ericaceae are important elements of the epiphytic and shrub flora, with Ceratostema peruvianum exceedingly common, as well as Cavendishia cf. cuatrecasasii.

Many of the species were shared between the ridge and the slopes near our camp. However, we observed some species only on the ridge: a scrambling Chusquea (Poaceae) bamboo, a Desfontainia spinosa (Loganiaceae) shrub with red flowers, a simple-leaved tree Weinmannia (W. balbisiana, Cunoniaceae), and Oreopanax nitidum (Araliaceae), a tree with 3-to-5-lobed leaves. We suspect that all of these species are likely present near camp, and would almost certainly appear with more extensive searches. Much greater variation exists between the species present on slopes and ridges and the species present within the glacial valley.

Glacial valley

The glacial valley is relatively flat and drained by numerous tributaries of the Amarillo River. Podocarpus disappears here, despite being common on the ridge and neighboring slopes. The valley is substantially wetter than other habitats at this site, and some plant species were observed only here: Brunellia cayambensis (Brunelliaceae), Gaiadendron punctatum (in flower at Laguna Negra but not here), another Ocotea (Lauraceae) with much smaller leaves, and two species of Hedyosmum (Chloranthaceae). The two species of Hedyosmum (H. cuatrecazanum with smaller leaves, and H. strigosum with densely pubescent leaves) appear to replace H. translucidum, and give an indication of the small-scale heterogeneity and species replacement at this site.

Within the valley, there are a series of successional habitats that seem to respond to the amount of water present. The youngest areas are the wettest and are represented by three Andean bogs that may be small former lakes filling with vegetation. Crossing the valley, the forest structure changes as one approaches the granite cliffs. Trees are covered in more moss, and there is almost no understory. Presumably this reflects the moister
microclimate created by water pouring off the cliffs and the near-persistent clouds and mist against the cliff faces.

Andean bogs
In the Andean bogs we were surprised to document paramo vegetation, including a *Puya* bromeliad (Fig. 4S), *Ugni myricoides* (Myrtaceae), *Hypericum* (Clusiaceae), abundant cushion plants, as well as numerous individuals of a tiny white-flowered orchid (*Epidendrum fimbriatum*). Woody vegetation surrounds the bogs, including species of *Clethra* (Clethraceae), *Eugenia* (Myrtaceae), *Gaiadendron punctatum*, and *Geissanthus* (Myrinaceae).

Riverine herbs
Along the Sucio River, herbs are abundant on exposed rocks and cliff faces. Most of these are genera typical of disturbed montane habitats, e.g., *Gunnera* (Gunneraceae, with fruits), *Begonia fuchsiiflora* (Begoniaceae, with big red flowers and perhaps not buzz-pollinated like the majority of Begonia), *Fuchsia pallescens* (Onagraceae), *Bomarea* (Alstroemeriaceae, with red flowers), herbaceous *Phytolacca rugosa* (Phytolaccaceae), woody *Cleome anomala* (Capparaceae), and numerous Asteraceae herbs.

Río Verde (650–1,200 m)
Río Verde was our lowest elevation site, our most diverse site, and the only site where we recorded species more typical of the Amazonian lowlands. Many species are shared between Río Verde and the Reserva Ecológica Cofan-Bermejo (Pitman et al. 2002).

Steep terrain characterizes the area, and landslides appear to be frequent. We loosely divide habitats into diverse forests growing on flatter areas and highly disturbed forests growing on slopes. Plant diversity is concentrated on the mountain crests and saddles, and even the flat terrace near camp was much more diverse than any of the slope forests.

Slope forests
Our trails scrambled up steep slopes, through areas recovering from landslides. One large landslide appeared to be a patchwork of smaller slides, each 30–50 m² in size. However, this may have been a larger landslide that came to a halt in flat areas, or encountered groups of trees that resisted the slide, creating an archipelago of less-disturbed patches (each with bigger trees, ~35-m tall and ~50 cm dbh) within a sea of disturbance.

The disturbed areas are covered in *Guadua* bamboo, a few species of *Acalypha* (Euphorbiaceae), several species of *Cecropia* (Cecropiaceae), and many *Piper* (Piperaceae). In the wetter disturbed areas we found *Alloplectus* and *Besleria* (Gesneriaceae), *Notopleura* (Rubiaceae), and *Costus* (Costaceae) and *Renealmia* (Zingiberaceae). The understory is dominated by Rubiaceae (*Faramea oblongifolia*, *Palicourea* sp., *Psychotria cuatrecasasii* and *P. racemosa*), Melastomataceae (*Clidemia heterophylla*, *Henriettella*, *Miconia*, *Ossaea macrophylla*, *Tococa*), *Pseuderantemum hookerianum* (Acanthaceae), cauliflorous *Calyptranthes speciosa* (Myrtaceae), and a floppy *Ischnosiphon* (Marantaceae).

In the less disturbed areas, individuals of *Pourouma* (Cecropiaceae) are abundant (especially *P. minor*), as well as *Capparis detonsa* (Capparaceae). Trees on slopes included *Dendropanax cf. caucanus* (Araliaceae), and in less disturbed areas, *Chryosophyllum venezuelanense* (Sapotaceae) and *Clarisia racemosa* (Moraceae). Growing on the larger trees, we found *Gurania* (Cucurbitaceae) vines, *Aracea* epiphytes (especially *Anthurium*), and a *Marcgravia* sp. (Marcgraviceae), which was common. We observed at least four species of *Burmeistera* (Campanulaceae) with remarkable leaf variation across species, akin to the variation in *Passiflora* (Passifloraceae) that appears to be driven by an insect-plant arms race.

Forests on crests, saddles, and terraces
Forests growing on flat areas harbor the greatest diversity at Río Verde: a mix of species from rich-soil lowland areas (e.g., Parque Nacional Yasuní) and species typical of lower montane forests. Although many rich-soil genera (e.g., *Ficus*, *Guarea*, *Heliconia*, *Inga*, *Protium*, *Virola*) are present, the richness within these genera is low, and each is represented only with a few species.

Examples of Amazonian species present include *Hasseltia floribunda* (Flacourtiaceae), *Grias neuberthii* (Lecythidaceae), *Warscewiczia coccinea* (Rubiaceae), *Protium amazonicum* (Burseraceae), *Marila laxiflora*
(Clusiaceae), Discophora guianensis (Icacinaceae), Guarea pterorachis (Meliaceae), Inga marginata and I. thibaudiana (Fabaceae s.l.), Minquartia guianensis (Olacaceae), and Theobroma subincanum (Sterculiaceae, with toothed leaves). On mountain crests, Amazonian species mix with montane elements, e.g., Saurauia (Actinidiaceae), Brunellia (Brunelliaceae), Billia rosea (Hippocastanaceae), and Blakea harlingii (Melastomataceae). Annonaceae and Lauraceae are dominant on crests, represented by Annona, Guatteria and Unonopsis (Annonaceae), and Aniba and Ocotea (Lauraceae). Palms (Arecaceae) were less common and diverse than in the lowlands. The most common palm was Oenocarpus bataua; we also recorded Aiphanes ulei, Chamaedorea pinnatifrons, Wettinia maynensis, an occasional Bactris gasipaes, and several species of Geonoma.

The lower, flat areas (old terrace around camp) are covered in monodominant patches of certain species, in both the tree and understory strata. Dominant trees include Dacryodes olivifera and Protium (Burseraceae), Vochysia braceliniae (Vochysiaceae), and Humiriastrum diguense (Humiriaceae). In the understory, the dominance of Tovomita weddelliana (Clusiaceae), Tabernaemontana sananho (Apocynaceae), and Psychotria cuatrecasasii (Rubiaceae) was overwhelming, substantially reducing understory diversity.

NEW SPECIES, RARITIES, AND ENDEMICS

Some of our 843 collections were identified to species during our extensive work in the QCNE herbarium in Quito, and the rest await revision by specialists. Based on our preliminary work, we highlight a number of species that are endemic to Ecuador, endemic to northern Ecuador and southern Colombia, new records for Ecuador, and/or species potentially new to science.

Endemics

- **Blakea harlingii** (Melastomataceae, Fig. 4J), endemic to Ecuador. Collected at 1,100 m on crests above our Río Verde camp, this species is known from only two other localities: the slopes of Cordillera Huacamayos and the slopes of the Reventador volcano along the Quijos River. It is considered rare, restricted to 1,000–1,500 m, and classified as Vulnerable (Valencia et al. 2000).

- **Meriania pastazana** (Melastomataceae), endemic to northern Ecuador and southern Colombia. This species has stunning, large, magenta flowers and is also known from La Planada in Colombia. We collected a specimen at Alto La Bonita.

New records for Ecuador

- **Miconia pennelli** (Melastomataceae). This species is known from the Pacific slopes in Colombia (both the type locality in the Cauca valley and in Antioquia), as well as an isolated collection in Cordillera del Condor in Peru. Our observation represents a new record for Ecuador. In addition, there are several existing specimens of *M. pennelli* in the QCNE herbarium that are currently misidentified as other *Miconia* (H. Mendoza pers. com.).

- **Morella singularis** (Myricaceae, Fig. 4P). There are two known *Morella* species from Ecuador, and we collected a third previously known only from Colombia, *M. singularis*, at Alto La Bonita.

- **Meriania peltata** (Melastomataceae). Our observation from Alto La Bonita represents a new record for Ecuador. This species was previously known only from Colombia, where it is threatened by large-scale habitat destruction (Mendoza and Ramírez 2006).

Possible new species

- **Meriania** (Melastomataceae, Fig. 4N). This specimen was collected along the river in Alto La Bonita on the strenuous hike from our campsite to the town of La Bonita. This beautiful plant with magenta and deep purple flowers is known from ~2,000 m in Colombia and appears to represent an undescribed species.

- **Semiramisia** (Ericaceae). Only one *Semiramisia* (S. speciosa) is known from Ecuador, and our collection from Alto La Bonita has much thinner and elongate leaves.

- **Protium** (Burseraceae, Fig. 4L). This species is a large tree with huge fruits. It appears to be similar to the
species known from the 50-ha plot in Yasuní that is currently being described as a new species (D. Daly pers. com.).

- *Puya* (Bromeliaceae, Fig. 4S). We collected a *Puya* with yellow flowers at Laguna Negra that does not match any of the *Puya* known from Ecuador (J. M. Manzanares, pers. com.).

**OPPORTUNITIES, THREATS, AND RECOMMENDATIONS**

In contrast to heavily deforested Andean forests elsewhere, Cabeceras Cofanes-Chingual represents an opportunity to protect a diverse, intact elevational gradient from low-elevation cloud forests up through the paramos. Despite difficult access and rugged terrain, some timber is cut in the area. We found evidence that both *Polylepis* (Rosaceae) and *Podocarpus* (Podacarpaceae) are extracted for local use and commercial markets, and we are almost certain that other species are removed. We recommend establishing park guard posts, regular patrols, and agroforestry initiatives to reduce and ultimately eliminate timber extraction from within Cofanes-Chingual.

In the region, our inventory represents the first plant collections away from the Panamerican highway and other major roads. Although our records represent an important, first effort in the area, much remains to be explored. We recommend additional inventories of the isolated massif to the east of La Sofía, the upper Condué valley, the Ccuttopoé paramo, the upper Cofanes drainage, and the forested areas on the western flanks in Carchi province. In particular, we recommend concentrating initially on unsampled elevations, specifically 1,100–2,500 m and 3,000–3,500 m).

**FISHES**

**Authors/Participants:** Javier A. Maldonado-Ocampo, Antonio Torres-Noboa, and Elizabeth P. Anderson

**Conservation targets:** Highly endemic Andean fish communities located between altitudes of 500 and 3,500 m, for which there is a dearth of documented information; healthy aquatic ecosystems within the Cofanes-Chingual basin; ecological integrity of aquatic communities, of which fishes comprise a principal component; hydrological connectivity between the headwaters and downstream areas throughout the Cofanes-Chingual basin, where both altitudinal and longitudinal gradients define composition and structure of the area's ichthyofauna

**INTRODUCTION**

Fish diversity within the neotropical region is the most diverse in the world (Vari and Malabarba 1998). The region includes the Amazon River Basin, which harbors approximately 2,500 fish species (Junk et al. 2007). Over the last few years, new studies conducted in systematics and biogeography have sought to understand the processes that generated this enormous diversity. It is widely recognized that the upper Amazon is particularly important in terms of ichthyofaunal endemism, as it may harbor approximately 50% of the species known from the entire basin (Junk et al. 2007). Tectonic movements associated with Andean uplifts have been identified as one of the main factors leading to isolation, thereby increasing the proportion of endemic species in the area (Lundberg et al. 1998; Hubert and Renno 2006).

Despite widespread recognition of the importance of the biogeography of fishes within the Andean-Amazonian piedmont, very few studies have attempted to determine the true richness of the communities in the piedmont, which extend from Colombia to Bolivia, especially at altitudes greater than 500 m. Henry Fowler, a North American ichthyologist, conducted the first fish inventories within the Andean-Amazonian piedmont, in Colombia, along the Ecuadorian border. Between 1943 and 1945, he described nine species from the piedmont surrounding the Caquetá River basin (Maldonado-Ocampo and Bogotá-Gregory 2007). Another inventory of native fishes took place in 2005 in the upper basins of the Mocoa and Putumayo rivers, in the department of Putumayo and documented a total of 29 species, of
which three were new registries for the hydrographic zone of the Colombian Amazon (Ortega-Lara 2005). A lack of information marks Ecuador’s case as well; some inventories have been made in the Andean-Amazonian piedmont of the Pastaza River basin (Willink et al. 2005; Anderson et al., unpublished data), yet a portion of the information remains unpublished.

The principal goal of this study was to document the ichthyofauna present in the Cofanes-Chingual-Aguarico basin in order to determine its ecological value and identify conservation opportunities. We present the results of our fish inventory conducted during 22–29 October 2008, the first study of the ichthyofauna of the Cofanes-Chingual-Aguarico basin. We also offer comparisons to previous studies in nearby basins of the Amazonian piedmont of Colombia.

METHODS

Sample sites

We sampled 18 collection stations located in three areas within the Cofanes-Chingual-Aguarico basin (Río Verde, Alto La Bonita, and Bajo La Bonita) (Fig. 19). These were located between 500 and 2,600 m in altitude in a heterogeneous landscape characterized by complex topography and geomorphology (Appendix 1). To ensure that our collections best represented the entire Cofanes-Chingual basin, especially rivers at lower altitudes with more fish, we included sampling sites within Bajo La Bonita, an area east and south of the three primary camps of the rapid inventory and not sampled by the other members of the biological team.

Collecting stations at the Río Verde and Alto La Bonita sites were located in rivers within forested areas. In contrast, collection stations at the Bajo La Bonita site were in rivers and streams that drain a mosaic landscape of forest, agricultural lands, and communities. (Stations 017 and 018 were outside of the proposed municipal reserve.) As such, Bajo La Bonita stations were subject to more anthropogenic influence than the other collecting stations.

We sampled mid-sized streams (5–15 m wide) as well as larger rivers (15–30 m wide). At each sampling station, we measured water temperature (°C), conductivity (µS), and pH using a HACH SensION156 Portable Multi-Parameter Meter. In addition, we recorded altitude and geographic coordinates (Appendix 3).

Collection

For collection of fishes we used an electrofisher along a 100-m transect at each sampling station (Fig. 5D). With this technique, electric current passes from two submerged electrodes that attract and stun fish, which are then captured using a trap basket (which also functions as one of the electrodes) and an additional net.

We fixed collected fish in a 10% formol solution, after which specimens were packed in plastic bags and labeled. In the lab, specimens were washed with water and placed in flasks with 75% alcohol for subsequent identification. We identified each specimen to the most precise taxonomic level possible, depending on access to taxonomic keys and existing bibliographic material for the taxonomic groups collected in the sampling area (Regan 1904; Géry 1977; Chernoff and Machado-Allison 1990; Vari and Harold 2001; Armbruster 2003; and Maldonado-Ocampo et al. 2005).

After identification, specimens were cataloged and deposited in the fishes collections of the Museo
Ecuatoriano de Ciencias Naturales (MECN) in Quito, Ecuador, and the Instituto Alexander von Humboldt (IAvH-P) in Villa de Leyva, Boyacá, Colombia. Our species list follows the taxonomic classification of Reis et al. (2003), where families are listed in systematic order, while genera and species of each family and subfamily are listed alphabetically.

RESULTS

Characterization of the collection stations

Our observations indicate that rivers found within the Cofanes-Chingual basin are typical of the Andean-Amazonian piedmont, characterized by high gradients, fast-running water, and bed sediments dominated by large rocks (>25 cm). As a result, rivers in this part of the basin are very dynamic and subject to rapid discharge fluctuation from rainfall events; habitats for aquatic fauna are unstable and few refuge areas are available during high-flow events. It has been shown that these unstable conditions could be regulating basic biological aspects, such as reproductive strategies, of the species distributed in these systems (Torres-Mejía and Ramírez-Pinilla 2008).

With respect to physicochemical sampling stations, water temperature ranged from 10.6°C to 22.9°C, conductivity ranged from 15.1 to 165.5 µS/cm, and pH ranged from 5.3 to 7.9 (Appendix 3). Of these parameters, the one most affecting fish distribution is water temperature, which is directly related to altitude. The average temperature of stations sampled in the Río Verde and Bajo La Bonita areas was 19.9°C and 20.6°C, respectively, while Alto La Bonita was 11.9°C. In our experience, a noteworthy decrease in fish abundance and diversity occurs in areas with water temperatures below 15°C; our results here support this idea. Conductivity values at stations sampled in Río Verde and Bajo La Bonita were similar: average values were 55.6 µS/cm and 58.6 µS/cm, respectively. In certain areas of the basin, our data suggest that soils of volcanic origin influence the water’s chemistry; this could be the case in the Chingual River, which has elevated conductivity (165.5 µS/cm) relative to the other sites. For more detailed discussion of the bodies of water found within the basin, see the chapter on geology, water, and soils elsewhere in this report.

Richness, abundance, and composition

In total, we captured 653 individuals, representing 32 species (one introduced), 10 families, and three orders (Appendix 4). The most diverse order was Characiformes, followed by Siluriformes (Table 7).

This representation of orders, families, and species marks a pattern that has been recorded in other areas of the Amazonian piedmont of Ecuador, Peru, and Colombia (Ortega-Lara 2005; Ortega and Hidalgo 2008; Anderson et al. unpublished data). The families with greatest species richness were Characidae, Loricariidae and Astroblepidae. All other families had between one and three species (Table 8).

In terms of patterns of distribution, 31 native species were collected at stations located below 1,000 m. We registered the most number of species (17, representing 53% of all species collected) at station 017, located in Río Cabeno at 483 m; in fact, of those 17 species, 12 were found in no other station (Appendix 4).

### Table 7. Number and percentage of families and species for each order present in the Cofanes, Chingual, and Aguarico River Basins.

<table>
<thead>
<tr>
<th>Order</th>
<th># Families</th>
<th>%</th>
<th># Species</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Characiformes</td>
<td>6</td>
<td>54.5</td>
<td>16</td>
<td>50.0</td>
</tr>
<tr>
<td>Siluriformes</td>
<td>4</td>
<td>36.4</td>
<td>15</td>
<td>46.9</td>
</tr>
<tr>
<td>Salmoniformes</td>
<td>1</td>
<td>9.1</td>
<td>1</td>
<td>3.1</td>
</tr>
</tbody>
</table>

### Table 8. Number and percentage of species of each family present in the Cofanes, Chingual, and Aguarico river basins.

<table>
<thead>
<tr>
<th>Family</th>
<th># Species</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Characidae</td>
<td>10</td>
<td>31.3</td>
</tr>
<tr>
<td>Loricaridae</td>
<td>6</td>
<td>18.8</td>
</tr>
<tr>
<td>Astroblepidae</td>
<td>5</td>
<td>15.6</td>
</tr>
<tr>
<td>Crenuchidae</td>
<td>3</td>
<td>9.4</td>
</tr>
<tr>
<td>Trichomycteridae</td>
<td>3</td>
<td>9.4</td>
</tr>
<tr>
<td>Parodontidae</td>
<td>1</td>
<td>3.1</td>
</tr>
<tr>
<td>Erythrinidae</td>
<td>1</td>
<td>3.1</td>
</tr>
<tr>
<td>Lebiasinidae</td>
<td>1</td>
<td>3.1</td>
</tr>
<tr>
<td>Heptapteridae</td>
<td>1</td>
<td>3.1</td>
</tr>
<tr>
<td>Salmonidae</td>
<td>1</td>
<td>3.1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>32</strong></td>
<td><strong>100.0</strong></td>
</tr>
</tbody>
</table>
We registered 19 native species in the proposed conservation area of the Cofanes-Chingual basin (Bajo La Bonita’s stations 017 and 018 are outside of the proposed borders). We consider this to be a low number, taking into account the basin area and type of habitats found within the basin. We estimate that 25–30 species live between 500 and 3,000 m altitude.

The fact that the number of native species is greater at the lower altitude stations (e.g., Río Cabeno) could be the result of covarying hydro-geological factors along the area’s altitudinal and longitudinal riverine gradients. These factors may limit dispersion of some species to upstream waters within the basin, as documented in other Andean and piedmont regions (e.g., Alvarez-León and Ortiz-Muñoz 2004; Miranda-Chumacero 2004; Pouilly et al. 2006). However, we did not sample in the important altitudinal zone between 1,000 and 2,000 m. Absence of species data from that zone may influence our results and observed patterns related to the decrease in species along altitudinal and longitudinal gradients.

In terms of abundance, the largest number of individuals collected belonged to the Siluriformes order (548, or 83.9%). We collected 103 individuals (15.8%) of Characiformes. The families Astroblepidae and Loricariidae were most abundant, with 296 and 226 individuals, respectively. We collected the species *Astroblepus* sp1, *Astroblepus* sp2, and *Chaetostoma* sp2 most consistently; they were present in 10 of the 13 stations and were the most abundant. Dominance of Siluriformes (in terms of abundance) was the result of the ecomorphological adaptations of Astroblepidae and Loricariidae species to habitats found in Andean and piedmont rivers. These species are classified as “torrent species” according to Maldonado-Campo et al. (2005).

Of the 32 registered species, rainbow trout (*Oncorhynchus mykiss*) was the only non-native. In this study, it was only collected at the three stations located in the Sucio River at altitudes greater than 2,500 m in the Alto La Bonita area, where water conditions are optimal for its development. According to locals, *O. mykiss* was introduced to the upper Cofanes-Chingual river basin three years ago. We expected to capture species of the family Astroblepidae at stations 011, 012, and 013 in Alto La Bonita, but none were encountered. Additional studies should be conducted to determine whether or not the presence of the introduced rainbow trout has resulted in the absence of native species because of competitive exclusion (we noted a large abundance of rainbow trout at these sites) or if the presence of physical barriers—specifically waterfalls—has limited dispersion of native species upstream.

Within the genera *Characidium*, *Hemibrycon*, *Astroblepus*, and *Chaetostoma*, it is possible that we registered new species not previously described (one species per each genus; see Figs. 5B, 5E–G). During identification, we encountered certain characteristics in our collections not present in species described for the genera. Additional material must be collected and further work conducted on collected specimens in collaboration with specialists in order to confirm this possibility.

We expect that the number of species in the area is greater than the number registered during this study. Climatic conditions during our sampling affected collection, especially in the area of Río Verde, where water levels were high. Furthermore, the collection stations represented only a small percentage of the entire Cofanes-Chingual basin. Due to logistical constraints, collection stations were concentrated around Río Verde and Alto La Bonita. The fact that this study did not include any sampling sites between 1,000 and 2,500 m provides an additional explanation for the low number of recorded species relative to the number of species that actually inhabit the basin.

**THREATS**

- Protection measures should be prioritized in areas below 1,000 m for two important reasons: (1) most human activity and consequent effects on rivers occurs in areas below 1,000 m, and (2) all native species collected were present at sampling stations below 1,000 m. Through interviews with locals we learned that rivers in the region have been affected by activities such as mining, and fishing with dynamite and *barbasco* (a fish poison, typically plant based), with probable effects on the ichthyofauna.
Possible construction of a hydroelectric dam in the Cofanes-Chingual basin could negatively affect riverine connectivity and habitat availability within the aquatic ecosystem. The kinds and extent of effects will depend on the design and location of dams.

The wide distribution and abundance of non-native rainbow trout in various rivers within the Cofanes-Chingual basin is notable, although the impact or threat its presence has on native fishes remains unknown. In certain parts of the basin where anthropogenic influences on the landscape are noteworthy, such as near Alto La Bonita, the habitat conditions remain in a natural state; however the presence of rainbow trout could be affecting the structure of biological communities. From conversations with locals, it became clear to us that people are interested in introducing rainbow trout to other rivers.

Water pollution from increasing use of agrochemicals, as well as direct, untreated wastewater discharges, may affect the water quality of the Chingual River and its tributaries, with consequences for the aquatic biota.

From a conservation perspective, a lack of local knowledge of the zone’s native fish can be considered a threat. When we spoke with people living near La Bonita, La Barquilla, and Rosa Florida, several said that rainbow trout was the only kind of fish in the rivers. Without knowledge of native ichthyofauna, it is quite probable that locals will utilize rivers without regard for the quantity and quality of water needed by native fish populations.

OPPORTUNITIES

Compared with other river basins in the Andean-Amazonian piedmont, the Cofanes-Chingual basin still maintains a high level of ecological integrity. Because most of the basin drains healthy forests and there are no hydrologic alterations, aquatic ecosystems maintain natural physiochemical conditions and connectivity. In contrast, other Andean-Amazonian basins within Ecuador are degraded substantially as a result of polluting industrial and agricultural activities or because of water diversions for irrigation or hydroelectric projects, as is the case within the Pastaza and the Napo basins. In its current state, the Cofanes-Chingual basin offers a unique opportunity—not available in other parts of Ecuador—to conserve aquatic ecosystems and protect important fish populations along an altitudinal gradient, between 500 and 3,500 m.

RECOMMENDATIONS

Protection and management

- Prioritize protection measures in areas below 1,000 m and restrict unsustainable fishing methods, such as the use of dynamite or barbasco.
- Maintain hydrologic connectivity of the bodies of water throughout the Cofanes-Chingual basin.
- Implement clear regulatory and control measures over rainbow trout introductions that take into account possible negative effects on native fish communities.
- Seek out alternatives to the use of harmful agrochemicals and promote development of water treatment projects.
- Review hydroelectric project designs to verify that they include strategies to reduce negative effects on hydrological connectivity and aquatic environments.

Research

- Determine the distribution of rainbow trout in the Cofanes-Chingual basin and research the effects of its introduction on aquatic ecosystems, particularly native fish species. The studies should include comparisons between rivers without rainbow trout and rivers where rainbow trout were introduced at different times.
- Conduct cost-benefit studies of rainbow trout cultivation for alternative income to determine whether or not it is financially feasible.
- Collect complementary information (i.e., hydraulic parameters) to understand the habitat needs of different species.
- Conduct natural history studies (i.e., feeding habits, reproduction) for species in the Cofanes-Chingual basin.

**Additional Inventories**

The Andean-Amazonian piedmont, whether in Ecuador or Colombia, is one the least explored regions for fishes, yet it harbors incredible richness. We were able to sample a mere fraction of the ichthyofauna within the vast Cofanes-Chingual basin. Additional inventories are essential in other major tributaries of the Cofanes and Chingual rivers (Figs. 11G, 12B), as well as in the mainstem rivers themselves. Greater knowledge of the region and its fish fauna will help us identify additional conservation threats and opportunities. The geographic range and length of the inventories should be increased to gain a more complete understanding of the region’s ichthyofauna.

**AMPHIBIANS AND REPTILES**

**Authors/Participants:** Mario Yánez-Muñoz and Jonh Jairo Mueses-Cisneros

**Conservation targets:** Endemic species of Nudo de Pasto and the eastern foothills of northern Ecuador and southern Colombia classified as Endangered (EN) by the International Union for Conservation of Nature and Natural Resources (IUCN), including Cochranella puyoensis, Gastrotheca orophylax, and Hypodactylus brunneus; amphibians whose reproductive strategies have been affected by climate change and epidemiologic factors in the Ecuadorian and Colombian Andes (Hyloscirtus larinopygion, Cochranella puyoensis, Gastrotheca orophylax); species with restricted distribution, associated with paramo microhabitats, which are threatened by excessive burning by humans (Osornophryne bufoniormis, Hypodactylus brunneus, Riama simoterus, and Stenocercus angel); endemic species categorized as Data Deficient with restricted distributions in northern Ecuador and southern Colombia (Pristimantis ortizi, P. delius, and P. colonensis)

**INTRODUCTION**

Biological conservation of the tropical Andes region is of global importance because the region harbors some of the richest biodiversity in the world (Freile and Santander 2005). The Andes’ dominant physiographic characteristics have had a direct influence on the diversification and endemism of the herpetofauna. Thus, this a biologically important life zone because of the adaptations to the region’s bio-ecological conditions exhibited by these organisms (Duellman 1979; Mena et al. 2001). Regionally, the Ecuadorian Andes harbor the largest diversity of amphibians, where endemism reaches 77% of the known species (Coloma 2005–2008). Despite their importance, dramatic population decreases—attributed to disease and abnormal climatic factors during the 1980s, stemming from global climate change—have been catastrophic in the region at altitudes between 1,200 and 3,000 m (Merino-Viteri 2001). Furthermore, biodiversity studies and inventories in the region have been focused on Amazonian tropical humid forests. Only a handful of scientists have ventured to the slopes and paramos of the Andes to study the richness of the herpetofaunal communities.

Herpetofauna are distributed throughout the upper mountains and eastern slopes of the Andes along the Ecuador-Colombia border, where vast, continuous expanses of natural vegetation connect the paramos to the forested foothills. The only sources of information about area’s amphibian and reptile species are the original species descriptions and certain systematic studies of specific groups, mostly based on material obtained in El Playón de San Francisco, Santa Bárbara, La Fama, and La Bonita in Ecuador; and in the Pasto-Valle transect of Sibundoy-Puerto Asís in Colombia (Duellman and Altig 1978; Duellman and Hillis 1990; Lynch and Duellman 1980; Williams et al. 1996; Mueses-Cisneros 2005). During the last decade, there has been a notable increase in the number of studies in Ecuador. Marsh and Pearman (1997), Frolich et al. (2005), Yánez-Muñoz (2003), and Laguna-Cevallos et al. (2007) have researched the paramos and Andean forests of the Cordillera Oriental along the provincial border of Carchi and Sucumbíos. Based on work by Aguirre and Fuentes (2001) in the biological corridor north of the Reserva Ecológica Cayambe-Coca, Campos et al. (2001) developed a study of the herpetofauna between 1,000 and 2,000 m around the areas of La Bonita, Rosa Florida, La Sofía, and La Barquilla. Several additional studies focused on lower elevations (600 to 1,200 m) have contributed to a general picture
of the species present in the region, such as Altamirano and Quiguango (1997) in Sinangoe (part of the Estudio Biológicos para la Conservación de Ecociencia Program), and the work of Rodríguez and Campos (2002) in Serranías Cofán-Bermejo, Sinangoe (during their Rapid Biological Inventory with the Field Museum). Less work has occurred in Colombian territory; there is only one study by Mueses-Cisneros (2005) in Valle de Sibundoy (between 2,000 and 2,800 m). No information exists for the foothills area in Mocoa.

Our principal objective was to characterize the composition of the herpetofauna diversity in Cabeceras Cofanes-Chingual, in order to establish baseline information needed for the area’s conservation, zoning, and management. In addition, we provide an overall summary of the herpetofauna located along the border of northeastern Ecuador and southern Colombia, compiling available information from various studies of the region’s herpetofauna conducted to date, while also highlighting this group’s diversity and conservation importance.

METHODS

From October 15 to October 30, 2008 we worked in three camps located in Cabeceras Cofán-Chingual region (see Regional Overview and Study Sites). We conducted visual surveys with manual capture (Heyer et al. 1994) in each sampled location, completing 8 daytime walks of 2–8 h each and 11 nocturnal walks of 2–8 h each. We thoroughly reviewed all microhabitats along the established trails in order to find the greatest number of species in the least amount of time possible. We walked freely and directly to sites of interest (which is not permitted under transect or parcel methods). We quantified sampling effort by calculating the time (in hours) each person spent searching and capturing or observing individuals. We inspected any pond, puddle, or area with collected water that we encountered, including those along the trail, on the beaches along streams and rivers, as well as natural water deposits found between bromeliad leaves, in search of tadpoles. In the paramo ecosystem, we implemented a rake-and-hoe-removal technique (Remoción con Rastrillo y Azadón, or “RRA”), which we describe in detail in Appendix 7. Furthermore, we registered vocalizations by anurans and any casual off-trail encounters. To verify our taxonomic identifications and for future reference, we deposited 432 voucher specimens in the collection at the Herpetological Division of the Museo Ecuatoriano de Ciencias Naturales (MECN).

We verified the species taxonomic nomenclature, known distribution patterns, and conservation status using the Amphibian Species of the World (Frost 2008), Global Amphibian Assessment (IUCN et al. 2004), and Reptile Data Base (Uetz et al. 2007).

To measure community complexity on the alpha-beta diversity scale, we utilized the Shannon Index ($H' = -\sum p_i \ln p_i$), which is based on proportional species abundance. Under this measure, a community is more diverse when the number of species within the community is great and the relative proportion of the species is relatively equal, that is, when no species are very common (“dominant”) compared to the rest (Magurran 1989). The relative abundance reflects the proportional contribution of a given species to the total abundance of a community. We expressed it in proportion of individuals per species ($p_i = n_i/N$) and realized dominance-diversity curves for each studied area.

The degree of similarity between sampled sites in each camp surveyed was calculated using a cluster analysis of similarity, based on the Jaccard coefficient. We analyzed the data using BioDiversityPro ver. 2 Software (McAleese et al. 1997).

RESULTS

Composition and characterization of the herpetofauna

After dedicating 170 man-hours, we registered 547 individuals representing 42 species (36 amphibians and 6 reptiles) in the three camps surveyed (Appendix 5). All amphibians belonged to the order Anura and represented seven families and 13 genera. The richest families (in terms of absolute richness) were Strabomantidae and Hylidae, with 38% (16 spp.) and 29% (12 spp) of all the species registered, respectively. Furthermore, the family Hylidae was represented by the most genera (five). We registered four species of Bufonidae and one species for each of the remaining
families registered (Amphignathodontidae, Centrolenidae, Dendrobatidae, and Leptodactylidae).

Only reptiles from the order Squamata were represented, with two snake species (both Colubridae) and four lizard species, each from a different family (Gymnophthalmidae, Hoplocercidae, Polychrotidae, and Tropiduridae).

In absolute abundance, amphibians were more abundant than reptiles. The families Strabomantidae, Bufonidae, and Hylidae were the most abundant, with 46%, 35% and 16% respectively; the remaining families did not have more than 7% of the individuals registered.

The herpetofauna studied correspond to three associated assemblages: (1) paramo communities of the upper Andes, in Nudo de Pasto of Cordillera Oriental, Ecuador, (2) mountain communities of the eastern Andean foothills, and (3) foothill communities that converge with Amazonian lowlands.

The paramo communities are located in our Laguna Negra camp, 3,800–4,100 m in altitude. High densities of frailejones (Espeletia pycnophylla, Asteraceae) and puyas (Puya, Bromeliaceae), scattered throughout rough topography, drainage, and ravines encapsulating wetlands and surrounding small patches of Andean forest on pronounced slopes, characterize this area. Within this environment, the assemblage’s composition is made up mostly of Anurans from the genera Pristimantis, Hypodactylus and Osornophryne, all of which have direct-development reproductive strategies associated with forest patches and other paramo vegetation, such as the puyas or decomposing leaves and/or trunks of Espeletia. Of the reptiles, the semi-fossorial lizard Riana simoterus utilizes decomposing frailejón trunks, like the Anuras; and Stenocercus angel was mostly observed in reed grasses (Calamagrostis sp.) and tall pampas grasses (Cortaderia sp.), although one individual was also found within a trunk.

The mountain assemblage of the eastern slopes found at Alto La Bonita, between 2,600 and 3,100 m. Frogs of the genus Pristimantis predominate this montane ecosystem, and we registered high dominance of the only species of Bufonidae here (Osornophryne aff. guacamayo; Fig. 6A). These species are distributed in the forest interior along the slopes and ridges, among shrubby vegetation and epiphytes (of families Bromeliaceae and Cyclanthaceae). Sizeable populations of Hylocoerus larinopygion and Gastrotheca orophylax (Fig. 6C) inhabit the upper and lower valleys of Alto La Bonita, along riparian systems and floodable drainages.

The foothills community was sampled at our Río Verde site, near the lower portions of the Río Cofanes basin between 700 and 1,000 m. Amazonian influence on the herpetofauna in this region is clear: Most of the species belong to the family Hylidae and are distributed in small streams in forest clearings, with Dendropsophus and Scinax being most common. Tributary streams and wetlands drained by mountain slopes and riparian vegetation along the Cofanes River likewise make ideal habitat for Hylocoerus phyllognathus, Hylidoboa boans, and Osteocephalus cabrerai. On forested slopes and terraces, the dominant species Osteocephalus planiceps prefers to inhabit canopy epiphytes (Bromeliaceae).

In the understory, Pristimantis frogs are common leaf-litter and ground dwellers, and Rhinella dapsilis has a conspicuous presence as well. Reptiles were not diverse in this ecosystem, although some were registered within the forest (Imantodes cencbo and Enyalioides praestabilis).

More than a quarter of the herpetofauna registered (29%) correspond to regional endemic taxa, restricted to the eastern Andean slope of southern Colombia and northern Ecuador. Furthermore, most correspond to montane and paramo communities, which harbor nine amphibians (Gastrotheca orophylax, Osornophryne buforiformis and O. aff. guacamayo, Hylocoerus larinopygion, Hypodactylus brunneus [Fig. 6E], and Pristimantis buckleyi, P. chloronotus, P. colonensis and P. leoni) and three reptiles (Riana simoterus, Enyalioides praestabilis, and Stenocercus angel). Four of the species have restricted distribution in the Amazon basin, three of which are present in Colombia, Ecuador, and Peru (Hylocoerus phyllognathus, Osteocephalus planiceps, Pristimantis quaquaversus) and one in Brazil, Ecuador, and Peru (Pristimantis diadematus). Two of the inventoried species are found only in Ecuador: we registered Cochranella puyoensis (Fig. 6F) in the foothills at Río Verde and Pristimantis ortizi (Fig. 6D) in the montane ecosystem of Alto La Bonita. A considerable percentage (38%) of the herpetofauna registered...
correspond to species with wide distribution throughout the Amazon Basin and Andean slopes:

We registered 13 amphibian species and three reptiles at Río Verde (amphibians Rhinella dapsilis and R. marina, Dendropsophus bifurcus, D. parviceps, D. cf. leali and D. sarayacuensis, Hypsiboas boans, H. geographicus and H. lanciformis, Osteocephalus cabrerai, Scinax ruber, Leptodactylus wagneri and Pristimantis altoamazonicus; and reptiles Imantodes cenchoa, Chironius monticola and Anolis fuscoauratus). The remaining species registered have yet to be identified.

We registered three Endangered (EN) amphibian species (Gastrotheca orophylax, Cochranella puyoensis, Hypodactylus brunneus), as categorized by the Global Amphibian Assessment (IUCN et al. 2004); three Near Threatened (NT) species (Osornophryne bufoniformis, Hyloscirtus larinopygion and H. phyllognathus); and two Data Deficient (DD) species (Pristimantis delius and P. ortizi). Nineteen species (42%) categorized as Least Concern (LC) correspond to Amazonian-foothills species with healthy populations in northern Ecuador and southern Colombia. Finally, 14 species registered have not been categorized at all, either because their conservation status is stable or because they have not been evaluated (as is the case with the reptiles), or because we have yet to determine their taxonomic status, as is the case with several amphibians.

**Indicators of alpha-beta diversity of the sampled sites**

Herpetofaunal diversity, whether measured in terms of absolute richness or with the Shannon Index (H′), differs among the ecosystems studied during the inventory. Species-richness values fluctuate from a low of 7 in Laguna Verde, to 11 in Alto La Bonita, to 25 in Río Verde. H′ Values obtained registered 1.3 bits in Alto La Bonita, 1.6 in Laguna Negra, and 2.6 in Río Verde. Absolute abundance in the studied sites averaged 182 individuals; Alto La Bonita had the most with 267 individuals and Laguna Negra the least with 136 individuals (Fig. 20). Relative abundance of the studied ecosystems shows that the species with the highest proportion of individuals (p) in Alto La Bonita is Osornophryne aff. guacamayo, with 59% dominance in the community assemblage. Dominant species in Laguna Negra and Río Verde represented only 34% and 18%, respectively, of the abundance obtained for each (Figs. 21–23).

**Laguna Negra**

We found 136 individuals representing seven species (five amphibians and two Sauria). The amphibians belong to two families, Bufonidae (one species) and Strabomantidae (two genera and four species); while the reptiles belong to two families and two genera. By utilizing the new “RRA” sampling methodology in this camp, we were able to obtain sizeable collections of both Osornophryne bufoniformis and Hypodactylus brunneus, which other herpetologists had categorized as rare. Absolute richness and diversity measures (H′) obtained for the five sites evaluated in Laguna Negra do not present major differences, representing on average of five species (H′= 1.3 bits), with a minimum of five (H′= 1.1 bits) and a maximum
of six ($H'=1.6$ bits). Absolute abundance in the five studied sites averaged 30 individuals (minimum 13, maximum 43). Species dominance varied among the sites: *Pristimantis* grp. *orcesi* was dominant in two, while *Hypodactylus brunneus*, *Osornophryne bufoniformis*, and *Pristimantis chloronotus* each were dominant in remaining evaluated sites. The dominance-diversity curve of the assemblage (Fig. 21), shows that five (or 71%) of its species possess high dominance values and concentrate 96% of the total abundance obtained, with *Pristimantis* grp. *orcesi* ($p_i = 0.34$) as the dominant species.

**Alto La Bonita**

We found 267 individuals representing 11 species (10 amphibians and 1 reptile). The amphibians belong to four families, of which Strabomantidae is best represented with one genus and six species, and the remaining families (Amphignathodontidae, Hylidae, and Bufonidae) each include only one species. One colubrid snake (*Chironius monticola*) represents the reptiles.

We noted the presence of *Pristimantis colonensis* (Fig. 6B) and *P. ortizi*, previously known only from their type locations. We also collected a rare endemic species (*Osornophryne aff. guacamayo*) and several frog species (such as *Hyloiscirtus* and *Gastrotheca*) whose reproductive strategies have been affected by climate change and epidemiological factors in the Andes of both Ecuador and Colombia. Absolute richness and diversity measures ($H'$) obtained for the four sites evaluated in Alto La Bonita registered an average of six species ($H'= 1.14$ bits), with a minimum of three ($H'= 0.8$ bits) and a maximum of eight ($H'=1.2$ bits). Abundance in the four studied sites averaged 69 individuals (minimum 50, maximum 104). Dominance between sites was similar, and *Osornophryne aff. guacamayo* was dominant in every sampled site. The dominance-diversity curve of the assemblage (Fig. 22) shows that 73% of its species possess low dominance levels; however 57% of the total abundance is concentrated in *Osornophryne aff. guacamayo*. 

**Figure 21.** Dominance-diversity curve for the herpetofauna at Laguna Negra.

**Figure 22.** Dominance-diversity curve for the herpetofauna at Alto La Bonita.
**Rio Verde**

We registered 144 individuals representing 25 species (22 amphibians and 3 reptiles). The amphibians belong to six families, of which Hylidae is best represented with six genera and 11 species, followed by Strabomantidae with one genus and 6 species. One species represents each of the remaining families of the assemblage (Centrolenidae, Dendrobatidae, Bufonidae, Leptodactylidae, Colubridae, Hoplocercidae, and Polychrotidae). The presence of *Cochranella puyoensis* stands out; this is an endemic species of south-central Ecuador categorized as Endangered (EN). In addition, our registry of *Rhinella dapsilis* is notable because it was previously only known to inhabit Amazonian lowlands below 300 m. Absolute richness and diversity measures (H') obtained for the four evaluated sites registered an average 9 species (H' = 1.09 bits), ranging from 7 (H' = 1.9 bits) to 12 (H' = 2.3 bits). Abundance in the four studied sites averaged 39 individuals, ranging from 22 to 53. Dominance among sites varied. *Scinax ruber*, *Pristimantis grp. conspicillatus*, *Osteocephalus planiceps*, and *Dendropsophus parviceps* were each dominant in their respective sampled sites. The dominance-diversity curve of the assemblage (Fig. 23) shows that 87% of its species possess low dominance values and that 18% of total abundance is concentrated in one species (*Osteocephalus planiceps*).

**Comparison between the three sampled camps**

Other than *Pristimantis chloronotus* (which was found at both Laguna Negra and Alto La Bonita), all of the other species were found at only one camp. This shows us that the altitudinal differences and distinct vegetation formations result in different faunal communities. Furthermore, each camp evaluated showed interspecific variations among sampled sites. The five sampled sites at Laguna Negra were highly similar (65%), while the four sampled sites at Alto La Bonita were only 43% similar. Finally, Rio Verde had only 25% similarity between its four sampled sites.

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**Figure 23.** Dominance-diversity curve for the herpetofauna at Rio Verde.
**Noteworthy records**

As a result of our inventory, we report increased latitudinal distributions for three species, we added one new species to Ecuador’s amphibian list, and we found that several species considered rare were present in high densities. We also have a possible new species to science.

*Cochranella puyoensis* (Fig. 6F): Previously, this species was only registered in four locations between the provinces of Pastaza and Napo (in the south) (Cisneros-Heredia and McDiarmid 2006). The individual captured in Río Verde increases the known range for the species, and Río Verde now represents its known northern limit. However, we believe that it likely that *Cochranella puyoensis* is also further north in Colombia, given its proximity.

*Rhinella dapsilis*: Previously this species’ range was between 100 and 300 m in Amazonian Brazil, Colombia, Ecuador, and Peru. In Ecuador, it had only been recorded in three locations, all below 300 m: Reserva de Producción Faunística Cuyabeno, Parque Nacional Yasuní, and the lower basin of Río Pastaza (IUCN et al. 2004). Its presence in Río Verde extends in its altitudinal and latitudinal distribution into foothill forests in Sucumbíos province at 800 m. Río Verde represents the fourth location in Ecuador and its upper altitudinal limit.

*Pristimantis ortizi* (Fig. 6D): This species was recently described (Guayasamín et al. 2004) and had been found in two locations in northeastern Ecuador. Our registry obtained at Alto La Bonita represents the third known location for this species as well as its northern distribution limit.

*Pristimantis colonensis* (Fig. 6B): Mueses-Cisneros (2007) recently described this species, and it had been known to exist only in its type location in Valle de Sibundoy, Colombia. Our record at Alto La Bonita increases is distribution range further south and represents the first registry of this species in Ecuador.

*Osornophryne* spp.: Although we have assigned the species registered during the inventory to *O. bufoniformis* and *O. aff. guacamayo*, our collection (174 individual specimens) represents the largest number collected for this group in Ecuador. We will use the collected material to understand intraspecific variations and to resolve taxonomic issues existing with the genus.

**Pristimantis spp.**: There were several species of the terrestrial frogs *Strabomantidae* that we were unable to identify to the species level and which could be new species for Ecuador. Furthermore, one of them, *Pristimantis sp. 3* (aff. *P. petersorum*), is possibly an undescribed species (= *Eleutherodactylus* sp. 4 in Mueses-Cisneros 2005).

**Discussion**

Ecological systems extending along the Andean Cordillera Oriental on the northern Ecuadorian-southern Colombian border harbor great herpetofauna diversity, represented by approximately 149 taxa (Appendix 6). This high concentration of species is distributed across an altitudinal mosaic (from 600 to 4,100 m) that integrates upper Andean biomes with foothill ecosystems. Within this range, amphibian and reptilian assemblages are fractioned into at least four altitudinal limits, spaced every 800 to 1,000 m.

The lower limit is found at the base of the range, below 1,000 m in altitude, and harbors the highest diversity (70 spp.). Mostly the area is influenced by the interconnection between foothill forests and adjacent forests of the Amazon basin.

The second altitudinal limit extends from 1,200 m to 2,000 m along the lower mountain slopes. Here there is a superposition of species: by 1,500 m, those found at 1,200 m and higher completely replace the assemblages found at the base of the Andes. This altitudinal strip harbors approximately 46 species.

Between 2,000 to 3,000 m, the assemblages are linked to the upper limit of the gradient with the high Andes above 3,000 m. Herpetofauna diversity drastically diminishes in this altitudinal strip, where there are between 34 and 13 taxa, respectively.

Our results show that Cabeceras Cofanes-Chingual harbors more than one quarter (28%) of the diversity reported in the region. Although we only evaluated three
of the four altitudinal limits of the gradient, we believe that by including the area known as La Sofía—located within the proposed municipal reserve—and increasing sampling effort within the foothills zone in Río Verde, richness could surpass 50% of regional diversity. In addition, we believe that diversity in the upper Andean zone would be increased notably if the high montane forests and paramos of Monte Olivo were included. (We were unable to access the area due to logistical issues).

The alpha-diversity values reported for each site show the compositions and structures of the assemblages, biologically representative in their respective altitudinal limits. In the paramo ecosystems of Laguna Negra, we obtained 84% of the expected maximum diversity in the 300-m altitudinal range between 3,800 and 4,100 m. In contrast, other ecosystems located towards the southern part of the Cordillera Oriental on the inter-Andean slope—specifically in the province of Carchi—are more diverse. Laguna-Cevallos et al. 2007 registered 15 species in the 800-m range between 3,200 m and 4,000 m. This larger altitudinal range harbors a better representation and extension of upper montane forests combined with paramo biomes thereby resulting in double the diversity of Laguna Negra. On the contrary, towards the southern paramos of the Reserva Ecológica Cayambe-Coca, in La Virgen (3,700–4,000 m) and Oyacachi (3,500–3,900 m), herpetofauna diversity is equal to or less than that of Laguna Negra; there only four to nine herpetofauna species have been registered (Yánez-Muñoz and Mejía 2004; Yánez-Muñoz 2005) with less than 10% resemblance between their compositions and our studied area, as well as smaller relative abundance in certain groups, such as Hypodactylus and Osornophryne, which were abundant in Laguna Negra.

Diversity within the montane assemblages in Alto La Bonita reached 82% of the expected maximum for the 500-m altitudinal range between 2,600 and 3,100 m. Although no data exist in Ecuador for this biome in sectors close to our studied area or within Reserva Ecológica Cayambe-Coca, we believe that the diversity in the area could be much greater within the range between 2,500 m and 2,000 m based on Appendix 6. In this range, diversity of the frogs of the genus Pristimantis and endemic saurian lizards is much greater but was not registered during our fieldwork. Diversity (in terms of absolute richness) is similar to diversity reported in other corresponding altitudinal zones towards the central and southern Ecuadorian Andes, in areas such as Machay (Parque Nacional Llanganates) and Tapichalca (the buffer zone of Parque Nacional Podocarpus), where it reaches 12–15 (Yánez-Muñoz 2005). Nonetheless, when analyzing the structure of the community, dominance of Osornophryne aff. guacamayo (59% of total abundance) over Pristimantis stands out. This species has not been reported in such densities in any other ecosystem in Ecuador or Colombia.

Only 53% of expected diversity was registered for the foothill forests of Río Verde located between 700 m and 1,000 m altitude. Previous studies carried out in the basin of the Chingual River, including those by Altamirano and Quiguango (1997), Rodríguez and Campos (2002), and Campos et al. (2001), show that in an altitudinal range of 600 m, diversity is relatively low despite direct influence from lower Amazon areas. Biological inventories of 11 days or less have reported absolute richness values between 29 and 31 species (Campos et al. 2001; Rodríguez and Campos 2002) whiles studies of 34 days resulted in 52 species (Altamirano and Quiguango 1997). Although richness specific to Río Verde only reached 25 species and its composition is similar to the other mentioned inventories, certain distinguishing elements that had not been registered previously along the Chingual basin or in Santa Cecilia were found. Specifically, Rhinella dapsilis and Cochranella puyoensis were not anticipated for the zone and demonstrate that the diversity in this altitudinal zone is relatively unknown and complex.

The characteristics of the herpetofauna on the alpha-beta diversity scale in Cabeceras Cofanes-Chingual make it a priority conservation zone within the Cordillera Oriental along the northern Ecuadorian-southern Colombian border. Vast expanses of natural vegetation along an altitudinal continuum harbor a significant number of species whose assemblages exhibit compositions and structures unrepresented within the Reserva Ecológica Cayambe-Coca, including presence of healthy populations of amphibians whose reproductive
strategies have been affected by climate change and epidemiological factors.

**Opportunities, threats, and recommendations**

Any conservation plan resulting from this rapid biological inventory must be carried out in coordination with regional inhabitants. We noted that the beliefs and actions of some local residents seem to show a lack of responsibility towards their environment—hunting and intentional burning within the paramos of Laguna Negra are prime examples. We did not find any amphibian or reptile within burned vegetation. Burning not only kills the organisms burned, it destroys this important microhabitat needed for herpetofauna reproduction and establishment.

The three study areas show that the herpetofauna composition differs within the transect from Laguna Negra to Río Verde. Conserving the altitudinal gradient of Cabeceras Cofanes-Chingual will guarantee establishment of at least three different faunal communities and includes paramo, montane, and Amazonian components. The level of endemism and number of threatened species further strengthen the rationale for conserving and managing this area.

In order for the conservation process to be successful, we recommend continued research to generate important information regarding the population dynamics of the species and places being conserved. Particular attention should be placed on species categorized as threatened but which were found in high densities in the study sites. Efforts to investigate the impacts of ecosystem conversion, from forest to agricultural land or pasture, are also recommended. Within the region, Laguna Negra and Alto La Bonita are ideal locations to study population dynamics of these species. Having a specific region for population studies will provide a continued source of information over the years that can be used to conserve the species and habitat. We also recommend extending complementary inventories in La Sofía and Monte Olivo, as well as increasing sampling effort in the foothill regions of the proposed conservation zone in order to obtain more information about the region’s herpetofauna.

**BIRDS**

**Authors/Participants:** Douglas F. Stotz and Patricio Mena Valenzuela

**Conservation targets:** Endangered birds, including Bicolored Antpitta (*Grallaria rufocinerea*); Threatened birds, including Wattled Guan (*Aburria aburri*), Military Macaw (*Ara militaris*), Coppery-chested Jacamar (*Galbula pastazae*), and Masked Mountain-Tanager (*Buthraupis wetmorei*); fourteen restricted-range species of Andean slopes and paramo; and the diverse forest avifauna across an entire montane elevational gradient.

**INTRODUCTION**

Although the Ecuadorian Andes have been reasonably well studied for birds, the eastern slope of the Andes in western Provincia Sucumbíos is quite poorly known compared to the western slopes of the Andes and to areas farther south along the eastern slope. The most important study in the immediate region is the rapid inventory in Serranías Cofan-Bermejo (Schulenberg 2002), which covered elevations between 450 and 2,200 m on a series of ridges east of our Río Verde site in this present rapid inventory. An earlier study by Mena (1997) at the town of Sinangoe was the first study of the region’s lower elevations.

South of Cabeceras Cofanes-Chingual, the Reserva Ecológica Cayambe-Coca is reasonably well known, with surveys at all elevations; an estimated 900 species occur within its borders. On the west slope of the eastern Andes, Guandera Biological Station in Provincia Carchi is relatively well known for birds (Creswell et al. 1999). Its northeastern corner is only 3 km from our paramo site, Laguna Negra, and reaches similar elevations. Cerro Mongas in southeastern Carchi also has a similar avifauna, and has been well studied (Robbins et al. 1994). The eastern slope of the Andes in far southern Colombia is not particularly well known; the nearest site that has been well worked is Parque Nacional Natural Puracé, at the head of the Magdalena Valley in northern Cauca and Huila (BirdLife International 2008a).

**METHODS**

Our fieldwork consisted of walking trails, looking and listening for birds. We (Stotz and Mena) conducted our
surveys separately to increase the amount of independent-observer effort. We departed camp shortly before first light and were typically in the field until mid-afternoon, returning to camp for a one- to two-hour break, after which we returned to the field until sunset. We attempted to walk separate trails each day to maximize coverage of all habitats in the area. At all camps, we walked each trail at least once, and most were walked multiple times. Distances walked varied among camps in response to trail lengths, habitats, and density of birds, but ranged from 3 to 8 km each day per observer.

Mena carried a tape recorder and microphone on most days to record bird sounds, to document the occurrence of species. We kept daily records of numbers of each species that we observed. In addition, we compiled a daily list of species encountered during a round-table meeting of all observers (including Debby Moskovits) each evening; this information was used to estimate relative abundances of species at each camp. In addition, observations from other participants in the inventory team, especially Randy Borman and Álvaro del Campo, supplemented our records.

We spent three full days (plus parts of arrival and departure days) at each camp. At Alto La Bonita, these three days were supplemented by observations along the trail from the camp to the town of La Bonita. Mena covered this trail on 30 October, while Stotz and Moskovits covered it across two days, 30 and 31 October. Total hours of observation by Mena and Stotz at Laguna Negra were about 52 h, at Río Verde about 54 h, and at Alto La Bonita about 54 h, plus 19 h on the walk between Alto La Bonita and the town of La Bonita.

At Laguna Negra, we primarily surveyed the paramo and isolated forest patches within it; however, both Stotz and Mena spent part of a day surveying the continuous forest below treeline. At Río Verde, we limited our surveys to the trails on the north and west sides of the Cofanes and Verde rivers; we did not survey trails on the other side of these rivers that were surveyed by some of the other groups.

In Appendix 8, taxonomy, nomenclature and the order of taxa follow the South American Checklist Committee, version 14 November 2008 (www.lsu.edu/~remsen/SACCBaseline.html). Spanish names follow Ridgely and Greenfield (2001a). Relative abundances are based on the number of birds seen per day of observation. Because of the short duration of our visits, these estimates are necessarily crude, and only apply to the period October–November. For all sites we employ three classes of abundance: “Common” birds were observed daily in their expected habitat; “rare” birds were observed only once or twice as single individuals or pairs; and “uncommon” birds were not observed daily but were encountered more than twice. At Laguna Negra, species found only in the continuous forest below treeline are flagged in Appendix 8 because we surveyed this habitat to only a limited degree. Similarly, we noted those species seen on the walk out of Alto La Bonita (below the end of that site’s trail system, at 2,580 m, and above the start of substantially human-altered habitats, at about 2,100 m) because of the very limited coverage these elevations received. (We do not include any of the species seen only in the vicinity of the town of La Bonita, where there was a mixture of agricultural habitats and small, disturbed forest patches. However, we do include records from the vicinity of La Bonita in the elevational distributions given in the appendix for species present at Alto La Bonita.)

RESULTS

We registered 364 species of birds among our three sites during the rapid inventory, from 15 to 31 October 2008. Sites varied substantially in elevation and habitat, with distinct avifaunas. The lower-montane site, Río Verde, was the most diverse with 214 species. The two high elevation sites were more similar to each other, with 111 species at Alto La Bonita and 74 at the paramo site, Laguna Negra.

We estimate a total regional avifauna of 650 species, including migratory species, rare species that we did not encounter, and species associated with middle-montane elevations that we did not survey. In the rapid inventory of Serranías Cofan-Bermejo, the total regional avifauna between 450 m and 2,200 m was estimated at 700 species (Schulenberg 2002). However, that inventory included some of the very diverse Amazonian lowlands
around Bermejo in its survey area, while this survey included no lowland areas. If the adjacent Amazonian lowlands were included in the regional estimate for this inventory, the number of species would certainly exceed 1,000 species.

**Laguna Negra**

The dominant feature of the landscape at Laguna Negra was the open paramo habitat, where we recorded only 18 species, of which 11 were completely restricted to paramo. While paramo at this site likely has become more extensive, more open, and more dominated by grasses due to regular burning, we think that the primary reason for the low diversity is that there are very few paramo specialists in the regional avifauna; only six other species could have been expected to occur primarily in paramo here. This is in contrast to the puna (drier montane grasslands) farther south, where a vast extension of that habitat supports a larger avifauna: Parker et al. (1996) list 69 species as regularly using puna.

We found 63 species in the paramo and isolated forest patches at this site. The remaining 11 species we recorded were only found in the continuous forest below treeline. Our sense is that the species list for the paramo and forest patches is relatively complete, while a number of additional species could be found in the continuous forest with more effort devoted to that habitat.

The avifauna in the continuous forest was rather different from species found in the forest patches: in addition to the 11 species found only in continuous forest (mentioned above), 13 species were found in isolated forest patches that were not found in continuous forest. In three cases, we observed species replacements within a genus between the continuous forest and forest patches. These were (continuous-forest species listed first): Tyrian/Viridian Metaltail (*Metallura tyrianthina/williami*), Blackish/Paramo Tapaculo (*Scytalopus latrans/canus*), and Hooded/Masked Mountain-Tanager (*Buthraupis montana/wetmorei*).

Frugivorous and nectarivorous species dominated the avifauna. The most diverse family is Trochilidae (nectarivorous hummingbirds), with 11 species, followed by Thraupidae (frugivorous tanagers), with 10 species. Many species of other families typically considered insectivorous, like flycatchers (Tyrannidae), are partially frugivorous, and the relative abundance of frugivory increases with elevation. The predominance of frugivorous and nectarivorous species that we observed is a consistent pattern in the Andes, where hummingbirds show essentially no decline in diversity with elevation, and tanagers, cotingas, thrushes and other largely frugivorous groups show only a moderate decline with elevation. This contrasts with the insectivorous antbirds (Thamnophilidae) and flycatchers, which are typically the two most diverse families in Amazonian lowland forests. Thamnophilidae are completely absent at high elevations, and flycatchers are much less diverse (we recorded three species at Laguna Negra) and more frugivorous.

**Río Verde**

Río Verde, in the foothills, was easily the richest site for birds that we surveyed. The avifauna was a mix of montane and lowland elements. However, compared to many other sites at similar elevations (see specific comparisons to other sites below), lowland elements were poorly represented. There were 22 species of antbirds (Thamnophilidae, often represented in the lowlands by more than 50 species), of which 9 are strictly montane species. Understory flocks led by *Thamnomanes* antshrikes, a characteristic element of lowland Amazonia that regularly occur up to about 900 m (and even higher where there is bamboo) were completely absent. Most of the lowland species we observed fell into two groups: open habitat species around camp and in the riverine habitat along the Cofanes River, and frugivorous species (especially tanagers) that joined mixed species canopy flocks throughout the site.

Río Verde is at the base of a tightly constricted river valley several kilometers away from the nearest expanse of true lowland forest. This topography likely excludes some lowland species typically found at similar elevations elsewhere. Thus, we observed a shift from an insectivore-dominated avifauna typical of the lowlands to one dominated by frugivorous species, a pattern much stronger at higher elevations during this inventory. As at higher elevations, tanagers and hummingbirds were well represented.
Some montane species occurred in the camp clearing at 730 m up to the hilltops surveyed, at 1,100 m. However, the montane element became much more pronounced as one moved up the slope, with lowland species disappearing and montane species progressively increasing. By about 950 m, the montane element dominated, and a number of montane species were found only above 1,000 m.

Within Río Verde, we found a small number of species replacements within genera, where a lowland species was replaced by a montane representative at higher elevation. Three examples of this were (with lowland species first) Lemon-throated/Red-headed Barbet (*Eubucco richardsoni/bourcieri*), Blue-headed/Red-billed Parrot (*Pionus menstruus/sordidus*), and Crimson-crested/Crimson-bellied Woodpecker (*Campephilus melanoleucos/haematogaster*). More commonly, the lowland representative was missing and only the montane species was found. Examples of this include Rufous-breasted Wood-Quail (*Odontophorus speciosus*), Band-bellied Owl (*Pulsatrix melanota*), Ash-browed Spinetail (*Cranioleuca curtata*), Rufous-rumped Antwren (*Terenura callinota*), Short-tailed Antthrush (*Chamaeza campanisona*), Chestnut-crowned Gnateater (*Conopophaga castaneiceps*), and Slaty-capped Flycatcher (*Leptopogon supercilias*). In one case, we found two congeneric montane species, Yellow-throated/Ashy-throated Bush-Tanager (*Chlorospingus flavigularis/caniger*), that largely replace one another at different elevations.

**Alto La Bonita**

At Alto La Bonita, we found a typical high-elevation avifauna, with a large number of species associated with mixed-species flocks led by Spectacled Redstart (*Myioborus melanocephalus*) and Basileuterus warblers. Besides these flocks, terrestrial and near-terrestrial birds like antpittas (*Grallaria* and *Grallaricula*) and tapaculos (*Scytalopus*), as well as skulking species of Furnariidae and flycatchers hidden away in the dense understory of the forest, comprised the majority of the avifauna. Overall, the abundance of birds at the site appeared low. Few species sang, even at dawn, and by mid-morning songs had largely ended. Afternoons were noticeably quiet. Stream noise and difficult trails may have contributed to our general impression of few birds.

There was a noticeable difference in the avifauna we observed around camp at about 2,630 m, and that of a ridge to the east at approximately the same elevation. Our camp sat in the bottom of a valley where cold air settled every morning. The avifauna was dominated by species that typically range to elevations higher than our camp. In an afternoon and part of a morning of survey on the ridge, we found ten species that were never seen near camp, and which reach their elevational limit around 2,600 m. It seems that the local topography contributes strongly to the differences in the avifaunas in these two areas: The ridge, because of continuity with lower areas, had an avifauna more characteristic of lower elevations, while areas near camp, with their proximity to the higher elevations that surrounded them and isolation from lower areas, were dominated by a higher-elevation avifauna.

**Endemic species**

Ridgely and Greenfield (2001a) list 36 species endemic to the eastern slope of the Andes in Ecuador and nearby Colombia or Peru. We found nine of these species: Ecuadorian Piedtail (*Phlogophilus hemileucurus*), Coppery-chested Jacamar (*Galbula pastazae*), Crescent-faced Antpitta (*Grallarica lineifrons*), Long-tailed Tapaculo (*Scytalopus micropterus*), Ecuadorian Tyrannulet (*Phylloscartera gualaquizae*), Orange-crested Flycatcher (*Myiophobus phoenicomitra*), Masked Mountain-Tanager (*Buthraupis wetmorei*), Black-backed Bush-Tanager (*Urothraupis stolzmanni*), and White-rimmed Brush-Finch (*Atlapetes leucopis*). Four of these endemic species occurred at Río Verde, three at Alto La Bonita, and two at Laguna Negra. Most of the endemics we did not encounter occur at intermediate elevations that we did not survey. Besides this group of endemics, at Laguna Negra we found five species listed by Ridgely and Greenfield among their 16 species endemic to Interandean Slopes and Valleys: Carunculated Caracara (*Phalcoboenus carunculatus*), Golden-breasted Puffleg (*Eriocnemis mosquera*), Black-thighed Puffleg (*E. derbyi*), Rainbow-bearded Thornbill (*Chalcostigma herrani*), and Stout-billed Cinclodes (*Cinclodes*).
excelsior). At Río Verde, there were three species listed among the species endemic to the Western Amazonian Lowlands: Salvin’s Currasow (Mitu salvini), Dusky Spinetail (Synallaxis moesta), and White-lored Antpitta (Hylopezus fulviventris).

**Rare and threatened species**

Ridgely and Greenfield (2001a) provide a list of species that they consider at risk in Ecuador. The categories they use are the same as those used by Wege and Long 1995; more recent listings (e.g., Birdlife International 2000a–k) use a more quantitative approach to determining threat levels, although the categories remain the same. Ridgely and Greenfield list as Endangered one species we encountered (Bicolored Antpitta, Grallaria rufocinerea; [Fig. 7O]); and three as Vulnerable: Wattled Guan (Aburria aburri), Military Macaw (Ara militaris), and Masked Mountain-Tanager (Buthraupis wetmorei). One species treated as Near-threatened by Ridgely and Greenfield, Coppery-chested Jacamar (Galbula pastazae), is considered Vulnerable globally by BirdLife International (2008b).

Bicolored Antpitta has a small range and occurs locally from central Colombia south to northern Sucumbios, Ecuador. Ecuadorian birds presumably belong to the southern subspecies romeroana. While treated as Endangered within Ecuador, it is now considered to be globally Vulnerable, with a global population of less than 10,000 birds (BirdLife International 2008c). We found this species to be common in forest at Alto La Bonita between 2,600 and 2,700 m. Above 2,700 m, the common Grallaria was Chestnut-naped Antpitta (G. nuchalis), and we did not encounter Bicolored Antpitta at those elevations. This species was previously known in Ecuador from a single record, a pair tape-recorded on the Interoceánica highway near Santa Barbara (Ridgely and Greenfield 2001a; BirdLife International 2008c). Along the highway, the forest is limited to small patches within a matrix of agriculture; however, our records from Alto La Bonita suggest there is likely a substantial population—almost certainly numbering in the hundreds—of this species at appropriate elevations where the forest cover remains intact. Maintaining forest cover west and south of La Bonita will be crucial for this species, as much of its range in Colombia is already deforested.

Wattled Guan occurs on the east slope of the Andes from Venezuela to southern Peru. Despite this extensive range, it is considered Near-threatened globally (BirdLife International 2008d) and Vulnerable within Ecuador (Ridgely and Greenfield 2001a) because of its narrow elevational range (mostly 800 to 1,500 m), the extensive deforestation within this elevational belt, and hunting pressure. We found this species to be common throughout the Río Verde site. In the Serranías Cofan-Bermejo, south and east of Río Verde, Schulenberg (2002) found this species at two of the three sites surveyed. Thus, there appears to be a significant population in the foothills region around the Cofanes River. Currently hunting pressure and deforestation in this region is low, but ensuring that this area remains a long-term refuge will be important to this species.

Military Macaw has a wide, but fragmented, range in mountains from Mexico south to northwestern Argentina. While it has a broad elevational distribution (from sea level to at least 3,100 m), in the Andes it is largely limited to the lower slopes between 600 and 1,600 m (Parker et al. 1996; Ridgely and Greenfield 2001b). Major threats are habitat loss due to deforestation and capture for the pet trade (BirdLife International 2008e). In Ecuador, the species is local along the eastern slope of the Andes (Ridgely and Greenfield 2001a). There was a substantial population near Río Verde, where we encountered it daily in moderate numbers (10–20 per day). There is a cliff with several nest holes along the Cofanes River, ca. 6 km downriver from our Río Verde camp, where we saw about 80 birds at once during the inventory (Á. del Campo pers. com.), and larger numbers have been reported there at other times of the year (R. Borman pers. com.). The cliff is composed in part of calcium carbonate (T. Saunders pers. com.) and the macaws probably ingest some of that material. During the Serranías Cofan-Bermejo survey, macaws were found at all three survey sites (Schulenberg 2002). There is clearly a very significant population—probably numbering in the hundreds—of this species in the foothills of western Sucumbios. Protecting the forest in the region, and
especially sites such as the cliff along the Cofanes River, is a priority for this species. Currently, capture for the pet trade does not seem to be a major concern in this area.

Masked Mountain-Tanager occurs in forest near treeline along the eastern slope of the Andes from southern Colombia to extreme northern Peru. It appears to be local and rare within this range and it is considered Vulnerable globally (BirdLife International 2008f) and in Ecuador (Ridgely and Greenfield 2001a). A major concern for this species is the continual burning of the paramo to provide pasture for domesticated livestock (BirdLife International 2008f). Paramo burning has lowered treeline over much of this species’ range and destroyed isolated forest patches used by this species above treeline. At Laguna Negra, where the depression of treeline and destruction of forest patches by regular burning was obvious, we found pairs of this species in two forest patches above our camp, between 3,700 and 3,750 m in elevation. At Alto La Bonita, our only record was a bird in forest at the edge of a large landslide near 3,000 m in elevation. Cuttropoé, the paramo site above Monte Olivo, could be important for this species. It is roughly the same elevation as Laguna Negra, but is not burned. Unfortunately, we cannot confirm that this species occurs there because we were unable to visit that site. It appears that the most crucial conservation measure required for this species is managing burning of the paramo at sites where it occurs. The total population in the Caberceras Cofanes-Chingual is probably small, under a hundred individuals, given that we found only a few at Laguna Negra and Alto La Bonita and that the forest patches within the paramo zone that this species inhabits is an intrinsically patchy habitat. However, this region, including the paramo on the west-facing slopes into Carchi, may very well be one of the most important strongholds for the species, given the extent of the paramo habitat and the generally low level of disturbance it has received relative to other paramo areas in Ecuador and southern Colombia.

Coppery-chested Jacamar has a narrow elevational range at the base of the eastern slope of the Andes, from extreme southern Colombia to extreme northern Peru. Almost all of its range is within Ecuador. It was fairly common at our Rio Verde site, where it was associated with clearings in the forest, landslides, large treefalls, and the clearing around the station. Its narrow elevational range and local distribution place the species at risk from the continuing deforestation in lower Andean slopes. The foothills of western Sucumbíos could harbor a significant population of this jacamar, but it was not found on the Serranías Cofan-Bermejo inventory (Schulenberg 2002), so it may be quite local in the region.

Black Tinamou (Tinamus osgoodi) is a Vulnerable species (BirdLife International 2008g) found in two disjunct populations: in southern Peru, and southern Colombia to extreme northern Ecuador. Although we did not find this species at Rio Verde (elevation there is mostly below the range of this species), it has been found on higher ridges in the vicinity (R. Borman pers. com.). The species was first found in Ecuador during the Serranías Cofán-Bermejo inventory (Schulenberg 2002) at Shishichio, south of the Cofanes River between 1,000 and 1,350 m. There is probably a reasonably large population of this species within the region at appropriate elevations. The main threat to this species is deforestation.

We encountered nine additional species that Ridgely and Greenfield (2001a) list as Near-threatened in Ecuador: Gray Tinamou (Tinamus tao), Salvin’s Curassow (Mitu salvini), Rufous-breasted Wood-Quail (Odontophorus speciosus), Black-and-chestnut Eagle (Spizaetus isidori), Black-thighed Puffleg (Eriocnemis derbyi), Gray-breasted Mountain-Toucan (Andigena hypoglauca), Black-mandibled Toucan (Ramphastos ambiguous), Spectacled Bristle-Tyrant (Phylloscartes orbitalis), and White-rimmed Brush-Finch (Atlapetes leucopis).

Gray Tinamou is widespread near the base of the Andes from Columbia to Peru. We found small numbers at Rio Verde. The region of this inventory and the Serranías Cofán-Bermejo inventory could house a significant population of this species, although it appears to be patchy in the region.

Salvin’s Curassow is restricted to northwestern Amazonia, and is under significant hunting pressure in many areas. It has disappeared from regions close to major population centers. We found small numbers at Rio Verde, and Sebástian Descanse (one of our Cofan colleagues) saw a pair of this species
at the extraordinarily high elevation of 2,800 m at Alto La Bonita. While this species is mostly known from the Amazonian lowlands (Ridgely and Greenfield 2001a), there does appear to be a substantial population in the foothills of western Sucumbíos, where it was found at all three survey sites during the Serranías Cofan-Bermejo inventory (Schulenberg 2002), and a population is known from the forested valleys near La Sofía at more than 1,500 m (R. Borman pers. com.). There is continuous forest cover between the La Sofía population and Alto La Bonita, so the birds seen at Alto La Bonita likely represent wandering birds from lower elevations.

Rufous-breasted Wood-Quail is treated as Near-threatened by Ridgely and Greenfield (2001a), but is considered safe globally (BirdLife International 2008h, because of an extensive range along the eastern slope of the Andes from northern Ecuador to northern Bolivia), and it is considered common in much of its Peruvian range. Our records at Río Verde are near the lower elevational limit for this species.

Black-and-chestnut Eagle occurs at low densities in high elevation forests of the eastern slope of the Andes, from Venezuela to northwestern Argentina. Although we had only a single record at Laguna Negra, the extensive expanse of forests at appropriate elevations from our study sites south into Cayambe-Coca could make this area an important stronghold for this species.

Black-thighed Puffleg is a local, restricted-range hummingbird of forest and forest edge near treeline. It is considered Near-threatened (BirdLife International 2008i) primarily because of this small range. It has been previously recorded from Guandera Biological Station ca. 3 km southwest of the Laguna Negra site. It is possible that this area could have a significant population of this poorly known species.

Gray-breasted Mountain-Toucan is a very widespread toucan of high elevation forests, extending from southern Colombia to southern Peru. It is moderately common over much of its range, and we found it at both Laguna Negra and Alto La Bonita. Despite this, it is treated as Near-threatened by both Ridgely and Greenfield (2001a) and BirdLife International (2008j).

Black-mandibled Toucan occurs locally in the Andean foothills. Its occurrence at Río Verde surprised us, but it was encountered several times and one bird was photographed. Its local distribution and narrow elevational range along the lower eastern slope of the Andes potentially puts it at risk from deforestation. The foothills of western Sucumbíos may harbor a significant population of this species as it was also found at all three survey sites on the Serranías Cofan-Bermejo inventory (Schulenberg 2002).

Spectacled Bristle-Tyrant has a wide range from southern Colombia to northern Bolivia along lower Andean slopes, but has a narrow elevational distribution. We found small numbers at Río Verde in the forests near camp.

White-rimmed Brush-Finch occurs from southern Colombia locally along the east slope of the Andes to southern Ecuador. While Ridgely and Greenfield (2001a) describe the species as rare and inconspicuous, we found it to be common at Alto La Bonita. It was also conspicuous, singing its loud saltator-like song from exposed perches in the canopy in the morning and being bold and inquisitive later in the day. Despite this, we think the treatment by BirdLife International (2008k) as of Least Concern to be unduly optimistic. Its local and small distribution in a region with substantial deforestation and the fact it is typically considered rare suggest that the species may require careful monitoring. The region around Alto La Bonita may be an important stronghold for the species.

**Migrants**

Ecuador is south of the wintering range of most North American migrants, yet we found 17 species during this inventory. At Laguna Negra, we saw four migrant shorebirds—Greater Yellowlegs (*Tringa melanoleuca*), Lesser Yellowlegs (*T. flavipes*), Spotted Sandpiper (*Actitis macularius*), and Baird’s Sandpiper (*Calidris bairdii*)—at a small lake near camp. The first three are widespread in the Neotropics during winter, but Baird’s Sandpiper winters mainly in southern South America and largely migrates through the Andes, using high-elevation lakes as stepping stones. Despite this we also saw Baird’s...
Sandpipers at Puerto Libre (550 m) and in the town of La Bonita (1,950 m) during travel between camps. A number of other shorebirds probably use the lakes within the paramo in this region. The only other migrants seen at Laguna Negra were an Osprey (*Pandion haliaetus*) flying over camp at more than 3,700 m on 16 October, and a Barn Swallow (*Hirundo rustica*) with a flock of Brown-bellied Swallows (*Orochelidon murina*) on 17 October. At Alto La Bonita, the only migrant we found was Blackburnian Warbler (*Dendroica fusca*), which barely reached the study site at 2,600 m. It was moderately common at lower elevations around the town of La Bonita and on the trail to the town.

The forests around Río Verde contained most of the migrants we saw, a total of ten species. These included three species of flycatchers: Olive-sided (*Contopus cooperi*), Eastern (*C. virens*), and Western Wood-Pewees (*C. sordidulus*); and two warblers: Cerulean (*Dendroica cerulea*) and Canada (*Wilsonia canadensis*). Other migrant species at Río Verde were Broad-winged Hawk (*Buteo platypterus*), Common Nighthawk (*Chordeiles minor*), Red-eyed Vireo (*Vireo olivaceus*), Swainson’s Thrush (*Catharus ustulatus*), and Summer Tanager (*Piranga rubra*). Eastern Wood-Pewee was easily the most abundant species of migrant, followed by Canada Warbler. However, the eastern slope of the Andes is most crucial to the three species of warblers, and Swainson’s Thrush, which winter largely in the humid Andes.

Among landbirds, a number of migrant species are known—but rare—along the eastern slope of the Andes. We expected only Gray-cheeked Thrush (*Catharus minimus*) and Scarlet Tanager (*Piranga olivacea*), but found neither. The latter is far more abundant than Summer Tanager in southeastern Peru at the elevation of Río Verde (Robinson et al. 1995; Stotz pers. obs.), so its absence seems puzzling.

**Other notable records**

At Alto La Bonita, we had records of two lowland waterbirds at an unusual elevation. We saw one individual of Neotropic Cormorant (*Phalacrocorax brasilianus*) flying over the forest on 28 October. Mena observed it flying from west to east over a broad valley at 2,800 m, and about 30 minutes later, Stotz saw it flying down the Sucio River valley below our camp. On 29 October, a Striated Heron (*Butorides striatus*) was perched in the canopy of low forest, with standing water underneath, at 2,800 m. Both of these species are widespread in the lowlands but occur locally in small numbers at higher elevations (Ridgely and Greenfield 2001a).

Two species that are not considered to be endemic or threatened were nonetheless interesting to encounter. At Laguna Negra, a single Stout-billed Cinclodes (*Cinclodes excelsior*) sang, displayed, and was generally quite obvious on 16 October in a forest patch with extensive *Polylepis* near camp. We did not see the bird subsequently. This is a local species in Ecuador and Colombia associated with patches of *Polylepis* woodland at and above treeline. At Río Verde, we found Buff-throated Tody-Tyrant (*Hemitriccus ruficularis*) to be uncommon in forest along the ridges around camp between 900 and 1,100 m. This is a local species largely restricted to outlying ridges of the Andes from southern Colombia to northern Bolivia between 750 and 1,500 m (Ridgley and Greenfield 2001a; Schulenberg et al. 2007). It was not unexpected at this site, since Schulenberg (2002) found it at all three of his survey sites, but it still remains known from a relatively few sites despite its very wide geographic range.

As noted in the accounts for the individual camps, the diversity of frugivores and nectarivores was high throughout this survey. Overall, the diversity of hummingbirds (29 spp.) and tanagers (52 spp.; see Fig. 7) was impressive. Hummingbirds were fairly evenly distributed across the three camps, although they were considerably more obvious at the Laguna Negra camp, where two species, Golden-breasted Puffleg (*Eriocnemis mosquera*) and Rainbow-bearded Thornbill (*Chalcostigma herrani*), were perhaps the most commonly seen bird species.

We found little evidence of birds breeding during this inventory. Low levels of singing further suggested that the main breeding period is not close to the time of the year when we conducted the study. At Laguna Negra, the only evidence of breeding was a chick of Band-winged Nightjar (*Caprimulgus longirostris*), which we photographed. At Alto La Bonita, there was somewhat more evidence...
of breeding. Torrent Ducks (*Merganetta armata*) had two small chicks along the Sucio River, slightly upriver from our camp. A pair of Hooded Mountain-Tanager (*Buthraupis montana*) fed a large juvenile above camp. Green-and-black Fruiteater (*Pipreola riefferii*) had a nest with two eggs, and Slaty-backed Chat-Tyrant (*Ochthoeca cinnamomeiventris*) attended a nest with a nestling along the edge of a stream above camp. At Río Verde, a pair of Military Macaws defended a nest hole downstream along the Cofanes River. We do not know if the hole contained any eggs or young.

**Comparison of sites surveyed and comparisons with other areas**

During rapid inventories in the lowlands typically we find high levels of species overlap among sites. Often 70%–80% of the species at one site are found at the other sites surveyed and across multiple sites frequently half or more of their species are found at all other sites. In this inventory, only one species, White-collared Swift (*Streptoprocne zonaris*), occurred at all three sites. It typically breeds around waterfalls at high elevations in the Andes, but forages widely during the day, often reaching the Amazonian lowlands. The lower montane site, Río Verde, was very different from the other sites. It shared no species other than the swift with Laguna Negra, and only seven other species with Alto La Bonita. This, however, is not particularly surprising because of the large elevational difference between Río Verde and the other sites. It shared no species other than the swift with Laguna Negra, and only seven other species with Alto La Bonita. This, however, is not particularly surprising because of the large elevational difference between Río Verde and the other sites. It is notable, however, that Laguna Negra and Alto La Bonita, which were within 400 m of each other in elevation, shared only 27 species, which is 36% of the total recorded at Laguna Negra. So, despite their elevational proximity, these two sites had very distinct avifaunas. In many ways even this limited overlap overstates the similarity between Laguna Negra and Alto La Bonita. Only one species, Great Thrush (*Turdus fuscater*), was common at both sites, and only four species were at least uncommon at both sites. The rest of the shared species were rare at least at one of the two sites.

Overall, the number of bird species recorded on this inventory is roughly comparable to that found on a typical rapid inventory of similar length in the Amazonian lowlands (e.g., Stotz and Pequeño 2006; Stotz and Díaz 2007). However, this diversity is distributed very differently. In the lowlands, individual sites generally have high species richness, but relatively little variation among sites. In contrast, in Cabeceras Cofanes-Chingual we found moderate species richness within our sites but very high variation across sites. This emphasizes the necessity to maintain natural habitats—especially forested habitats—that generate this beta-diversity across the entire elevational gradient. Habitat loss in any part of the gradient will precipitate the loss of a substantial piece of avian diversity, as well as diversity in other taxa.

Laguna Negra can be compared to two nearby sites on the west slope of the eastern Andes in Carchi that are at similar elevations, Guandera Biological Station (Cresswell et al. 1999) and Cerro Mongus (Robbins et al. 1994). Our survey period was much shorter and our survey team much smaller than that at these other two sites. We also covered a narrower and slightly higher elevational range (3,400–3,750 m, versus 3,100–3,700 m at Guandera and 3,200–3,650 m at Cerro Mongus), and as a result we recorded fewer species (74) than were recorded at Guandera (144) or Cerro Mongus (119). In particular, we recorded fewer species of the continuous forest below treeline, where diversity is higher, and which we covered only casually. Despite this, it is clear that the avifaunas at all three sites are quite similar. Most of the species recorded at both sites that we did not encounter at Laguna Negra were species of the continuous forest. The majority of them we recorded at Alto La Bonita, at somewhat lower elevation than Guandera or Cerro Mongus. Robbins et al. (1994) compare the avifauna at Cerro Mongus to that in similar habitat at Cerro Chingela in northern Peru, and note the great similarity among the two sites some 650 km apart, so the resemblance of Laguna Negra to Guandera and Cerro Mongus is not unexpected. It is striking, however, that the similarity across hundreds of kilometers at similar elevations is so much greater than the similarity across sites separated by only a few kilometers and differing by only a few hundred meters in elevation, like Laguna Negra and Alto La Bonita.
BirdLife International (2008a) treats Guandera and Cerro Mongus at both part of the same Important Bird Area (IBA). It seems clear owing to its proximity and similar avifauna that Laguna Negra also could be considered part of that IBA. BirdLife International (2008a) lists 29 species of threatened or restricted range species from this IBA. We recorded 20 of these species at Laguna Negra and found four of the other species at Alto La Bonita. Restricted or endangered species from Guandera and Cerro Mongus that we failed to encounter at either of our high elevation surveys sites were Golden-plumed Parakeet (*Leptosittaca branickii*), Rusty-faced Parrot (*Hapalopsittaca amazonina*), Chestnut-bellied Cotinga (*Doliornis rensumeri*), Agile Tit-Tyrant (*Anairetes agilis*), and Turquoise Jay (*Cyanolyca turcosa*). All of these species are likely present at Laguna Negra or Alto La Bonita, but were not recorded due to our brief survey periods.

Species that occupy paramo or isolated patches of forest above treeline recorded at either Guandera or Cerro Mongus that we failed to record at Laguna Negra included, besides the recently described Chestnut-bellied Cotinga, Cinereous Harrier (*Circus cinereus*), Short-eared Owl (*Asio flammeus*), Paramo Pipit (*Anthus bogotensis*), and Paramo Seedeater (*Catamenia homochroa*). Species we recorded at Laguna Negra that were not found at either Guandera or Cerro Mongus were few. They included a few migrants from North America, as well as Tourmaline Sunangel (*Heliangelus exortis*), Stout-billed Cinclodes (*Cinclodes excelsior*), and Fawn-breasted Tanager (*Pipraeidea melanotoma*).

An obvious comparison for our Río Verde camp is the rapid inventory of Serranías Cofan-Bermejo (Schulenberg 2002). On that survey, elevations between 450 and 2,200 m were surveyed (versus 750–1,100 m at Río Verde. The three survey sites at Serranías Cofan-Bermejo all included elevations comparable to those surveyed at Río Verde. Given that the three surveys sites were only 5–20 km from Río Verde, one might expect very high similarity among all the sites; however, there was much more variation among these sites than between Laguna Negra and the nearby high elevation sites described above. Most notably, Río Verde differed from the Serranías Cofan-Bermejo sites by having a smaller influence of lowland species. Montane species were more comparable. We failed to find at Río Verde 61 lowland species recorded between 600 and 1,100 m on the Serranías Cofan-Bermejo inventory, while only 19 lowland species we recorded were not found there. In contrast, we found 15 montane species not found at Serranías Cofan-Bermejo, while not finding 26 of the montane species found there. Besides have a greater proportion of montane species, a number of these occurred at lower elevations at Río Verde than at Serranías Cofan-Bermejo. Some of these were species found only above 1,400 m at Serranías Cofan-Bermejo (e.g., Barred Hawk [*Leucopternis princeps*] and Lineated Foliage-gleaner [*Syndactyla subalaris*]) and others were species found above 900 m there that we found down to 750 m (e.g., Wattled Guan, Black-mandibled Toucan, Orange-eared Tanager [*Chlorochrysa calliparaea*], and Spotted Tanager [*Tangara punctata*]).

Overall, Río Verde’s avifauna showed a much clearer montane signal than do similar elevations just a few kilometers to the east. This may reflect the position of Río Verde several kilometers up a river with a very narrow valley and limited floodplain that may limit the access of lowland species to the area. It may also reflect a very humid environment: Compared to other similar elevation sites where Stotz has worked, Río Verde has a shorter forest and much heavier epiphyte loads on the trees.

Sites at similar elevations in central Peru (Schulenberg et al. 1984) and southeastern Peru (Stotz et al. 1996; Fitzpatrick, Willard, and Stotz, unpublished) show a stronger lowland element than Río Verde, with approximately 75% of their avifauna being lowland species versus 65% at Río Verde. Local topography may have much to do with these differences, as both of these sites have more direct connections to lowland forest in broad valleys at about 500 m.

**RECOMMENDATIONS**

The major threats for bird species are deforestation, excessive burning in the paramo, and hunting and other exploitation by humans. Below we make specific recommendations for the protection, management, future
research, additional inventories, and monitoring of bird species in Cabeceras Cofanes-Chingual.

**Protection and management**
- Protecting the significant extent of the forest in this region is easily the most crucial measure required to protect the birdlife. In order to protect the forest, it will be crucial to limit the creation of new roads into the heart of the forested area. The road to La Sofía is clearly a threat to the ecological integrity of this area, and will need to be managed to reduce that threat. As long as the forest is protected, the area will maintain significant populations of nearly all of the species of birds and other fauna currently found here; without it a number of species will be lost.

- Hunting is one of the major threats to Wattled Guan. Currently limited access to the elevations where this species occurs means that hunting pressure is not severe. However, it could be affected by hunting with increased populations in the area, or increased mining operations.

- Limit use of fire in paramo. Studies demonstrate that overall species richness and abundance of birds in the paramo decrease with more frequent fire (Koenen and Koenen 2000). Some threatened species, for example Masked Mountain-Tanager, are known to be negatively affected by frequent fire (BirdLife International 2008f). Maintaining the avifauna, especially that associated with the isolated forest patches above treeline, will require careful management of fire in the paramo to maintain the diversity of habitats.

- Create a protected area that covers an entire elevational gradient. This will be needed to protect all of current diversity: Loss of any segment of the gradient will cause the loss of a significant part of the diversity. This also is critical in the face of impending climate change because the continuous gradient will provide corridors for species responding to changing conditions.

**Research**
Elaborate the details of Military Macaw ecology; in particular, seasonal movements, home ranges, crucial food plants, and nesting sites. This threatened species has a significant population in the area. In order to effectively manage it and counter threats from deforestation and direct exploitation, we will need to understand its ecology and determine whether the population here regularly ventures into surrounding areas that may not have adequate protection.

**Inventory and Monitoring**
- Inventory Bicolored Antpitta. The results from Alta La Bonita suggest that this region probably harbors one of the largest populations of this species in existence, given that much of its Colombian range is deforested. Understanding the size and extent of this population is essential for development of a plan to manage the forests it occupies.

- Inventory other paramo sites for Masked Mountain-Tanager, which seems to be negatively impacted by burning of the paramo. Cuttopoé is especially important because it lacks human-generated fires.

- Inventory appropriate habitat for locally distributed, near-threatened species, including Black-thighed Puffleg, Coppery-chested Jacamar, and White-rimmed Brush-Finch.

- Inventory elevations between 1,100 and 2,600 m not covered in this inventory. The major human population centers in the area (La Bonita and La Sofía) fall within this elevational slice, so threats to the forests in these elevations are potentially high. Additionally, substantial avian diversity, including threatened and range-restricted species, is concentrated in this elevation range. In fact, the peak in species richness of montane species is found at these intermediate elevations (Stotz et al. 1996). To effectively protect the fauna in this region, we need to know what is present throughout the elevational gradient.

- Monitor Military Macaw populations
MAMMALS

Authors/Participants: Randy Borman and Amelia Quenamá Q.

Conservation targets: Healthy populations of mountain tapir (*Tapirus pinchaque*) and Andean bear (*Tremarctos ornatus*); abundant populations of *Nasuella olivacea*, *Agouti taczanowskii*, and other montane species; important predators, including puma (*Puma concolor*) and jaguar (*Panthera onca*); intact populations of woolly monkey (*Lagothrix lagothricha*) and white-bellied spider monkey (*Ateles belzebuth*) at mid-level altitudes; protected altitudinal ranges for all these species, especially mountain tapir and Andean bear.

INTRODUCTION

Cabeceras Cofanes-Chingual is one of the most remote and difficult-to-access areas left in Ecuador. Covering over 100,000 ha, and with altitudes ranging from 600 m at the mouth of the Chingual River to over 4,200 meters in its highest ridges, this block is easily the most important remaining refuge in Ecuador for mountain tapir (*Tapirus pinchaque*). Cabeceras Cofanes-Chingual is characterized by an altitudinal shift from high tropical forest (>1,000 m, e.g., our Río Verde site), through montane ecosystems (1,000–3,000 m, e.g., Alto La Bonita) to high-mountain and paramo habitats reaching 4,100 m (e.g., Laguna Negra and Ccuttopoé). The mammalian community reflects this reality, with a mix of lowland and montane species at Río Verde, a more pure set of montane species at Alto La Bonita, and a mix of montane and paramo species at Laguna Negra and Ccuttopoé.

METHODS

From 20 to 27 September 2008, we visited the Ccuttopoé site together with the advance-logistics team, who were establishing a camp for use by the full inventory team. Later in October we visited the Laguna Negra, Río Verde, and La Bonita sites together with the complete rapid biological inventory team (see Overview of Region and Inventory Sites for details).

We worked with an initial list of approximately 50 species of large mammals, representing 8 orders and 19 families that we expected to be present in Cabeceras Cofanes-Chingual. We concentrated on tracks, scat, feeding sites, burrows, and other secondary forms of evidence for most of our observations; we also used visual observations to confirm the presence of mammals. At Laguna Negra (and to a lesser extent, at Ccuttopoé during advance team activities) we were able to run extensive cross-country transects, but in the other two camps we were forced to use existing trail systems (which is not a good way to sample the skittish and wary large mammal community). To fill in the picture for each camp, we also conducted interviews with local community members, Cofan park guards who have been working in the area, and other individuals with substantial experience in the region. “Confirmed species” include our direct observations, those of other members of the inventory team where there is little or no room for error, and local observations by people who are trustworthy observers of the species in question. (For example, a Cofan park guard who reports seeing a woolly monkey troop would be considered a trustworthy observer because this well-known animal figures heavily in the Cofan diet and would not be confused with any other primate by a practiced Cofan observer; however, this same person may not be a reliable observer when it comes to describing a small squirrel species that is not generally hunted.)

At Río Verde, we relied heavily on interviews with local populations. Our most reliable information came from conversations with Serafín Cárdenas, a miner who entered the region in 1980 and again in 2000, with continuous presence since 2000; and with the Cofan park guards, who have been in the area since 2003. Although these sources are not always precise, they add much information and context. For example, Sr. Cárdenas described his encounters with a pair of short-eared dogs (*Atelocynus microtus*) whose den was near his camp at Río Claro, and other interesting information (such as eating bananas at the edge of his field, or yipping at night while chasing a paca). Cofan park guards helped flesh out information for this site, especially the primate species present, based on their extensive patrols in the area.

RESULTS

We were able to confirm the presence of 40 species of large-and medium-sized mammals, representing 8 orders...
and 18 families across our four study sites, with 29 species at Río Verde, 15 at Alto La Bonita, 13 at Laguna Negra, and 12 at Cuuttopoé (Appendix 9; Fig. 8). The only species registered at all four sites were Andean (or spectacled) bear (*Tremarctos ornatus*) and puma (*Puma concolor*). Of the 19 families we expected to encounter, we did not record evidence of members of Dinomyidae or Bradypodidae, but unexpectedly recorded a member of the family Geomyidae.

**Laguna Negra**

We recorded 6 orders, 10 families, and 13 species at this site, including records from scat from colocolo (*Leopardus pajeros*). We also observed scat that may have belonged to crab-eating fox (*Cerdocyon thous*), but could not confirm this. Northern pudu (*Pudu mephistopheles*, Cervidae) probably is present, but we did not observe this species.

Of the four sites, Laguna Negra is definitely the most impacted by human activities. The majority of the extensive frailejon paramos show evidence of recent burns, and large, well-used trails extend throughout the paramo from the neighboring towns of Julio Andrade, Huaca, Playón, and other small settlements. Hunting pressure appears high, with obvious targets including rabbit (*Sylvilagus brasiliensis*), white-tailed deer (*Odocoileus virginianus*), and mountain tapir (*Tapirus pinchaque*). We were surprised that there were almost no rabbits: our only evidence of actual presence was rabbit hair in a single Andean fox (*Lycalopex culpeaus*) scat sample, although we did find bones of this species near the Laguna Negro. Whether this is a result of burn-offs combined with hunting or, more likely, one of the periodic epidemics of one of several diseases that attack rabbit populations, is unknown.

We registered only one set of mountain tapir tracks, near a small patch of intact forest that probably serves as a refuge for an individual tapir. Because this species is highly vulnerable to hunting with dogs, the survival of this individual is doubtful.

White-tailed deer (*Odocoileus virginianus*) is usually an extremely resistant species, and we found a stable and relatively intact population once we left the major trail systems: numerous beds, scat sites, and tracks all suggest that at least this species is in no immediate danger in the region.

Andean bear are present in reduced numbers, traveling and feeding at night and apparently holing up in remnant patches of Andean forest in the valleys during the day. Loss of habitat below 3,400 m probably limits the size of the population; the number of feeding sites we encountered suggests that there was probably no more than one pair of bears active in the area covered by our trail system. Habitat loss also severely limits its diet to the relatively nutrient-poor *achupalla* (*Puya hamata*), as evidenced by several, fiber-filled, almost cotton-like scat samples we found—these in sharp contrast to the dark and complex feces of bears in the Cuuttopoé area, where a broader elevational range of habitats is available.

Predators at this site include puma, a smaller species of cat (probably *Leopardus colocolo*, based on feces we observed), Andean fox (*Lycalopex culpeaus*), and possibly crab-eating fox. Scat samples show that these predators are all relying heavily on small rodents and marsupials, with the food situation being bad enough that one *Lycalopex* actually ate a striped hog-nosed skunk (*Conepatus semistriatus*)! This—for an animal that relies on its sense of smell for predatory activities—is extremely surprising, although it may represent scavenging rather than actual predation. Overall, *Lycalopex culpeaus* was common, with a diet consisting of small rodents and marsupials.

Small patches of intact Andean forests combined with more complex and unburned frailejón (*Espeletia*) meadows are home to little red brocket deer (*Mazama rufina*), *sacha cuy* or mountain paca (*Agouti taczanowskii*), mountain coati (*Nasuella olivacea*), striped hog-nosed skunk, and—a huge surprise—an armadillo, which at present we assume to be nine-banded long-nosed armadillo (*Dasypus novemcinctus*). This observation at 3,400 m constitutes one of the highest registries of this genus and species; it could represent an animal or population pushed upwards from the advance of the agricultural frontier—a “refugee population,” so to speak. All of these mid-sized mammals are able to survive in relatively small areas and resist hunting pressures well.
The higher ridges (3,800–4,100 m) are home to an experimental population of llamas, apparently released six years ago as part of a poorly planned “reintroduction” scheme. At this point, the herd numbers at least fifteen individuals, and seems to be healthy and stable, as evidenced by several young animals and one newly born calf. The impact on other mammal populations is probably minimal, although the puma population may benefit. It is not clear if llamas compete with white-tailed deer for habitat.

Much of the paramo at Laguna Negra has been subjected to repeated burns, probably for centuries and perhaps for millennia, and extensive access routes into the area have contributed to heavy hunting pressures. However, these impacts are relatively unimportant when compared with the huge consequences of the loss of lower-altitude habitats to the advance of the agricultural frontier. Loss of almost all of the original forests below 3,100 m—with intervention extending well into the higher forest remnants—has created a crisis situation for large mammals that will be extremely difficult to reverse.

**Río Verde**

Río Verde was the lowest-altitude site that we visited, and predictably had the greatest mammalian diversity, with tropical fauna dominating the list. It was also the location where we were able to rely most extensively on previous records made by Cofan observers, which added to our overall count. We recorded 5 orders, 11 families, and 15 species at this site. Previous work at the site by the Cofan adds 3 orders, 5 families, and 14 species, for a total of 8 orders, 16 families and 29 species (Appendix 9).

Cofan park guards and local miners consider the Río Verde region to be a game-poor section of forest; they describe patches at “Shancoé” and downriver at “La Chispa” as being far richer. Given the apparent soil fertility and complexity of habitats, we suspect that constant hunting by miners is the main reason for the area’s low species-richness and abundance. A secondary reason may be limited access to specific food sources and habitats, especially for the larger herbivores and omnivores. Throughout the contiguous forests in Cabeceras Cofanes-Chingual and the adjacent Reserva Ecológica Cayambe-Coca, “patchiness” of some species’ presence is a recognized phenomenon, although we don’t understand all the causes. Small game species (agoutis, paca, and armadillo) were abundant. Puma and ocelot tracks were evident. In spite of low fish populations, otters were present along the main river and its affluents.

Large primate species in the area include common woolly monkey (*Lagothrix lagothricha*), white-bellied spider monkey (*Ateles belzebuth belzebuth*), and red howler monkey (*Alouatta seniculus*). All three are scarce across wide home ranges, but repeated registers by Cofan park guards confirm a low level of use of this area by these monkeys. White-fronted capuchin monkeys (*Cebus albifrons*) are common, as evidenced by repeated sightings and abundant feeding sites. A single report of a squirrel monkey troop (*Saimiri sciureus*) traveling with *Cebus* is registered in monitoring books of the Cofan park guards. We were able to confirm the presence of black-mantled tamarin monkeys (*Saguinus nigricollis*), probably the only species of the family Callitrichidae to make it across the barrier of the Río Cofanes. Night monkeys (*Aotus vociferans*) have been registered several times in the area right around the camp, and are obviously abundant. Ranges of all of these primates are subjects for future studies. (Farther east, river systems create important species boundaries. We also suspect that, in addition to these obvious natural “fences,” habitat types created by geological events are at least as important in montane forests.)

Andean bears (*Tremarctos ornatus*) are present in low densities. We were able to observe tracks and feeding sites. In 2005, a group of Cofan guards observed an individual swimming across the Cofanes River, and the Cofán have observed several bears feeding on fruits in the area. This is probably near the lower altitudinal edge of the bear’s range, although we have records down to 450 m from the neighboring Reserva Ecológica Cofan-Bermejo.

Primary threats to the area continue to be the uncontrolled entry of *mestizo* artesanal miners, who seek to stretch their food with hunting, and the potential opening of the region by trail and road systems. The Federación Indígena de la Nacionalidad Cofan del Ecuador (FEINCE) is in the process of creating a
“strategic village” at Río Verde, with a strict management plan aimed at recovery of local game populations. This settlement will allow a far better control of the entry of mestizo miners, and will hopefully allow the Río Verde area to recover.

Opportunities include the chance to build realistic management plans and structures that will facilitate long-term conservation of this area. Extensive research needs to be applied to the “patchiness” of species presence.

Alto La Bonita

We recorded 5 orders, 8 families, and 8 species at this site. Additional observations by local hunters added 3 families and 7 species, for a total of 5 orders, 11 families, and 15 species at the site.

This forest was difficult to sample: our activities were confined to recent, well-defined trails where the perturbation is high. We normally traverse between trails, but here this was impossible because of the vegetation and terrain, which sharply limited our ability to sample the mammals present. We expected to see squirrel species and perhaps other medium-sized mammals, but we recorded no visual registers. We were able to observe extensive evidence of feeding and travel by Nasua and Agouti, which indicated a healthy tall-montane-forest environment. Bear and tapir tracks were found throughout the area, likewise suggesting healthy and as-yet intact populations of these two animals. The presence of an intact altitudinal gradient was apparent for both of these large mammals, with trails leading through the Andean forests directly up the hills to higher-level forests we were unable to access.

All three “banner” species are present: Mountain tapir (Tapirus pinchaque, in healthy but not abundant numbers), Andean bear (Tremarctos ornatus, using the trails as transit routes to feeding sites), and puma (Puma concolor, which left a sample of its diet, Agouti taczanowskii, complete with claws and crushed bones, on a trail). Both A. taczanowskii and mountain coati (Nasuella olivacea) are very common in the forest, often with well-marked trails and frequent feeding signs. One observation of white-fronted capuchin monkey (Cebus albifrons) confirms that this species at least occasionally uses these forests; at 2,700 m, this could be one of the highest-altitude observations recorded. Larger mammals use the vertically oriented strips of habitats, providing many stages of succession, generated by constant landslides.

An extremely interesting register occurred, not at the actual campsite, but when we returned to La Bonita and began to interview local hunters, conservationists, and other residents concerning the mammals of the area. Apparently three months prior to our inventory, tractors working on the new road being built to link La Bonita with the town of La Sofía—in the high valley of Valle Negro (roughly analogous in altitude and habitats to the Alto La Bonita camp at Río Sucio)—accidentally exposed a burrow of a large rodent in a four-meter-deep road cut. We have tentatively identified this as a pocket gopher (Orthogeomy sp., Geomyidae). The captured adult was approximately 45 cm in length, dark brown with gray hairs on the back (giving it a “grizzled” look), and possessed massive front claws. The den was lined with plucked hairs and contained two half-grown babies. After inspecting the basically helpless animals, the workers released them, and watched as they crawled off through the mud and dug their way underground again. If this is Orthogeomy sp., it would suggest a tremendous extension of its range from previous records in northwestern Colombia. Further information, and if possible, properly collected specimens will be necessary before we can follow up on this interesting find. The fact that these animals pass all of their lives deep under the ground allows us to hypothesize a large and healthy population living out of sight and out of mind! These rodents may account for repeated stories from miners, park guards, and other local people of loud subterranean noises heard on ridge trails above 1,700 meters in both the Reserva Ecológica Cofan-Bermejo and in the Muraya complex between Río Verde and La Bonita.

Wide, new trails expose the area to hunting by La Bonita residents and others.

Ccuttopoé

This is a large and intact block of paramo and high montane forests that is still in its natural state. We recorded 5 orders, 10 families, and 12 species at this site.
Ccuttopoé is located at the headwaters of the Condué River system. Entrance to the region is via the town of Monte Olivo, located at 2,400 meters in the Pacific drainage. From the town, the trail rises steeply to the Asociación de Palmar Grande, a small community on the hillside between 2,700 and 3,100 m. From this point one enters mixed pastures and relatively intact Andean forests, in which better-quality woods such as olivo (Podocarpus sp.) and cedro (Cedrella montana) have been largely extirpated, with aliso (Alnus sp.) as the primary target of current lumbering. The trail follows a course established to bring water from the headwaters of the river, and rises to 3,200 m before dropping sharply to the streambed. From the stream, the trail then rises through intact Andean forests to open paramos, topping out at a small peak overlooking the Laguna Las Mainas. This lake is oval shaped, around 800 meters long by 600 meters wide, and has been stocked with trout during the past 30 years. The fame of the location as a trout fishing site has inspired a constant stream of fishermen, both local and from other parts of the sierra, creating a tremendous potential for tourism that the town of Monte Olivo and the Asociación para Turismo in Palmar Grande are seeking to tap as a source of revenue. In spite of the heavy human traffic to the lake, once past the more open section of the stream, all signs of recent human activity vanish, and abundant tapir and bear sign are immediately visible. A new trail recently established by the Cofan rises sharply through heavily forested sections of the valley and up to frailejon (Espeletia) and reed meadows, and then to the windswept and virtually bare ridge of the continental divide. From this vantage, with clear weather, the vast Condue valley drops away in one of the most impressive views of the region. The Ccuttopoé camp proper is located beside a small lake at 3,600 m. Heavily forested hillsides alternate with frailejon meadows down through the valley to the confluence of the Ccuttopoé and Agnoequi rivers, at 3,200 m. A marked change in flora occurs on this slope at approximately 3,350 m, with large arboreal bromeliads suddenly and dramatically appearing on branches in these Andean forests.

Large mammals include Andean bear, little red brocket deer (Mazama rufina), mountain paca (Agouti taczanowskii), striped hog-nosed skunk, (Conopatus semistratus), puma, and others; but the easily apparent dominant mammal is mountain tapir (Tapirus pinchaque). Large, well-traveled trails, grazing sites, feces, sleeping locations, and swimming holes were all incredibly abundant, indicating an extremely healthy and strong population of this endangered species. The ecological impact of this tapir population is immense, and is probably a major factor in the maintenance of the extensive meadows and patches of open paramo. At first glance, it is easy to note that these meadows and paramos are far more diverse than their burned over counterparts in locations such as Laguna Negra. We estimate a density at this site greater than one animal per five hectares. A large-mammal population of this size has a significant effect on its habitat. The tapir is a known disperser of seeds as well as a creator of trails and, apparently, an alternative to fire as a maintainer of paramo plant communities. At least tentatively, we can suggest that the Ccuttopoé region is an environment created by and for the mountain tapir, and at this point is probably unique as an example of what much of the high Andean region must have been prior to human intervention.

All of the large mammals seem to make extensive use of the altitudinal ranges present in the region. Tapir and bear trails range from 4,100 m down into the forests at 2,800 m and lower. A female tapir with a young colt stayed above the 3,700-m mark during the month we were involved in setting up the camp, probably taking advantage of the openness of the paramo habitat to easier defend the young from huge pumas (whose tracks we found on our trails on both sides of the continental divide). Meanwhile, the fact that most of the tracks near our camp site were old, and that most of the tracks led downward, suggested to all of us that some food was available at lower elevations during our stay, and that the population had moved down the hill to take advantage.

This intact altitudinal gradient contrasts sharply with the situation at Laguna Negra, where most of the lower-level habitats have succumbed to the advance of agriculture and other human activities. Bear scat at Ccuttopoé is full of seeds, fruit, small rodent bones, and insect remains, in addition to the easily recognized achupalla shoots, indicating access to a varied and complex diet. This stands in sharp contrast with the
fluffy white, pure chupaya-shoot scat of the bears at Laguna Negra. While we were unable to sample tapir scat at Laguna Negra, it would undoubtedly reflect this tendency as well.

Another noteworthy register from Ccuttopoé was an incredible set of large tracks left by a huge puma that preceded us down our trail past the Laguna Las Mainas. The tracks suggest an animal adapted to killing large prey—such as tapirs! Based on previous experience, we estimate this puma to easily surpass 2.5 m in total length, with a weight of greater than 75 kilos—truly an amazing animal.

A final note of interest was our discovery of the remains of a small porcupine in these Andean forests at approximately 3,500 m. We were unable to determine the species from the spines, and at present taxonomy of Coendou is poorly known, so the possibility of a new species is high. In fact, the entire mid-sized mammal population remains poorly known and has never before been sampled in an intact and tapir-dominated ecosystem.

DISCUSSION

The most impressive lesson from our observations is the extreme importance of contiguous multi-elevation habitats for the larger mammals, especially mountain tapir (Tapirus pinchaque) and spectacled bear. Even tropical rain forest species, such as white capuchin (Cebus albifrons), make use of this altitudinal gradient, with a register from 2,600 meters near the Alto La Bonita site.

Within the overall panorama of mammalian diversity, the most important and impressive register is the intact population of mountain tapir at two of our four sites; it occurs in most of the region above 2,000 m. Andean bear appears to be present throughout the region. It was present in all four sites, with healthy populations at Ccuttopoé, Alto La Bonita and Río Verde; but at Laguna Negra it was scarce and potentially in danger due to habitat loss. Both species are considered vulnerable or endangered (UICN 2008), or near extinction (CITES 2008). We observed abundant tracks and feeding sites of the little known mountain paca (Agouti taczanowskii) and mountain coati (Nasuella olivacea). And, an unidentified species of Coendou observed at Ccuttopoé is present. At lower elevations (below 1,500 m), relatively intact populations of Lagothrix lagothricha, Ateles belzebuth, and Alouatta seniculus still exist. The protection of contiguous forests, covering altitudinal ranges for each of these animals, is critical for their conservation.

Extensive discussions with local hunters about techniques and primary prey animals gave us a better picture of some of the immediate threats to the large mammal populations. Tapirs are commonly hunted with dogs: a single hunter will lead the dog pack into a known tapir area, find fresh tracks, and begin the tracking process. Once the pack has a positive scent, the hunter will stay in the forest to help the hunt while other hunters wait in the nearest stream channel. The tapir will almost invariably descend to the stream and take refuge in one of the deeper pools. The hunters stationed in the stream will converge, kill the tapir, and pull it down the stream to a convenient butchering location. Deer are killed in the same manner. Tapir populations cannot withstand this relatively easy system of hunting, as witnessed by the decimated populations in most of Ecuador. Bear are more resistant.

Bear are considered a far more difficult prey, with a tendency to head off cross-country and not come to bay in accessible locations. They are also considered dangerous by both hunters and the dog packs; two hunters we interviewed pantomimed (amid laughter, but with obvious respect) the fear of the dogs when running into a bear. Bears are hunted occasionally when they raid crops or are found feeding in fruit trees near towns. But, while considered to be good meat, they are not frequently sought because of these difficulties.

Mountain paca and mountain coati are both trapped, using their tendency to follow set paths. The hunters use simple snares and deadfalls. Near agricultural lands, especially pacas are frequently hunted with dogs, taking refuge in holes from which they are then dug out.

THREATS

Laguna Negra

- Intentional burning of paramo
- Loss of contiguous habitats below paramo
**Río Verde**
Uncontrolled entry of mestizo artesanal miners, who supplement their food with hunting, and the potential opening of the region by trail and road systems

**La Bonita**
New, well-established trails that expose the area to hunting by La Bonita residents and others

**Ccuttopoé**
The development of a receptive tourism market for the Laguna Las Mainas could constitute a threat to this very vulnerable region. Because of our trails, the Ccuttopoé area can be accessed from Monte Olivo in less than seven hours, with the potential for clandestine hunting and even colonization. Poorly managed tourism could create a human impact on what are obviously very sensitive populations.

**RECOMMENDATIONS**

**Laguna Negra**
- Protect habitat at lower elevations, to allow for a healthier population of Andean bear (*Tremarctos ornatus*) and mountain tapir (*Tapirus pinchaque*).
- Study potential competition for habitat by white-tailed deer and the recently introduced llamas.
- Study the effect of controlled burns on populations of white-tailed deer (*Odocoileus virginianus*) and other medium-sized mammals.

**Río Verde**
- Create a “strategic village” at Río Verde to control exploitation and colonization.
- Build solidly based management plans and structures that will provide long-term conservation of this area.
- Study ranges of all the primates.
- Study “species patchiness” to better understand the mechanisms that create ecological barriers in montane forests. (We are seeing the extreme need for altitudinal and ecological gradients and diversity in the case of bears and tapirs, while at the same time running into the opposite phenomena with many of the other large mammals. For example, there is no apparent reason why woolly monkeys should be in one area and not in another.)

**La Bonita**
- The threat posed by the well-used hunting trails can be countered by establishment of the proposed municipal reserve and prompt initiation of patrols by park guards.
- Study mammalian use of vertical strips of habitat created by landslides of various ages, to determine how they affect mammal abundance.

**Ccuttopoé**
- With a minimum of infrastructure, a constant presence of Cofan park guards, and close coordination and friendship with members of the Palmar Grande and Monte Olivo communities, this region could be adequately protected.
- Future studies should first concentrate on the incredible opportunity to look at an intact, tapir-dominated environment and second on management mechanisms to allow a selective and carefully controlled tourism that will help raise public awareness and provide economic incentives for local peoples.

**ARCHEOLOGY**

**Author/Participant:** Florencio Delgado

**Conservation targets:** Two archeological settlements, a pre-Columbian settlement at La Bonita, made up of mounds and other modifications of the environment; and a pre-Columbian settlement at Río Verde, at the confluence of the Verde and Cofanes rivers

**INTRODUCTION**

Conservation-oriented biological and ecological studies have long presumed the existence of areas undisturbed by human activity. The classic example is Amazonia, which was thought to contain landscapes that were completely “pristine.” In a discussion of the landscape of the New World before European colonization, Denevan (1992)
pointed out that the idea that many areas uninhabited today have never been colonized is actually a myth. He indicated that after the European conquest, densely populated areas saw sharp reductions in indigenous numbers due to disease and other consequences of the conquest. In upper Amazonia and the Andean foothills, many communities abandoned their settlements to escape colonial rule (Denevan 1992).

The myth of pristine places has now largely been discredited as a result of the quantity of archeological information (Heckenberger et al. 2008). After human populations disappeared, these areas saw a return of wild animals and plants, as forests replaced savannahs and native animals repopulated areas previously inhabited by humans and domesticated species. These findings underscore the need to study areas considered pristine until recently: first, to establish whether human communities were once present, and second, to uncover their histories in order to understand how these communities transformed the environment and its biological and ecological components. The archeology and historical ecology of a region are modern contributions to the understanding of past societies, based on the idea that the present landscape is the result of a long process of both wild (i.e., non-human) and cultural transformation, making an analysis of anthropogenic intervention imperative. Through archeozoological and paleobotanical contributions, as well as geoarcheological studies of the environment, investigators have recently been trying to understand how previous societies adapted to various environments and transformed them.

In light of these findings, the rapid inventory included a sampling of evidence of human impact that might have transformed the landscape of Cabeceras Cofanes-Chingual (Murra 1975).

From the perspective of the past, this is a unique opportunity because it permits study of an altitudinal gradient from approximately 4,000 m (with a paramo ecosystem) to 600 m (considered the upper Amazonian zone), including the foothills of the Andes, and because it contributes to the understanding of the historical process of a section of northern Ecuador.

**Historical context**

One of the most important characteristics of past societies in the area is their extensive regional interactions, based on trade and vertical economies (Murra 1975; Oberem 1978). These interactions are seen in the constant exchange of food and ideas occurring in the region, with basic necessities and exotic (i.e., non-local) goods being transported among the various continuous ecological zones. In fact, northern Ecuador and southern Colombia are endowed with valleys that connect the inter-Andean region with eastern and western temperate zones across the foothills (which are transitional between the upper and lower zones).

Studies conducted in adjacent areas to the north as well as the south indicate marked cultural interaction between communities of various ecological zones, especially between those in the inter-Andean river basins and the Andes’s eastern slope. It is believed that these routes of integration correspond primarily to the continuous valleys formed by the rivers, which allow access to various altitudinal zones. Ethnohistorical information, as well as that from the settlements themselves, attests to this vertical interaction, although how long it has occurred and what it involves remains unknown.

There are still many gaps in the cultural history of the region, as well as problems hindering attempts to reconstruct the historical process of the past. Although there is abundant archeological material in public and private collections, almost all of it was excavated clandestinely by antiquities thieves and bought by collectors. Despite this, there have been various attempts to reconstruct the cultural history of northern Ecuador and southern Colombia (Francisco 1969; Uribe 1986; Cardenas-Arroyo 1989, 1995; Groot de Mahecha y Hooykaas 1991; Jijón y Caamaño 1997).

There are no research data for the study area, and consequently the historical reconstruction that follows has a wider context and uses published data on Carchi and Sucumbíos on the Ecuadorian side, as well as on Nariño and Putumayo in Colombia.
The Pleistocene Era

The population of South America at the end of the Pleistocene is still a matter of debate because of controversial data and the lack of data for many areas. In the Carchi-Nariño-Sucumbíos-Putumayo region, no settlements have been recorded to date for the Paleoindian period (about 11,000–9,500 BC), a period corresponding to the end of the Pleistocene and the beginning of the Holocene. Paleoindian settlements such as La Elvira and La Inga have been found in adjacent areas as well as north of Popayán in Colombia and the Quito Valley in Ecuador (Salazar y Gnecco 1998). This period is characterized by the exploitation of the Pleistocene megafauna whose habitats were in the upper altitudinal zones. (Caves formed in the glacial valley of Laguna Negra may have functioned as shelters for groups of this era.) In general the paramo zones and the upper foothills of the Andean Mountains are the niches exploited during the period.

The Archaic Period

Ecological changes, which occurred with the arrival of Holocene-generated changes in adaptational processes, were expressed in the use of inter-Andean and alluvial valleys that had formed along rivers on both sides of the mountain range. On the eastern slope, alluvial valleys of the Cofanes-Chingual system would have provided areas for the formation of camps within a system much more mobile than that of the Paleoindians (in response to animal species that were much smaller and more mobile). This led to the need to intensify hunting activities and to develop specialized tools to hunt with. The increased time required for hunting led to a sexual division of labor, in which women contributed to their diet by collecting seeds, tubers, and other plants. Throughout this long transition, which occurred during what is referred to as the Archaic Period (around 9,000–4,000 BC), plant domestication was developed, resulting in the social transformation of hunter-gatherer groups into agricultural ones. In the northern region, a lack of paleobotanical and archeozoological studies precludes establishing how these changes happened. Investigations of the Araracuara (Mora 2003) indicate that communities of the southwestern Colombian Amazon were cultivating crops since approximately 2,000 BC. Although somewhat controversial, a palynological analysis of sediments from Lake Ayauch in Ecuadorian Amazonia indicates the existence of domesticated corn in deposits that may date from 5,000 years ago. The study area is one of the most likely places for this process to have occurred, but to date it has not been confirmed.

From the Formative Period to the Present

Information is nonexistent for the subsequent cultural period known as the Formative (~5,000–2,800 BC), which is characterized by the development of agricultural, pottery-making, sedentary societies. Some authors ascribe this phenomenon to the intense volcanic activity occurring in the area, although others argue that in areas with the same or even more-intense volcanic activity, such as the Quito Valley, formative communities are observed, and that this instead is due to the absence of archeological research in the area. In any case, the study area constitutes, again, a perfect scenario for evaluating the way this change occurred.

After a long formative process, the local communities came together and formed villages, which significantly affected the environment. In regional terms, the settlements became less dispersed and more centralized, clearing significant areas of forest, increasing the amount of land used for agriculture, and in some places transforming the agricultural system from an extensive system to an intensive one. This transformation caused significant changes in the environment because whereas the former is based on slash-and-burn agriculture (which tends to convert large areas of land into cultivated plots through a system of rotation), the latter concentrates and intensifies activities in specific places. (Thus, although the transformation of the landscape is not extensive, it is more pronounced in the regions where intensive agriculture is practiced.) Noteworthy results of intensive agriculture are the construction of crop terraces, the implementation of irrigation systems, and improvement of the soil with fertilizer. Construction of terraces and irrigation canals caused direct modifications to the environment, whereas production of fertilizer
required the use of feces of domesticated animals, for whom corrals were constructed, which also would have modified the environment.

In the study region, at the La Bonita archeological site, there were transformations that could have dated from this period; although currently just a hypothesis, this could be confirmed through analysis of carbon samples obtained in the present inventory.

The last pre-Columbian period in the region is notable for the formation of large confederations, or groups of chieftainships, which formed strong regional structures (Uribe 1977; Athens 1980). In the border region there were four ethnically distinct groups: the Pastos, the Quillacingas, the Sibundoyes, and the Abades. The Pastos occupied inter-Andean territories from the vicinity of Popayán in the north to the Chota-Mira valley to the south, whereas the Quillacingas and the Sibundoyes were located in the western foothills (Ramírez de Jara 1992, 1996). The Pastos are known to have begun to form an alliance against the Incas with their neighbors in the País Caranqui (Bray 1995, 2005), but the history of the Quillancingas, the Abades, and the Sibundoyes is more obscure. One hypothesis proposes that the Pastos populated the inter-Andean passage, the Quillacingas and the Sibundoyes the eastern foothills, and the Abades the lower region. Taking this argument a bit further, it has been proposed that the late conformation of the region was made up of the Pastos, the Quillacingas, and the Abades, since they are ethnically related to the present-day Cofan.

The collapse of the Incan Empire cut short any attempts at domination. Instead, the colonial system was established in the region, which maintained a system of control over the land and the labor force through settlements of converted indigenous people and commissions. At this time there was a rupture, however, between the control exercised in the upper Andean zone and the more-limited success of the Spanish to dominate the communities in the foothills and Amazonia. These communities abandoned the foothills and upper Amazonia and relocated to jungle areas to escape domination. Many of these groups underwent significant transformations through a process of ethnic redefinition.

Today’s groups such as the Cofan appeared as a result of this process.

METHODS

The conventional practice of archeology has three stages: one in the library, one in the field, and a third in which results are analyzed and presented. The three activities carried out in the field are examination, exploration, and excavation. Examination entails a first overview of the area of study, to determine whether it contains archeological material. Exploration requires a systematic analysis of areas in search of archeological sites, whereas excavations involve work carried out at specific archeological sites.

Although archeological investigations and contract archeology work follow clearly established procedures, these have not been defined for rapid inventories. Consequently, a strategy developed for this study that allows the goals of the inventory to be met for the most part. Although the study of the past takes time, a rapid inventory of archeological resources offers a wonderful opportunity for a first glimpse of a region to determine the early presence of humans in areas long considered to be pristine territory as far as human habitation.

The methodology used included the following tasks: (1) Bibliographic review of the area of study and adjacent zones, with the aim of identifying information about the area within a broad context. (2) A visit to the sites to establish a rapid inventory of existing evidence able to be examined during the short visit. (3) A return visit to write brief descriptions of the cultural, tabulated, and photographic material.

Work in the field included interviews with the population adjacent to the study sites. These interviews included the guide staff, people who had not only traveled several times through the region but had cleared paths for this rapid inventory. In the populated centers, such as La Bonita, Puerto Libre, and Monte Olivo, I spoke with the local population to which I had access. In La Bonita I interviewed professors at Colegio Nacional Mixto Sucumbíos; also the director of culture, and the director of tourism and the environment, of Cantón Sucumbíos (the county of Sucumbíos). At the Colegio
Nacional Mixto Sucumbíos I had access to a collection of axes and pottery that had been established through donations from students of the institution. Municipal employees provided information on settlement areas within the town and accompanied me in the search for evidence and the inspection of archeological “profiles” in various parts of the town.

Another field activity consisted of examining profiles of road cuts and banks of rivers, streams, and ravines. I also did a visual analysis of the local geomorphology, locating level areas with potential as human settlements. These areas were cleared in order to look for buried evidence of human activity. Finally I carried out several rapid probes using drills and trowels. At Río Verde, I performed 12 drilling tests, using an x-y grid, to define the size of a site located through the cleaning of profiles from a small stream on a high terrace, currently occupied by a Cofan park-ranger post. The drilling tests and the cleaning of profiles were done to establish the historical presence of humans through pottery and stone fragments and, more importantly, through the presence of soils modified by humans. As the material was found, it was collected, washed, and classified. I made a graphic record of the provinence of these artifacts. At several sites I took soil samples from the profiles and charcoal samples, but given the scope of the inventory, this material will have to be analyzed at a future date.

The material was washed and classified as to its components (that is, pottery, stone, soils, and so on). I grouped pottery fragments at each site on the basis of surface decoration, thickness of walls, and parts of the body to which they pertained. Edges were identified and separated from the other sherds, because they are diagnostic fragments with which the shapes of the vessels can be reconstructed (Rice 1987). I classified stone samples on the basis of the raw material of which they were made (Andrefsky 1998). Charcoal samples were inventoried and moved to the archeology laboratory of the Universidad San Francisco in Quito, where they will be stored until they can be sent out for radiocarbon dating.

The constructed cultural landscape

In the 1970s, studies of settlement patterns indicated that the concept of the archeological site had various problems, and therefore landscapes as such should be studied. The problem always arose from the question of what constitutes a site, which is a matter of the scale of the analysis. One could identify a neighborhood of a large city and call it a site, whereas others could identify a single structure and call it a site also. This can be solved by instead focusing on the landscape, which is considered an aggregate of “sites” and archeological zones. In this work the focus is regional and centers on the identification of landscapes as cultural events.

RESULTS

The present study resulted in the identification of two archeological settlements, Río Verde and La Bonita. It was easy to determine the existence of the first site because it corresponded to our base camp at the base at Río Verde, whereas the second one was found during the visit to the town of La Bonita.

Río Verde

The inventory site is located on an alluvial terrace at the confluence of the Cofanes and Verde rivers, formed by the action of the Cofanes River, which includes a level area that today is used for farming by members of the Cofan community. A small stream crosses through the site and flows into the Verde River. The surface of the land is being transformed by current human activities, including logging and the clearing of forest for agriculture.

Stratigraphy

Although the four profiles that were cleaned here vary slightly, their structure indicates that the stratigraphy of the site is made up of horizons O (humus), A (transitional deposit), Bw (buried soil), Bwb (human-modified soil), and finally bedrock. The cultural deposit has a thickness of ~40 cm and is found at a depth of ~50 cm.
Cultural material

The recovered material consists of pottery and stone fragments (Fig. 9A). Of the pottery fragments, 12 from the body of vessels were found. These fragments are of two types, one from coarse and thick pottery, and the other coarse and delicate. Eight stone fragments were also found, made up of two types of parent material.

La Bonita

The settlement of La Bonita (Fig. 9B) is located in the contemporary town of the same name, which is found on one of the alluvial terraces of the Chingual River. It is one of the few places with a topography less steep than the ravines dominating the region. A large part of the center of the site was probably destroyed by construction of the current settlement, which resulted from the migration of populations from north of the Chingual, beginning during the rubber era. Most noteworthy in La Bonita and its vicinity is the coexistence of pre-Columbian and modern transformations of the landscape, which has resulted in a cultural landscape whose construction probably dates back to the first centuries of the Christian era. The information obtained to date does not allow us to establish the size of the settlement, but if the settlement area is added to the zone of production, La Bonita constitutes a settlement of important size for the region.

Stratigraphy

Because of the complexity of the site, no one stratigraphic profile is representative. In most sectors whose soil under the humus layer was inspected, the soil containing cultural evidence has a variable thickness as a result of the human constructions of platforms and mounds. Inspection of the various exposed profiles suggests that there were two periods of occupation; however, this remains hypothetical until the samples obtained from these profiles can be dated.

Cultural material

The cultural material found at La Bonita also included ceramic and stone material. The pottery was widely variable stylistically and can be differentiated in a very preliminary classification based on surface, decoration, and thickness of the walls. Fourteen styles were found, which were arbitrarily given the names A–N. These defined types, even in preliminary form, exhibit the local variability, with two fragment types—K (46%) and M (18%)—in the collected sample. These two types represent pottery for domestic use, whereas the rest of the material represents decorated, delicate pottery, that is, luxury items.

Although these types were not defined on the basis of consultations with museums and the literature, I grouped the material to demonstrate the richness of ceramic material in the area. Nevertheless, at a preliminary level one can see high variability in the treatment of the vessel surfaces. Along with this high variability there is a great abundance of ceramic material, which, together with the considerable volume of soil removed for the construction of the housing platforms and mounds, suggests that a sizable population settled in the La Bonita valley.

Pottery predominates in the material sampled, with an abundance so much higher than that of the stone material as to make it impossible to have resulted from a prejudice of the sampling. It is common at sites occupied by complex farming and pottery-making communities for the density of ceramic material to surpass that of stone material.

It should be noted that this description corresponds to the material collected in the present rapid inventory and does not include the collection of axes observed and photographed at the Colegio Nacional Mixto Sucumbíos (Fig. 9C). This collection has polished-rock material, with sophisticated shapes and an impressive variability. The raw material used to make stone tools in La Bonita includes local minerals, like granite and basalt, but obsidian is also incorporated, whose known natural sources are found a long distance from the site (Salazar 1992). In the sample no traces of bone or metal were identified, although current residents of the area indicate that metalurgical material did exist and was associated with tombs.

DISCUSSION

The evidence allows us to establish the existence of two settlements located on a gradient from 600 to 2,600 m above sea level. Whereas La Bonita appears to have been
a structured settlement with clearly sedentary inhabitants, who used the valley for agricultural production, the Río Verde site was a small settlement, with inhabitants who possibly subsisted through hunting, fishing, and slash-and-burn agriculture on a small scale in the Cofanes River valley. In demographic terms, La Bonita was a settlement of several families, whereas Río Verde may have consisted of one extended family.

Impact on the environment is much more evident in La Bonita, whose inhabitants transformed the landscape through the construction of terraces and mounds. In Río Verde, this transformation was barely perceptible. This suggests that La Bonita was a community with a complex social organization, that is, it could have been a settlement ruled by a local foothills chieftain, whereas Río Verde may have been a settlement of one family, that is, an egalitarian society.

Since pre-Columbian times, inhabitants of this area have maintained contact across a range of different altitudes. Among the ceramic material found in Río Verde were two fragments with red paint on the interior, characteristic of the high-altitude zones, which suggests it had been obtained through trade. Some authors have noted that axes have been found among the products traded between the mountains and upper Amazonia, which indicates the existence of a trading network between the upper and lower zones. In La Bonita, the axes we examined at the local college included a particular specimen that must have been traded (Fig. 9C).

Opportunities

The presence of these archeological sites increases the conservation value of the area, and permits study of the way ancient inhabitants used the local environment. This provides a new dimension within the conservation program, while at the same time fostering new ways for the local population to relate to their cultural patrimony.

Threats

The principal threat to which these cultural artifacts are exposed is destruction from antiquities theft (i.e., huaqueo, treasure-hunting), which is common in the area. I was told that some people in La Bonita even had metal detectors with which they located areas for excavation.

Other threats include infrastructure projects, such as the opening of roads and housing construction, as well as other types of construction, which alter sections of the sites; this clearly was occurring in La Bonita. Agricultural activity also changes the structure of the sites, as in La Bonita and Verde River.

Finally, the introduction of cattle in the region constitutes a threat; for example, in La Bonita cattle have destroyed terraces and places where pre-Columbian residential sites have been found.

Recommendations

The protection of these sites requires some prompt measures:

- Before activities further alter the surface of the terrain where settlements are found, studies should be carried out that help minimize their negative impact.

- Through the conference of the Instituto Nacional de Patrimonio Cultural workshops should be held in which communities in or near the archeological sites can be informed about the laws protecting these sites, whose legislation is regulated by this institution.

- Methods of investigation of the defined sites and of the general study area should be developed. The investigation should start with analysis of the material obtained, radiocarbon dating of the material, and so on.

A HISTORY OF THE RÍO COFANES TERRITORY

Author: Randall Borman A.

This history, with a Cofan perspective, was assembled from many sources, including Ferrer (1605), Velasco (1841), Porras (1974), and Cofan oral histories.

Constant and often violent change typifies the ecosystems of the Río Cofanes-Chingual region through the millenia. Human presence probably dates at least as far back as the late Pleistocene, when Paleolithic hunters pushed southward along the edges of the Andean glaciers.
As these glaciers melted during the early Holocene, populations began to settle in the inter-Andean valleys, and hunter-gatherers spilled through valleys (such as that of the upper Chingual) into a relatively cool and moist Amazonia.

We have no accurate way of determining when the first “proto-Cofans” entered the region, but direct cultural ancestors, at least, were active in these valleys at least as far back as 5,000 years ago. These early settlers must have been witnesses to incredible events. Soche, a small and still-active volcano on the banks of the Chingual, staged its last major eruption approximately 10,000 years ago. Reventador, to the south and east, was still recovering from blowing itself apart 5,000 years earlier, when it spewed out over eight cubic kilometers of material and decimated most of the upper Aguarico valley in a tremendous lateral blast. And, Cayambe, perched a little higher and farther west than these two lesser volcanoes, experienced a period of fairly steady mountain-building events throughout much of this time. Meanwhile, earthquakes were constantly occurring, with the Abra and other major faults vying for importance with dozens of lesser faults. At least one “great” earthquake per century continues to be the norm for the region even today. Top all of this off with constant erosion processes—landslides, rivers changing course, mountains being eaten away by high rainfalls—and throw in floods of all sorts and sizes on a regular basis—and the presence of humans in region at all becomes surprising.

What is not at all surprising is that the myths and legends of present-day Cofan culture are full of references to these geological events:

“...The earth moved and shook for days, and in its wake the whole earth turned into mud...”

“...and from the mountain came the devils, with fire in their eyes...”

“...they climbed and climbed, but the waters kept on rising, until they reached the top of the mountain, but the waters stopped there...”

“...the demons used boulders as their rafts, standing on them in the waves...”

These are the indelible imprints of living in a world where fire, ice, water, and an unstable earth challenged the daily survival of all who sought to make their homes in the region.

In spite of all this, by the late 1300s, the presence of Cofan and other indigenous groups in the region was well-established, with extensive trade routes, large populations, and sophisticated systems of social interaction, both within cultural units and with other actors. The Cofan language has long been considered an isolate, derived from proto-Chibchan roots. However, recently, extensive research suggests that far from being an isolated language of a small montane culture, it was once part of a much larger linguistic block that included much of what is today northern Ecuador, including the Caranqui, Quijos, and perhaps other historical groups. These other groups lost their original languages to Quichua, as first the Incas and then the Spanish imposed this Bolivian-indigenous language as a lingua franca for their empires. The Cofan language of today is therefore likely the last remaining manifestation of what was once a much larger linguistic family. For example, “Cotacachi” and “Sumaco” are the names currently used for two Ecuadorian volcanoes, one in what was Caranqui territory and the other in Quijos territory. Cottacco is the Cofan word for mountain. Cotacocho would translate easily in modern Cofan as the “round mountain,” while Sumaco is still called Tsumaco (the “mountain of the beetles”) by Cofan. Endings such as gué (in modern Cofan indicating “the location of,”) qui (“stream or small river”), and cco (“mountain”) all appear frequently in place names both in original Spanish histories and present place names throughout northern Ecuador.

The first historical mention of the Cofan people by name comes from Cieza de Leon’s account of the Caranqui resistance to Inca expansion under Huayna Capac in the late fifteenth century. The Cofan joined with the Quijos, the Pimampiros, and others as part of a mixed group of allies from the eastern montane region that fought and lost to the Inca forces near the present site of Ibarra. The Cofan forces evidently retired into their montane territories along with the other eastern groups, leaving the Caranquis to bear the brunt of the
Inca anger and revenge at Yahuarcocha, where over 3,000 warriors were massacred.

The Inca military victories in the region probably affected the Cofan and other eastern groups only marginally. Trade apparently continued, with trail systems intact and population sites stable during the following decades. Inca attempts to conquer the montane tribes militarily met with little success: at least two and possibly three invasions were staged via the present Papallacta routes, with the Incas claiming “victories” but with little apparent damage to the affected Quijos groups. Inca linguistic and cultural missionaries spread out into the montane tribal groups with better success. By the time the Spanish arrived, most of the northern highland tribes were already using Quichua as their primary language, and the Quijos, Archidona, and Napo cultures were beginning to learn Quichua.

All these processes, however, came to a screeching halt with the Spanish invasions beginning in the 1530s. The partially consolidated Inca expansion was destroyed in a spectacular fashion as the Spanish rolled through the highlands. Meanwhile, European diseases also spread out, destroying entire populations far beyond the reach of the Spanish military activities. Quito and other sites were quickly conquered and “refounded” as Spanish cities, and, after the first dizzying harvest of gold and silver from the Incas, they served as jump-off points for numerous expeditions into all the corners of the region.

Here the Spanish were able to use the extensive trail systems that had developed through the centuries as trade routes, including the four previously mentioned routes into the northeastern montane regions. Expeditions went out as early as 1536 into the Quijos and Cofan territories, and came back with stories of cinnamon, gold, and extensive agricultural lands. Gonzalo Díaz de Pineda brought back an extensive report in 1538 that included information on the “province of the Cofans” but concentrated his colonization efforts on the presumably easier Quijos valley. Gonzalo Pizarro’s ill-fated venture in 1541 explored much of the area between the upper Napo and the Coca rivers, but probably didn’t get into Cofan territories proper. It is interesting to note the importance of the trail system in the Quijos area: Díaz de Pineda was able to use horses in most parts all the way through to the Cosanga valley and the present day site of Baeza (although he spoke disparagingly of the lack of maintenance on the route). Less than four years later, Pizarro’s troops marched over this route with at the very least over a thousand people, two thousand pigs, and various and sundry horses, cows, and other livestock. Francisco Orellana, arriving late for the expedition, laments that the road was in a terrible state—not at all surprising with this sort of traffic! But the fact that these trails, made for foot travel, were able to withstand this sort of abuse at all indicates the high degree of sophistication and engineering invested in trade routes.

During the following years, the Cofan appear mainly as a war-like group that caused grave problems for Spanish activities along the Guamues and San Miguel rivers. Ecija was destroyed by Cofan warriors in 1550. Subsequent warfare resulted in the burning of Mocoa and a siege of Pasto during the latter part of the century. The Cofan Nation was considered to be war-like, intractable, savage, and a source of constant revolt among more well-behaved neighbors. It was probably during this time period that the trading trails in the north began to fall apart as trade systems into the highlands broke down.

The first well-documented entrance to the Río Cofanes region proper came with the rambling exploration of Pedro Ordóñez de Cevallos, an adventurer who had decided to become a priest in addition to a long list of occupations that included corsair, writer, biologist, pugilist, and explorer. He entered the montane region via Papallacta, went down the Coca, swung over into the Aguarico basin, visited numerous Cofan towns, and eventually returned via the now-overgrown Pimampiro trade route. His robust form of Christianity evidently went down well with the Cofan chieftains he encountered: The Cofan soon began visits to Quito and Bogotá to acquire Catholic images, bells, and other church paraphernalia, and the warlike activities associated up to this time with the Cofan Nation seem to have subsided.

This sparked the interest of the Jesuits. While they had no use for the particular brand of Christianity that Ordóñez had gotten started, they were not loathe to take
advantage of the opening of a “new” field for church activities. Thus, Rafael Ferrer of the Jesuits ventured into the “savage” province of the Cofan via the Pimampiro trade route in 1602. Unfortunately, at this point we still do not know for sure exactly where this trail was. We suspect that it crossed the cordillera near the present site of Monte Olivo, and followed the Condué river valley down to what was evidently the well-populated valley of the Rio Cofanes. Padre Juan de Velasco, the Jesuit historian of the eighteenth century, tells us that the Cofan were divided into approximately twenty population centers at this time, scattered along the banks of the Cofanes, the Sardinas (later changed to the Chingual), the Azuela (possibly the present day Dué), the Aguarico, the Duvuno, and the Payamino rivers. Velasco refers to a number of cultural attributes of the Cofan of this time, such as the dispersed households along the river, each with its fields and extended family huts but connected via local trails that allowed the people in a particular community to “visit everyone in the area during a single day.” Ferrer promptly began to try to form full-blown towns—to aid in his evangelistic work—so that he could “teach a superior number of people at once, teaching them the Christian and civilized culture, to help one another” and to form “ civil governments with annual elections.”

In 1603, he managed to unite five communities in a single town that he dubbed “San Pedro de los Cofanes” somewhere in the Río Cofanes river valley. We have no idea of where this original town was located, but one possible site is the present location of La Sofía. This strategic point had access to both the highlands (via the Condué trail) and the lower areas of the Aguarico. Wherever this town was established, it probably was too big to be able to survive. Ferrer speaks of a population of 3,000 people, which would have strained the forest resources, not to mention the arable lands available in the Río Cofanes valley. Other secondary towns were formed farther out “along the Payamino and the Diuno in the north and the Aguarico and the Azuela to the south,” with populations of over 6,500 in total. This sparked interest among the Spaniards in Quito to recover the previously destroyed towns of Ecija and Mocoa and also to establish the encomienda system among the Cofan. To his credit, Ferrer appears to have protested the implementation of forced labor among the Cofan, citing the fact that they were “new to Christianity.” He returned to San Pedro for a short time, tried to straighten out the various problems he found there, and then began a voyage back to Quito. At the bridge across the Cofanes River, he evidently fell to his death—whether at the hands of the accompanying Cofan guides (as suggested in Velasco’s account) or by simply slipping on the single log that evidently spanned the chasm, we will never know. But with the death of Ferrer, the impetus of missionary activities among the Cofan began to wane. By 1620, the town of San Pedro was all but abandoned, with only one of the original five communities still living there. At the same time, Spanish soldiers based out of the newly re-established towns along the San Miguel River were applying pressure on the Cofan in the north, trying to establish the encomienda system with its forced labor. The Cofan staged a general uprising, once again destroying the Spanish towns, and leaving the “Gobierno de Mocoa y Sucumbíos tán perdido como antes.” Thus ended the first missions and colonization attempts in the Río Cofanes region.

However, by 1630, Spanish attempts to conquer this region where once again under way. Gabriel Machacón, named Luietenant general of the province of the Cofan, established the “city” of Alcalá del Dorado along the Aguarico River. Once again, we can only guess at the location of this Spanish outpost, although it apparently was strategically located along one of the two northern trade routes. Likewise, Ecija was re-founded somewhere in the San Miguel drainage, and served as a jump-off point for missionary efforts that were increasingly concentrating on groups farther east. Alcalá seems to have survived for awhile; it appears in Dominican records in 1637, and again in 1644. However, the overall impression we get from the accounts during this time is that Cofan presence is minimal. What happened? Probably the same thing that was also happening at much the same time among the Cofans’ old allies to the south, the Quijos: White man’s diseases (like smallpox, measles, cholera, diphtheria, influenza, and a host of others) were destroying populations wholesale. We would suspect that by the middle of the seventeenth century, only a tiny
fraction of Cofan remained of the numbers Ordónez and Ferrer encountered mere decades earlier. With this, the Río Cofanes valley was left largely unpopulated. The numerous communities were gone; the agricultural system based on extended family holdings that used most of the arable lands in the region was gone, and the extensive trails that communicated from the highlands to the flatlands of the east began to grow over. Interestingly, most of the areas that might have been suitable for agriculture—relatively flat shelves in a world of steep mountains and deep ravines—are at present covered by immense trees of species that typically are colonizers or second growth species. Below 1,000 m altitude, *canelo*, *copal*, and *chanul* dominate these shelves, while above the 1,000-m mark, *cedro* (*Cedrella montana*) takes over and reaches up to 2,800 m. I would suggest that these trees grew up on the abandoned farmlands of the peoples who lived in these montane forests and were exterminated in the wake of the European expansion.

The following centuries saw only occasional human activities within the Río Cofanes region. With the collapse of the indigenous populations within the Aguarico drainage, the remaining family groups adopted a semi-nomadic lifestyle, basing their social organization on extended family units that seldom stayed in one location for over five or six years. Historical references to the Cofan nation as a whole are scanty from the middle of the seventeenth century until the middle of the nineteenth century. This was a period of political instability for Spain, and the huge and aggressive wave of colonization and missionary activities that characterized the early Spanish empire all but collapsed during these centuries. The only trail that was maintained into the Oriente (the eastern rainforests) was the Papallacta route that allowed travelers to get as far as Baeza and Tena, where missions retained a precarious existence. The few mentions we have of the Cofan during this time period is rich in information about the area, especially the valley of the Cofanes River. Stories include mention of the huge tapir colpas, or salt licks, located at the present site of the junction of the Saladero de Cuvi and the Cofanes River, and speak of the mineral-rich caves used as salt licks by spider monkeys. Gold is also frequently mentioned, although the Cofan saw this as a commodity to collect for trade with the mestizo world on a strictly “when-I-want-to-buy-something-special-I’ll-go-collect-some” basis rather than as a substance to seek aggressively. Occasional incursions by mestizos during these years apparently met with little success.

By the early twentieth century, there were probably fewer than 400 Cofan surviving in the entire historical Cofan territory. One family group, numbering perhaps 25 people, lived along the upper reaches of the Aguarico and occasionally wandered into the Río Cofanes region, usually as guides for mestizo explorers. This family group enters modern history as the Umenda clan. Soju, the chief and patriarch of this group, was a noted shaman and healer. Their semi-nomadic lifestyle included at least one village site on the lower Cofanes River (probably at the Claro River) and locations along the Due, the Coca, and other rivers in the area. Soju’s trade routes continued to be important. He and groups of relatives from farther down river made several trips over the trails to Quito, apparently using the Papallacta route, and his
connections included the Waorani to the south, with whom he traded fishing bows for curare.

Meanwhile, his sons Lino, Aquero, and Sebastián served as guides for increasing numbers of mestizo explorers seeking rubber and gold in the Río Cofanes region. While we have no clear idea of all the places visited, these Cofán were instrumental in the reopening of the Río Chingual route (which was used by the mestizo family Calderón to colonize what is now Puerto Libre) and were probably involved in the opening of the locations of La Bonita and La Barquilla. La Sofia, accessed from La Bonita, was apparently colonized without the help of these guides, although most of the colonists during this period knew these Cofán by name and relied heavily on their help for their activities.

However, by the late 1900s, these Cofán were old men, and their sons and grandsons had little interest in continued exploration. The Umenda family group settled down at the present site of Sinangue (also spelled “Sinangoe”) and largely abandoned their travels and activities outside of the immediate vicinity. It was not until 2000 that renewed Cofán interest in the area began to develop, sparked by Cofán activities in the neighboring areas of the Reserva Ecológica Cayambe-Coca. With the formation of the Cofán Ranger program in 2003, a large number of Cofán from all the different Ecuadorian communities began to become familiar with ancestral Cofán territories. Young men and women fanned out across the forests, charged with monitoring and protecting areas that until now had been mythical. The site of the stump of the “fish tree” (a massive rock in the form of a tree buttress), the site of the “cave of the spider monkeys,” the site of the “image of the jaguar,” and more references from Cofán legends now became real-life locations for these rangers, and interest grew in recovering the Río Cofanes territories. Exploratory trips into the area began during 2004 and culminated in the actual delimitation of what is now the 30,700 ha Río Cofanes Territory (Figs. 2A, 2B, 10J of this report), a titled property owned by the Cofán Nation.

This, then, is the background for the acquisition of the Río Cofanes Territory.

CONSERVATION HISTORY: A brief review of conservation action in the buffer zone of the proposed La Bonita Municipal Reserve

Authors: Susan V. Poats and Paulina Arroyo Manzano

When recalling the conservation history of the region in Carchi and Sucumbíos provinces known as the “rim area” or “buffer zone” and located in the northern part of the Reserva Ecológica Cayambe-Coca, it is important to appreciate the contributions of the biologist Patricio Fuentes. Beginning in 1995, he worked for several years to awaken interest in this northern part of Ecuador, which he named “the forgotten corner.” His efforts stimulated The Nature Conservancy (TNC) to consider projects in the area, and subsequently Corporación Grupo Randi Randi (CGRR) and the Fundación Jatun Sacha also became involved there.

Patricio, a native of San Gabriel, Montufar, Carchi, studied biology at the Universidad Central del Ecuador in Quito and had a long-standing interest in the natural resources of Carchi and in the transition zone between the paramo and the tall Andean forests (the ceja andina), which was always in view from the town of San Gabriel. Patricio became a researcher at the Centro de Datos para la Conservación (CDC) at its inception, with TNC providing partial support for his graduation thesis. (Years later, the CDC became affiliated with the Fundación Jatun Sacha, as it remains today). While at the CDC, he and his wife, Ximena Aguirre (also a biologist, and a professor at the Universidad Tecnológica Equinoccial and researcher at the Herbario Nacional), started a thesis project together on the region “behind” the Cordillera Oriental, at the northernmost point of the Reserva Ecológica Cayambe-Coca (referred to hereafter as “Cayambe-Coca”). TNC and the CDC had previously shown interest in this area; since the early 1990s, they supported the Fundación Antisana and then the Fundación Ruminococha (recently created conservation NGOs) in improving conservation in Cayambe-Coca and in fostering community conservation projects around it to increase local participation and, above all, a local commitment to environmental conservation and the adoption of agricultural and silvicultural practices.
friendly to the environment. These efforts, led by TNC, identified current and potential threats to Cayambe-Coca and developed appropriate conservation actions. At that time, the most active threats to the Reserve were the burning of paramo habitats and expansion of agricultural and livestock activities, both of which were part of the survival strategies of local communities. Consequently, promoting these communities’ participation in conservation and illustrating its benefits became key strategies for the protection of Cayambe-Coca and the management of natural resources. This position did not resonate well with the state environmental authorities, because they still maintained a park-centered vision for the management of the area. However, these organizations worked closely with park authorities to try to encourage an attitude of participation.

TNC initiated its work in Cayambe-Coca with the SUBIR/USAID project, on which it worked jointly with Conservation International (CI) and the Wildlife Conservation Society (WCS). However, despite the completion of two phases of the project (after which the alliance split up), no work was done in the “forgotten corner.”

In 1995, TNC, in collaboration with the Facultad Latinoamericana de Ciencias Sociales de Ecuador (FLACSO), obtained funding from the Ford Foundation to study the impact of community conservation around Cayambe-Coca. The study was conducted during 1996–1997 and was later published as “Constructing Participatory Conservation in the Reserva Ecológica Cayambe-Coca, Ecuador: Local Participation in the Management of Protected Areas” (Poats et al. 2001). As part of the fieldwork, in 1996 the Pimampiro area and the Julio Andrade-Playón de San Francisco area up to La Bonita were traversed, continuing as far as the highway extended at that time (12 km past La Bonita). However, no activities were encountered that could have qualified as community conservation. Nor were any studies on this part of the buffer zone or on the influence of Cayambe-Coca identified. What could be verified was the heavy flow of colonization coming from Carchi, following the highway. Several people referred to land speculation in the area, the result of an expectation of lucrative opportunities accompanying the construction of the highway. However, the highway construction took years, and even when it was finished, travel was difficult until it was paved (which still was not complete as of the time of the study), and so the expected wave of colonization did not happen. Colonization was also influenced by increased insecurity in the area, resulting from the large guerrilla presence on the border with Colombia.

Another important observation was that there was active logging in the area during this period. Past Santa Barbara, the forest extended to the edge of the highway, as it did in patches before this point, after Playón. Along the highway there were many tall stacks of planks that had been recently cut with chain saws. We observed the destruction that rapid highway construction can cause in an area with such a pristine cloud forest.

In 1997, TNC, within the framework of the Biorreserva del Cóndor project (with funding from USAID and through its partner Fundación Antisana in Quito), decided to finance the development of two community-management plans with the indigenous communities that have ancestral territories within Cayambe-Coca: Oyacachi and Sinangoe. This work was done through a shared consulting contract between Susan Poats and Segundo Fuentes (currently regional director of MAE-Ibarra), with the support of Adriana Burbano (currently with WCS Ecuador) and Paulina Arroyo (currently with TNC’s Amazonia Program). During several visits to Sinangoe, interviews, transects, and participatory workshops, there was little mention of the lands upriver from Sinangoe, which today make up part of the territory claimed by the Cofan people. The closest thing to it were the stories or life histories of some of the people in the community who had been born in Carchi but who had become part of the community through marriage to Cofan women. This is probably because families in Sinangoe do not use that part of their territory regularly. This does not mean, however, that the Cofan people as a whole did not at one time use the territory, as certain bibliographic references indicate.

TNC obtained resources to pursue some of the research paths identified during the first phase of
PALOMAP, which made possible the first meeting of Patricio Fuentes and the PALOMAP team in Ecuador. Patricio and Ximena had already started their fieldwork (then 60% complete) and were looking for support to finish it. On the basis of their proposal in 2000, EcoCiencia and TNC supported their fieldwork so they could conclude the study and therefore their thesis.

In their thesis, “Study of management alternatives for montane forests in the area of influence in the northern part of the Cayambe-Coca Ecological Reserve” (Aguirre and Fuentes 2001), Patricio and Ximena present maps that demarcate the area of the study (“the forgotten corner”). They strongly recommend the need for swift action to protect this area and its ecosystems and suggest that Cayambe-Coca be expanded to include the entire area and the Andean forests up to Playón, including the forests around La Sofía. They indicate the need to reach an agreement with the community of La Sofía and they identify the conflict with the municipality of La Bonita. They do not mention in their thesis, however, the ancestral interest of the Cofan in a part of this territory.

One very important aspect of the maps and the description in the text is that they also define a buffer zone to be conserved. This strip of land covers the transition zone of Andean forests just below the paramo, which extends from Julio Andrade in Tulcán to Monte Olivo in Bolívar, including the forests and forest remnants in Montufar and Huaca. One vital part of this zone is the Estación Biológica Guandera de Fundación Jatun Sacha, covering 1,000 hectares in Cantón Huaca (Huaca county), in the Mariscal Sucre parish. It delineates a wooded corridor of over 40 km that adjoins the entire area of current interest to the west, in Sucumbios. This map and the various debates and discussions that it provoked stimulated an interest in somehow protecting this important area, recognized as the last extensive area of tall Andean forest in the Andean range.

In 2002, Patricio returned to the area, this time to work on a small project supported by TNC with the CGRR (with funding from the Parques en Peligro project in the Biorreserva del Cóndor) to further identify conservation strategies for the “forgotten corner.” Patricio produced the study “Conservation strategies for the montaine forests of the area of influence of the Cayambe-Coca and Cofan-Bermejo Ecological Reserves” (Fuentes 2002), in which he recommends a concerted effort on the part of TNC, CGRR, Fundación Jatun Sacha, Fundación Espeletia, and others to encourage conservation actions in the area. This effort arose from Nature Conservancy workshops on Planificación para la Conservación de Sitios (PCA) in 2002, which defined conservation objectives for the Biorreserva del Cóndor (with Cayambe-Coca in the center). Eight objectives were identified, after which conservation strategies, courses of action, geographic areas of intervention, and responsible parties were determined. Patricio’s work was concentrated on the transition zone (ceja andina) of the Cordillera Real and the paramo of the Mirador, as well as on the “forgotten corner,” and produced “an analysis of the definition of conservation strategies for these two geographic zones based on a determination of the quality of several previously defined conservation objectives.”

This work induced TNC to later support, together with the United Nations’ Programa de Pequeñas Donaciones (PPD), an initial study and then in 2003 the “Plan of support for parish development and community management of natural resources in La Sofía Parish, Sucumbios Cantón.” After the Plan was finished, TNC held two work meetings with members of the Fundación Espeletia with the goal of finding a way to support the execution of the Plan. However, because of the weak legal structure of the Fundación, a formal alliance could not be established. For this reason, a manager was contracted in La Sofía to implement the Plan. The manager organized two meetings with representatives from La Sofía, in particular with Antonio Paspuel, with the goal of identifying initial actions for the area with respect to the Plan. The families of La Sofía were very interested in being trained as community park rangers and participating in the network that existed in other parts of the Reserve. TNC tried to coordinate with the Fundación Rumicocha and with the MAE to allow two or three people from La Sofía to visit the work sites of the community park rangers. However, because of the dangerousness of the northern border, difficulty of access to La Sofía, and above all the limited capabilities...
of the institutions, this plan was unsuccessful. At that time, the MAE did not consider the expansion of the northern part of Cayambe-Coca to be feasible because it could not manage the area without field personnel and because those responsible for the areas were stationed far away, in Lumbaquí and Cayambe. For this reason, Cayambe-Coca was not enlarged nor was a position of forest manager created, which was the proposal Patricio and the families of La Sofía presented to the MAE.

Subsequently, several organizations supported the first meeting between the Cofan and the residents of La Sofía and La Bonita, whose purpose was to analyze the proposal to expand the ancestral territories in the northern part of Cayambe-Coca. Initially it appeared that the people of La Sofía and the Cofan had common objectives because of their interest in protecting the forest. However, during the negotiation process after the land was given over, other interests arose that were negotiated between the two groups.

**SOCIAL ASSETS AND RESOURCE USE**

Authors/participants: Alaka Wali, Stephanie Paladino, Elizabeth Anderson, Susan V. Poats, Christopher James, Patricia Pilco, Freddy Espinosa, Luis Narváez, and Roberto Aguinda

Conservation targets: Access roads for horseback or pedestrian travel, such as the road from La Bonita to La Sofía and the road to Estación Biológica Guandera (as opposed to bigger thoroughfares that expose the area to colonization and large-scale natural-resource extraction); small-scale production of artisanal cheeses; ecologically-conscious, organic farms using traditional methods and crops; the use of native medicinal plants; local documents on the history of the area; artisanal gold mining operations and technology, including apparently premodern sites, which could also be tourism opportunities; archeological or historical sites known by the residents; the “Eastern Road” (Camino del Oriente), a historical path linking Monte Olivo and La Sofía, which could complement community efforts in ecological and historical tourism; the Laguna de Maynas, near Parroquia Monte Olivo

**INTRODUCTION**

The social inventory was carried out 8–30 October 2008 by an intercultural, multidisciplinary team (anthropologists, ecologists, educators, and leaders of the Cofan Nation). The social inventory had several objectives, among them (1) to analyze the main sociocultural assets and opportunities in the area; (2) to learn how natural resources are used in the inventoried area; (3) to determine possible threats to human populations and ecosystems; and (4) to inform communities about the biological team’s activities at the sampling sites.

We visited 22 communities, selected on the basis of how well they represented the social pattern of the region and for their proximity to the proposed conservation area. In 13 of these communities we interviewed authorities and key residents and observed patterns of natural resource use. In 9 communities (Figs.2A, 24) our work was more intensive: we stayed two or three days, visited families and fields, and conducted informational meetings or workshops. We divided the communities visited into three geographic or “socio-environmental” sectors—Southeastern, Northern, and Southwestern—according to their geopolitical location and patterns of natural resource use (Fig.24, Table 9). The communities...
of the Southeastern Sector are very interconnected as far as their history, settlement patterns, development, and economy; the altitudinal range is 800–2,500 m. The communities of the Northern Sector are found partly in Sucumbíos Province and partly in Carchi Province. Those on the northern edge of Sucumbíos share historical relations with those of the Southeastern Sector, but geographically, ecologically, economically, and in terms of communication they have more in common with the neighboring communities of Carchi Province. This sector is located at altitudes of 3,000–3,800 m. Settlements in the Southwestern Sector surround the main town, Monte Olivo, and fall within the altitudinal range of 1,900–3,100 m.

In this chapter we detail the methodology used and provide an overview of our results through a discussion of the history of the settlement process; demographic and infrastructure information; and descriptions of social assets, economic patterns, natural resource use, and primary threats. We also offer recommendations for conservation of the inventoried area.

METHODS

We followed a methodology that includes techniques similar to those used in previous inventories (e.g., Wali et al. 2008). For the rapid social inventory, we carried out more-intensive research in nine focal communities (Table 9), including semistructured interviews with women and men, key informants, and community authorities; for these interviews we used a protocol with open-ended questions on general topics. We also participated in the daily life of residents, accompanying them to their farms, attending town meetings, and visiting their homes. For the informational workshop about the inventory, we used visual aids (like posters and maps) to explain the objectives of the inventory and to generate discussion. In the other communities, we combined observational trips with interviews of key informants.

In seven of the focal communities, we had participants at the informational meetings draw maps of their towns and their uses of the environment and natural resources, and we conducted a group activity called “The Good Life Dynamic.” This exercise generated discussion among community members about their perceptions of

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1 In Ecuador, the province is the largest geopolitical unit, of which there are 24. Each province is divided into counties (cantones), which are in turn divided into parishes (parroquias). The highest authority in each province is the Prefectura. The counties have municipalities governed by a mayor and a council.

2 “Focal” communities where we conducted more-intensive research.
different aspects of life: the environment, cultural aspects, social conditions, politics, and the economic situation (see Wali et al. 2008 for more details).*

In addition to activities in the field, we consulted secondary sources to gather information: documents, databases, reports, and bibliographic material (particularly Aguirre and Fuentes 2001; the 2005 strategic development plan of Cantón Sucumbíos; CGRR 2005; and the 2006 development plan for Parroquia Monte Olivo); and an unpublished, pre-inventory report by P. Pilco, in 2008.

RESULTS

History of the settlement process

The three sectors (Southeastern, Northern, and Southwestern) have different settlement patterns. The entire region covered by the inventory has a pre-Hispanic history that merits further study (see the Archeology chapter of this report). Carchi Province has a colonial history, and several of the cities we visited, such as Huaca, San Gabriel, and Tulcán, retain their colonial roots in their design and architecture. Settlements in Provincia Sucumbíos do not date from colonial or post-colonial times, but there is archeological evidence of prehistoric settlements.

Southeastern Sector: Cantón Sucumbíos (Rosa Florida, La Sofía, and La Bonita parishes), Provincia Sucumbíos

We compiled the history of this sector through interviews with key informants (including some of the oldest residents of the communities and descendents of founding families). Their stories generally correspond with the history documented by Professor Fernando Cuarán Ibarra, resident of El Playón and recognized historian of Cantón Sucumbíos. The Southeastern Sector was settled during several waves of natural-resource extraction, beginning at the end of the 19th century with rubber. The rubber workers came to the cantón (county) from Colombia and other parts of Ecuador, making inroads for later settlers (Cuarán Ibarra 2008: 11–12). According to local sources, during the rubber era there were so many workers that the area had a very large school for their children. Many of the workers did not settle in the area and lived in camps near the extraction site for periods of one to two months, afterward returning to their home communities. Rubber extraction was self-limiting and ephemeral, because the methods used required killing the trees. This area had also long been the site of artisanal gold extraction, which is still occasionally practiced, particularly around La Sofía, by local residents as well as outsiders. Other minerals were exploited in the area, as was timber.

Between the years 1915 and 1944, the parishes of La Bonita, Rosa Florida, and La Sofía were established, opening schools and legalizing their status as recognized parishes. The Carmelite Mission played an important role in the region by promoting schools and bringing in people to work in the Mission. In La Bonita and La Sofía, families stayed in the area to farm the land, whereas in Rosa Florida a large number of the people left, settling farther south toward Puerto Libre in search of rubber and gold.

In subsequent decades, the population grew little by little, but population density remained low because of the difficult access to the area. The first landowners in the La Barquilla and El Paraíso area were members of the cooperatives “20 de Febrero” and “Los Cerritos,” with headquarters in La Bonita, who arrived in the 1970s and obtained collective deeds (property titles) for the alluvial terraces along the river—flat, fertile areas that are limited in La Bonita. During the first decades, the owners grazed livestock on these lands but continued living in La Bonita. At that time, there was also property that had been appropriated by individuals from Colombia, Carchi, and other parts of Ecuador, but the majority were absentee landholders (who had not settled in the area). It was not until the improvement of the Vía Interoceánica between 1995 and 2000 (and during the period it was anticipated) that people began to make permanent settlements in the La Barquilla and El Paraíso area. The “Vía” made possible more-intensive logging and the commercialization of the fruit naranjilla (Solanum quitoensis), which were the strongest driving forces of the area’s economy, thus creating better conditions for the establishment of permanent homes.

* Several members of the team suggested modifications to this exercise (for example, adding a fifth dimension to fill the head) that we plan to try in the next inventory.
Over time, members of the cooperatives divided the communal land into individual farms. Only a few settled in the communities; others remained absentee owners, and still others sold or rented their land, including to Colombian immigrants.

In this way the permanent settlement of La Barquilla and El Paraíso advanced, primarily during the past two decades. There are links of kinship between members of the parishes of La Bonita, Rosa Florida, and La Sofía and members of La Barquilla and El Paraíso; and people from the first, oldest communities have come to live in the new ones. In contrast with the first three, however, in La Barquilla and El Paraíso, there are more absentee landholders, a higher rate of turnover of landowners, more settlers from other parts of Ecuador and Colombia, and more immigration and emigration among the residents.

Ownership of the land in the entire Southeastern Sector, in the terms of legal status, continues to be in flux. Although the first arrivals simply took possession of tierras baldías (“wastelands,” or “unclaimed” lands), subsequent settlers often bought land through sales contracts (but usually without legal title). Many current residents have gained ownership of land only through inheritance, without the support of a legal title. Other arrivals have occupied land belonging to absentee owners and are considered by some to be invaders. In this sector, there is a strong movement among residents to obtain documents for their properties, something that is necessary for participating in various government projects and to obtain loans.

Northern Sector: Santa Bárbara and El Playón de San Francisco parishes, Cantón Sucumbíos, Provincia Sucumbíos; Cantones Huaca and Montúfar, Provincia Carchi

The parishes of Santa Bárbara and El Playón de San Francisco were established at the beginning of the 20th century by people from Carchi and Colombia, as well as Ecuadorians with Colombian roots looking for land suitable for cultivation. According to informants in the area, there were also marriages between Colombians and Ecuadorians during that period. The families took possession of the land and continued their mountain traditions of planting potatoes. However, the communities of Parroquia Santa Bárbara depended more on timber extraction and resource-use patterns like those of the Southeastern Sector.

At first, the land was divided using rivers as borders (“from river to river,” according to local residents). Some of the area founders are still alive, transmitting down the generations their knowledge and stories about the region. The influence of the Carmelites has also been important in this part of the Northern Sector because of their help in organizing activities to improve the local economy and educational opportunities. The Carmelite Church continues to play an important role in these parishes, supporting various production-related and educational programs. These two parishes are historically important because they were “ports of entry” from Colombia during the rubber era. La Fama, for example, was an important point along the rubber workers’ route between Colombia and the Southeastern Sector.

In contrast with the other parishes in the Southeastern Sector, El Playón and Santa Bárbara were well linked early on with Carchi and its markets by means of roads and telephone communication. Santa Bárbara was also the governmental seat of Cantón Sucumbíos for 31 years, until 1999 when it was moved to La Bonita.

Cantones Huaca and Montúfar in Carchi Province, adjacent to Cantón Sucumbíos, grew and became urbanized during the past century. The main cities, such as Huaca and San Gabriel, were developed as points of connection and as principal markets for this sector of Carchi Province. There was also a period of heavy logging here, as much to clear space for agriculture as for the sale of wood and the manufacture of charcoal. With the growing economy and population, as well as the expansion of agricultural areas, deforestation in both cantones has advanced to the transition zone between the montane forests and the paramo (the bosque siempre-verde montano alto). The population of Mariscal Sucre parish grew rapidly during the 20th century, similar to other parts of the eastern range. At first, the settlement was known as Colonia Popular Huaqueña, because the people who colonized the area were originally from Huaca. Later the name was changed to Mariscal Sucre. Clodomiro Aguilar (who died in Monte Olivo) led
the founding of the community and governed with an “iron fist.” There are several common names among the numerous families in Mariscal, such as Cando, Rosero, Chamorro, Quimbal, and Imbaquingo. The residents dedicated themselves to potato cultivation and selling lumber. According to one of the oldest residents, when the first settlers arrived from more-developed regions in the central part of Carchi, life was much more difficult, with long journeys on horseback to sell wood in San Gabriel. He/she emphasized that in those years (before the 1980s), the area was so humid that agriculture was impossible. Instead, the people who went up to occupy these lands made a living from timber harvest, cutting it for firewood, boards, and charcoal. Gradually the population grew, converting the forest into pasture and potato fields. Today there are four communities in this parish. According to the oldest residents, the zone is slowly becoming hotter and drier.

Southwestern Sector: Cantón Bolívar (Monte Olivo parish), Provincia Carchi

The history of Parroquia Monte Olivo is recorded in several documents produced by the parish government (see Benavides 1985). These documents and the stories of the residents whom we interviewed reveal that the territory originally belonged to a large ranch—Hacienda San Rafael—whose owners did not want to give up land to others. Between 1920 and 1935, a group from the “Colonia Huaca” (today Mariscal Sucre in Cantón Huaca) decided to occupy part of the ranch, initially settling in the highlands (today the community of Palmar Grande) and then descending to Monte Olivo. In 1937, these colonists succeeded in being recognized as landowners and formed the parish in 1941. During the years 1940 to 1970, the parish grew with the formation of new communities and hamlets, and with the expansion of agricultural activities. But in 1972, a strong flood and landslide in the canyon of the Carmen River caused tremendous damage to the communities, and as a result some families fled and formed a new settlement, Pueblo Nuevo. Its population is made up primarily of landless, agricultural laborers from other areas. Since that time, the community of Monte Olivo has not recovered its central role in this region, in large part because of a bridge collapse that isolated the community and severed lines of communication and transport for several years.

Demography and infrastructure

Today the human population around the proposed areas of conservation (excluding Parroquia San Gabriel) is 11,500 (according to data gathered from various documents and the Sistema Integrado de Indicadores Sociales Ecuador, SIISE). The demographics vary by sector, and so we refer to specific sectors in the discussion below. The ethnic composition of the region reflects the national diversity and includes highland, Amazonian, Afro-Ecuadorian, and indigenous Cofan populations. It is a frontier zone, with a significant historical and current Colombian presence. However, this population is somewhat marginalized, above all in legal affairs: the majority do not have Ecuadorian papers, which makes transactions such as obtaining property titles difficult. None of the authorities mentioned whether the overall population was growing, but they did note the constant immigration and emigration of Colombians. There are no exact figures on the economic stratification of the region, but our observations suggest that there is a high variability of economic conditions.

Southeastern Sector

In Cantón Sucumbíos (Provincia Sucumbíos), the total population is 2,686. According to the municipal government, the population growth rate of the cantón is 1.7%.

In the Southeastern Sector, on the basis of interviews and observations, we noticed that the level of inequality among families was not very high compared to the other two sectors. For those who do not own land (many of them young people), work is available as day laborers, in agriculture, logging, and for the municipality. The municipal policy of creating jobs for local residents through “microbusinesses” (for example, maintenance of the Vía Interoceánica) also helps in providing non-landowners with a source of income. Others with more resources, such as some of the original landowning families in the region, have deeds for 25 ha or more of land.
In terms of infrastructure, all of the communities visited have basic educational centers such as primary schools and distance-learning secondary schools (colegios de distancia). The distance-learning system is a service of the Ministerio de Educación Nacional, in which one or two local teachers are assigned to advise students interested in continuing their secondary education, using the same books and curricula as on-site secondary schools (colegios presenciales). People taking advantage of the distance-learning schools are young people and adults who have not completed their secondary education. La Bonita has the only on-site secondary school in this sector but it takes boarders, and students come from the entire region. The La Bonita School is implementing a new curriculum developed by the Secretaria Provincial of the Departamento de Educación in Sucumbíos, a guide for professors called the “Green Notebook” (Cuaderno Verde), which describes how to integrate environmental education into course curricula from primary to secondary school levels, using coordinated themes.

The communities of La Bonita and La Sofía have health clinics (La Sofía’s will open in 2009), and Rosa Florida, La Barquilla, and El Paraíso have pharmacies established with support from municipal governments, each run by a local resident. With the exception of La Barquilla, all the communities visited have electricity, and La Barquilla will have it by the end of 2008. Small hydroelectric plants provide electricity for La Sofía and El Paraíso, and the other communities are connected to the provincial network.

All of the communities except La Sofía border the Vía Interoceánica and are thus connected to the markets and provincial administrative centers of Sucumbíos and Carchi. The Vía is completely paved, except for a section between Rosa Florida and La Bonita. There is a system of public transport, with buses run by private companies. A road connecting La Sofía to La Bonita is under construction and is about half completed; it is scheduled to be finished by the end of 2009. Where the road ends there is a pedestrian and horse trail leading to the community, which takes about 3–4 hours to travel.

La Bonita, as the municipal seat, has administrative offices, including the Departamento de Medio Ambiente y Turismo. The municipal library offers free Internet service, though it is a bit sporadic. There is also satellite telephone service for public use. Other communities visited in this sector do not have telephone service, and it is difficult to get a cellular signal. The Junta Parroquial of La Sofía arranged for the installation of a satellite tower for Internet connection, which is expected to be operating by the end of 2009.

It is also important to mention the water supply systems in the region. All of the communities visited in this sector have access to piped water and have sewage-drainage systems that are already installed or are in the process of construction. However, according to community and municipal government authorities, there is no budget for the treatment of wastewater, which is discharged directly into the adjacent rivers—the Chingual, Sucio, and Laurel. At present there is no shortage of water, and the population is aware that their water is abundant because of the still-intact forests, which protect the headwaters.

**Northern Sector**

In the Northern Sector, our interviews suggest more economic stratification than in the Southeastern Sector, based on access to land (particularly in the cantones of
In these cantons, the large properties and ranches (>20 ha) are in the lower communities near the Panamerican highway, whereas at higher altitudes families have an average of 5 or 6 ha of land. In Parroquia El Playón, there is a significant population of Colombians, who came seeking jobs and remain doing work a medias or a partir, that is, sharing the agricultural products produced with the landowner. According to a member of a women’s organization in El Playón, 30%–50% of the population works in this way. Simply being Colombian has prevented many people from attaining land ownership. Many Colombians, after arriving in El Playón, continue on to the urban centers in Carchi and Imbabura.

Another demographic factor that contributes to stratification is the presence of young people without jobs or sources of income. According to the source cited above, there are about 30 single mothers in the community. Many of them live with their parents and receive no support from the fathers of their children. In El Playón and Santa Bárbara parishes, many young people leave the cities to study but return and look for work. They resort to agricultural labor, especially in potato production, but local informants report that it is difficult to support a family solely on the basis of this type of income. Also, the availability of this work varies according to market fluctuations: when the price of potatoes is low, landowners tend to invest more effort into dairy farming, which requires little labor. Families in these parishes have kinship ties with other communities in Cantón Sucumbíos. Within the El Playón community, kinship ties also are strong.

There are secondary schools in El Playón (Sucumbíos), Santa Bárbara, and Mariscal Sucre. The largest cities in Provincia Carchi (e.g., Julio Andrade) also have their own local educational infrastructures. There are also health clinics in all of the focal communities visited in this sector. Here, the roads, lines of communication (radio, telephone, television), and basic services are more developed than in Cantón Sucumbíos, particularly in the more urbanized areas (Huaca, Tulcán, San Gabriel).
Water issues link the provinces of Carchi and Sucumbíos: the current water sources for certain communities in Carchi—for example, Julio Andrade and Huaca—are inside Sucumbíos at the headwaters of the Chingual River. There are also new proposals to carry water from the Agua Clara stream close to El Playón in Sucumbíos to about 21 communities in Carchi. There is strong interest in protecting the forests around the water sources; however, several intakes are located on private land and their conservation depends largely on the actions of the owner. Systems for drinking water or piped water are administered by juntas de agua potable (“drinking water boards”), which consist of elected members from the community authorized to charge users and maintain the system. In this sector, as in the Southeastern, attention to the development of wastewater treatment systems has been lacking.

Southwestern Sector

The population of Parroquia Monte Olivo is 1,811 (Table 12), but we noticed that the parish is shrinking because of the steady exodus of families toward urban centers (such as Ibarra and Quito) in search of jobs or other economic activities. Locals comment that young people and non-landowners emigrate away and tend not to return and invest their earnings in the communities they left, for example in businesses or agricultural activities. Others say people have left because of changes in rain patterns that have intensified the dry seasons, making agricultural work more difficult in some nearby towns, such as Rairgrass and Miraflores. This is said to have contributed to a vicious circle, in which the decrease in local labor due to emigration has in turn affected those who continue to cultivate crops and need farmworkers.

We also noticed that economic inequality among members of the parish is due to factors such as age and access to land. Many of the elderly people in the community of Monte Olivo live off social welfare and are not able to work their land; their children do not always maintain them either, because many have left the community. In Palmar Grande, we met and talked with older people who live somewhat isolated from the services of Monte Olivo because of the lack of a road connecting the community to that parish or to other communities. Also, there are segments of the population in the parish, in some cases significant segments, that do not own land and work as day laborers in agriculture or as employees of local landowners, or both. In Pueblo Nuevo, in particular, it is said that between almost 50% (in the Plan de Desarrollo de la Parroquia, of 2006) and 96% (according to local Monte Olivo residents) of the inhabitants work part-time or as day laborers. Some residents of Monte Olivo also indicated that, in some communities in the parish, property was concentrated in the hands of a few families. Here, also, although apparently to a much lesser degree than in the other sectors, there are descendents of Colombians who have had difficulty obtaining enough land to make a living.

Populations of other communities in the parish—Rairgrass, Agucate, and Palmar Grande—have been losing population during the past 10 years for various reasons. The people interviewed told us that many families went to live in Monte Olivo because the local schools were not good. In Palmar Grande, only five students remained in the school. Families with property


<table>
<thead>
<tr>
<th>Cantón</th>
<th>Parish (individuals)</th>
<th>Community (families)</th>
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</thead>
<tbody>
<tr>
<td>Bolívar (Provincia Carchi)</td>
<td>Bolívar (19,230)</td>
<td>Las Lajas, Cuesaca, Pistud, Bolívar, Santa Marta, La Purificación, Angelina, Impueran</td>
</tr>
<tr>
<td>Monte Olivo (1,811)</td>
<td>Rairgrass (17), Miraflores (4), Palmar Grande (25), Monte Olivo (150), El Agucate (32), Pueblo Nuevo (145), Manzanal (45), Motilón (32), El Carmen (4), San Augustine (4)</td>
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<tr>
<td>San Rafael (1,699)</td>
<td>Alor, El Rosal, Caldera, Sixal, San Rafael</td>
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9 Data from the Sistema Integrada de Indicadores Sociales Ecuador (SIISE 2001).
10 Data not available except for communities where values from the 2006 development plan of Parroquia Monte Olivo are indicated.
in this community also have houses in Monte Olivo, and the majority come to Monte Olivo on weekends. Palmar Grande is apparently the only town in the parish without direct access to a road. In contrast, Monte Olivo and the other communities in the parish are connected to the Valle de Chota by road. Currently, many members of the community get their products out, especially tomate de árbol (tree tomatoes), using a tarabita (a basket-and-pulley system suspended over the valley), to one of the nearby communities. One association of Palmar Grande residents has begun building a road between Monte Olivo and their community to improve access, make getting products out easier, and support a tourism project that the association is establishing in the paramo just above the community. The road is being built almost completely with resources from the community itself; residents commented that they had not been able to obtain support from the cantón, and some were aware that one of the reasons for that was the fear that a road would facilitate more-intense exploitation of the remaining forests.

Monte Olivo has a well-equipped health center, with the services of a nurse and a dentist. The nurse goes to the other communities in the parish for vaccination programs and medical visits. The secondary school of Monte Olivo serves the entire parish. Monte Olivo also has several telephone centers, and the parish office has satellite Internet service.

The Junta de Agua Potable of the parish is very active, having implemented a Plan de Protección Parroquial for the water sources and a bacteriological and physical study carried out by the Ministerio de Desarrollo Urbano y Vivienda (MIDUVI). It has also been responsible for administering funds from PRODERENA. Currently, the population centered in and around Monte Olivo (200 users, according to the president of this Junta), has five water intakes, a filtration tank, and an operator who maintains the chlorination of the water and inspects the system every two weeks. One of the goals of the Junta has been the protection of water sources, on the one hand from floods and landslides characteristic of the region, and on the other from certain types of land use by owners of property where the intakes are located, such as logging or livestock pasturing. In one case, the Junta bought a small piece of land around an intake, and there are plans to fence in others.

Irrigation canals deliver water from the upper zones of the parish to the lower communities, as well as to farm plots in the San Rafael area. Juntas de agua de riego (irrigation boards) manage and maintain both canals.

**Dynamics of natural resource use**

In the three sectors, relations between residents and the environment are determined by economic activities involving the use of natural resources at the family level as well as the institutional level. In contrast with other, more-remote regions where we have conducted rapid inventories, the communities around the headwaters of the Cofanes and Chigual rivers are in a more urbanized zone and are more involved in national markets.

Regional and national institutions play key roles in determining the relations between residents and the environment. Governmental as well as nongovernmental institutions determine policy, provide financial resources, and offer technical support. In this sector we delineate the way in which families, communities, and governmental and nongovernmental institutions interact with the environment.

**National programs**

The national government, through several ministries, has fostered or is beginning to foster programs and initiatives for environmental conservation and sustainable development that affect the entire region. Notable among these initiatives is the creation of an office in Ibarra of the Ministerio del Ambiente (MAE) to better-coordinate efforts in the provinces of Carchi, Sucumbíos, Imbabura, and Esmeraldas. This regional office (which has existed for more than 15 years) is now, under the leadership of Ing. Segundo Fuentes, establishing connections with municipal environmental departments and is supporting programs such as the community management of forests and sustainable forestry for small landowners. New programs that we heard much about in the communities, such as Socio Bosque (“Forest Partner”), are still in the planning phase but are generating high expectations.

* Programa de Apoyo a la Gestión Descentralizada de los Recursos Naturales del Norte del Ecuador.
The Socio Bosque program launched its pilot phase in September 2008. The national government, under the leadership of the MAE, established a special fund to give incentives to individual property owners and indigenous communities in the form of an annual payment for conserved hectares of forest. Programs under the new Plan Ecuador (a program conceptualized as an Ecuadorian response to Plan Colombia, which promotes development and sustainability in the frontier region) also has had an impact in the region (e.g., the Federación Indígena de la Nacionalidad Cofan del Ecuador [FEINCE] and the Gobierno Municipal Cantón Sucumbíos just received funds from the Fondo Italo-Ecuatoriano, sponsored by the Plan Ecuador).

**Water conservation**

Water is an important issue in all three sectors. In all of the workshops where we had participants sketch their own communities, they began by drawing the rivers. In conversations during the workshops, they explained the importance of water for both agriculture and everyday use. All the communities visited recognized the need for long-term care of the headwaters of the rivers and streams, and all have a pressing need for wastewater treatment systems. However, in each sector, there are challenges or concerns related to water use. In the Southeastern Sector, the challenge is maintaining intact forests around the water intakes and protecting the headwaters. Some people in the community of La Barquilla also mentioned several episodes of contamination of the Chingual River (namely, wastes and oil slicks that killed fish). In La Sofía, the Sucumbíos provincial government is beginning construction of a hydroelectric project to increase water for Lago Agrio. Feasibility and environmental impact studies have already been done for the project, but there are doubts about its impact. The project has the support of the parish board because it may generate employment and income for the parish, as an alternative to mining activity in the area.

In the Northern Sector, there is the threat of water shortages because of an increase in demand and the lack of protection for the headwaters. In El Playón and Santa Bárbara, there is no current need for irrigation; however, residents commented that there has been a decrease in water quality of the streams and that droughts affect lakes in the nearby paramos. People recognize the value of intact forests to maintain the high quality of the water. Currently there is little need to treat the water to make it safe to drink, except for basic filtration and chlorination.

In Carchi, control of water resources often produces conflicts between those living higher up and those living lower down who depend on water for irrigation. The water intakes are frequently found on private property, which makes conserving the forests around the water sources more difficult. Recognizing the challenges facing the province, governmental entities and user organizations are trying to take steps to protect the rivers and headwaters. For example, Cantón Huaca recently entered into an agreement with Cantón Sucumbíos to protect the Chingual River.

In the Southwestern Sector, the community of Monte Olivo is worried about water because the demand for irrigation systems by downstream communities is growing. Community members also commented on their frustration with the irrigation water boards for not participating in forest conservation around the water sources. The community was very concerned recently by the sale of land around the Fuente San Miguel (the San Miguel spring), where the new owner (from Quito) is logging (with semilegal permission from MAE). Also, the lake in the paramo above Palmar Grande, a prospective site for ecotourism, is a regional fishing destination that has been subject to the use of harmful methods such as dynamite. Below, we document the use of other resources, by sector.

**Southeastern Sector**

In this sector, the majority of people are engaged in a variety of activities related to both national and regional markets. In La Bonita, Rosa Florida, La Barquilla, and El Paraíso, very few families live primarily off of their own lands (in a subsistence economy), although almost all of them cultivate cassava, bananas, beans, sugarcane, and other basic crops for their own consumption. In the oldest communities, such as La Bonita and Rosa Florida, many traditional agricultural practices and
products continue to be used, but it was also noted that the improvement of the Vía and the increase in salaried work has made people more dependent on products brought by traders. Only in La Sofía did we see an economy based more on self-sufficiency and less linked to the market (because of the lack of access to the Vía Interoceánica). The main points of connection to the market are wood extraction, agricultural production, and salaried work (in the municipality or in microbusinesses, or as day laborers). In the sector in general, there is a strong lack of technical advice for the development of agricultural activities and sustainable logging, a pervasive dependence on the use of agrochemicals, and many problems in establishing production activities adapted to the environment.

With respect to forest resources, there has been a significant amount of selective logging for some time, and it continues today in various parts of this sector. Along the road between Puerto Libre and Santa Bárbara one can see cables (like a modified tarabita system) that are used to move the lumber easily from the forest to the roadsides. In the most recently established communities, such as La Barquilla and El Paraíso, timber harvest is the main activity generating cash, and species of greater value have already been extracted. Although there are regulations for extraction, the problem of illegal logging has been serious and difficult to regulate in this border zone. In 2008, the national government made a major effort to control this activity, by increasing surveillance and penalties for excessive logging, by ensuring that loggers in the region are governed by plans of sustainable management, that they reforest their land, and that they organize to improve the prices they receive and get more added value for the product. These actions have helped to convince the majority of residents with whom we spoke that they should look for legal avenues for harvesting lumber. With the partial support of the MAE, many are in negotiations to develop management plans for the legal exploitation of wood. Some are now members of the Asociación de Propietarios de Pequeños Bosques Nativos at the cantón level. This association receives support from the municipality of Sucumbíos and the MAE to participate in the Socio Bosque program, carry out reforestation activities, and develop individual forest management plans.

Cattle husbandry in this sector is done on a small scale (between 2 and 20 animals per family) but with extensive use of the land (1 ha of pasture per animal). Wood extraction is sometimes a precursor of the establishment of pastures. La Sofía has a long history of raising commercial cattle, linked with merchants in Carchi, and of absentee owners who pasture their cattle in the area. Some families maintain livestock as a “savings bank” and sell it during emergencies. Others regularly sell their animals. In La Sofía and La Bonita there is milk production and artisanal cheese making. People in La Barquilla and El Paraíso discussed investing in more milk production, but currently they lack a viable market. In La Bonita, several farm owners mentioned to us their desire to have a more intensive production system so that they can increase productivity and avoid cutting primary forest. In La Bonita, Rosa Florida, and La Sofía, the soils are more fertile (with volcanic characteristics) and are better able to support pastures (in contrast with Amazonian soils, which cannot support livestock grazing).

Agricultural production varies in the region according to the altitude and the soils of the different communities. One of the main challenges of the sector is the establishment of crops that are adapted to the region, are sustainable, and have good markets. The first wave of crop production was the naranjilla, beginning approximately 12 years ago. The naranjilla (Solanum quitoensis) produces a small fruit whose juice is sold commercially; it is currently the most common commercial crop in the zone. It has been an important source of income for communities along the Vía, but it is very susceptible to diseases and requires an intense regimen of agrochemicals, in many cases reducing or eliminating its profitability. Some people in La Barquilla also commented that the naranjilla does not produce like it used to because of climate change or inadequate soils. In some cases (especially in La Bonita), members of other producers’ associations are experimenting with granadilla (Passiflora quadrangularis) but with organic methods.
In this sector, two semi-governmental organizations—ECORAE (Instituto para el Ecodesarrollo Amazónico) and CISAS (Centro de Investigaciones y Servicios Agropecuarios de Sucumbíos)—have encouraged or supported other agricultural initiatives, such as vegetable production; raising guinea pigs, sheep, and cattle; and aquaculture. Both ECORAE and CISAS require the establishment of a legally recognized and formally registered association before starting a line of credit and giving technical support. It is government policy to work with these associations.* In La Barquilla, we saw an aquaculture project that had nine pools with a variety of fish—tilapia, sábalo, and cachama, among others. The president of the association told us that the project currently has many problems, in marketing as well as maintaining the fish. Because of the loss of profitability, the project is not reaching its goals, and the association has lost members. All profits have been used to pay the debt on the line of credit.

Despite the strong presence of these activities “domesticating” the countryside, there is still a link with the tall forests. The residents of the sector expressed their appreciation for the forests and the abundant water in the region. When participants in our workshop in La Bonita, the most urbanized community in this sector, drew their environment, they emphasized the forests, the flora and fauna, and, especially, the rivers and streams. The oldest families in the sector feel a strong, personal link with the local countryside and an appreciation for the flora and fauna. Since many of the most recent residents come from similar regions in Colombia or Ecuador, they are also fairly knowledgeable about the ecology of the area. In general, except for fishing, which is practiced in all of the communities for family consumption, it was difficult to evaluate the present-day intensity of hunting and use of wild resources in the various communities. Many residents related their previous experiences linking human actions with environmental change and the consequences of degradation.

La Sofía has the most noticeable link to the forest. Here, we saw medicinal forest plants in the gardens, and significantly more hunting and fishing. The parish of La Sofía finished developing its Plan Estratégico in late 2008, and the Junta Parroquial was able to obtain funds ($6,000) for the plan through the NGO Plataforma de Acuerdos Socioambientales (PLASA). It received technical support from CODIS (another NGO, with headquarters in Lago Agrio) and from the Frente de la Defensa de la Amazonía (also of Lago Agrio). But even so, there are resource extractions that strongly impact the environment, among which industrial gold mining is having the greatest effect. The main mine is owned by an Australian company (Halls Metals, S.A.) and is a source of work for some families in the sector. (There are families in all of the communities visited who had members associated with the mine.) In La Sofía, the mine caused a division: some families supported the activity and others were against it. In 2007 the national government repealed the mining concessions, which supported the families in Parroquia La Sofía who were against the mining activities.

In February 2008, the municipal government of Cantón Sucumbíos established a department of the environment and tourism. It is also developing new environmental policies, reflecting appreciation on the part of the cantón’s residents for the importance of intact forest. Of these, the most important is the declaration of an Área de Conservación Municipal, made up of approximately 70,000 ha of “unclaimed lands” (tierras baldíos). The cantón also has reforestation programs, with a budget of $215,000. An agreement was signed in August 2008 with the MAE to protect the environment, including a Socio Bosque pilot program.

Northern Sector
People throughout this sector depend on agriculture for their primary income, and much of the countryside visible from the roads is made up of a mosaic of various crops mixed with patches of forest. In the Northern Sector, logging for the production of charcoal has generated income for the communities, as well as had a strong impact on the forests. Charcoal is sold in regional (e.g., Tulcán) as well as national markets. However, some people commented that charcoal production in Parroquia El Playón had decreased in recent years because of the

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* We observed that, in many cases, producers’ associations suffer from organizational problems. It is difficult for members to follow all of the registration procedures, to maintain broad participation, and to then make enough profit to pay off their loans.
increased presence of the Ministerio del Ambiente. We observed very little use of, or marketing of, non-wood forest products. The advance of the agricultural frontier reaches in some places to the forest/paramo transition zone, although in the areas of El Playón and Santa Bárbara the forests still extend down the mountainsides and into the farms, in strong contrast to the countryside of Carchi just on the other side of the Chingual River. In places where the agricultural frontier has not yet reached the transition zone, the locals say it is because the owner does not have the necessary resources (e.g., money to pay workers) to clear the land. Several people also confirmed that the agricultural frontier and cleared areas do not cross the mountain ridge. Agricultural activity is concentrated on raising livestock (primarily dairy cows) and potato cultivation.

In Canton Sucumbíos, a family farm near the road or a town usually has 5 or 6 ha and is almost entirely dedicated to crops and livestock. The farms in Parroquia El Playón that are farther from the road are larger, especially those that are closer to the forest/paramo transition zone and that define the agricultural frontier. In El Playón and the surrounding area, commercial production is currently focused almost entirely on a potato variety that is intended exclusively for Quito markets, although some families report the occasional rotation of potatoes with crops such as melloco (a tuber) and broad beans for local consumption, to rest the fields. This is in contrast to agricultural practices of decades past, according to locals who were interviewed, when during their childhoods there was a greater diversity of potato varieties and other crops, such as wheat, barley, and broad beans, and family vegetable gardens were more common. In Santa Bárbara, tree tomato (Cyphomandra betacea) production is more important, and farmers are experimenting with growing granadilla (passion fruit). Since the 1980s, agrochemicals have been heavily applied on crops throughout the sector. Particularly with potatoes, producers report the regular use of up to 20 or more applications of agrochemicals per production cycle. According to interviews in El Playón, it is recognized that high yields in the zone have become very dependent on the intensive use of these chemicals.

Dairy farming on a family scale is another source of income. Residents commented to us that when the price of potatoes is low, people tend to invest more effort in livestock, with possible implications for the expansion of pasture at the expense of the forest cover. This fluctuation also affects the quantity of paid agricultural work that can support local residents. In El Playón, milk is sold to outside buyers who arrive in the community every day. In Santa Bárbara, a local value-added business has been established that buys local milk and makes cheeses to sell in Colombian and Tulcán markets.

In El Playón and Santa Bárbara parishes, the effort put into sustainable development on the part of institutions has varied. As in the Southeastern Sector, CISAS and ECORAE have supported family gardens, credit unions, and large- and small-livestock production. They have also promoted experiments with organic production of tomatoes (tomate de riñon) in small greenhouses. In general, residents interviewed report that many of these projects fail because of a lack of technical advice and long-term monitoring, as in the other sectors. In both parishes, the Carmelite Church has also supported income-generating projects carried out by local associations. As in other parts of Cantón Sucumbíos, there are aquaculture projects supported by ECORAE, but on a smaller scale. In the community of Santa Rosa, in Parroquia El Playón, there is a trout farm with about 12,000 fish, owned by the municipality of Sucumbíos. This is a business venture, and the fish is sold every eight to nine months at the Tulcán markets. However, because of the high cost of feeding the fish, the business is not very profitable. Trout has also been introduced into many bodies of water in the region, providing recreational fishing and a supplement to the diet of local residents.

The strategic plan of the Junta Parroquial del Playón places ecotourism as another axis of local development (with the support of ECORAE), taking advantage of regional paramos and waterfalls. Regional and national tourists already come to these sites, and community tourism guides are in training.

In contrast, Carchi Province has a long history of governmental and nongovernmental efforts to better manage natural-resource use. The provincial
Departamento de Ambiente y Desarrollo (with headquarters in Tulcán) is involved in zoning projects and initiatives (with the support of PRODERENA), the management and protection of water sources, reforestation, and technical support for farmers (with financing from several international development agencies). Cantones Huaca and Montúfar are also implementing measures on reforestation, organic crops, and conservation of the forest/paramo transition zone. Cantón Montúfar has the oldest department of the environment in the province and is experimenting with a combination of conservation incentives at the community as well as property level. The department looks for alliances with non-governmental organizations (NGOs) to implement technical support programs for farmers. It also supports the management of the Bosques Protectores el Chamizo (2,750 ha) and El Hondón (4,283 ha) in the eastern and western mountain ranges of Cantón Montúfar; neither has a management plan.

Activities of NGOs in Carchi have focused on supporting small producers in the search for alternatives to the strong dependence on agrochemicals, environmental education, the strengthening of farmworker organizations, and improved management of natural resources. We observed several of these efforts. For example, in Mariscal Sucre, the Estación Biológica Guandera de la Fundación Jatun Sacha has played an important role in local environmental education and in promoting organic agriculture and fertilizer. One result of these efforts is a small “Club Ecológico,” which conducts recycling projects, makes ecological art, and educates residents about environmental issues.

In the year 2000, ECOPAR (an NGO) ran a project entitled *La biodiversidad como sustento de la vida del bosque de ceja andina: Uso sustentable de la agro-biodiversidad de los bosques de ceja andina del Carchi, Ecuador* (“Biodiversity as a means of support for life in the transition-zone forest: Sustainable use of agro-biodiversity in the transition-zone forests in Carchi, Ecuador”). This project generated management plans for streams at El Oso and Juan Ibarra, in Parroquia Piartal, Cantón Montúfar. This effort could be a model for other parishes in the sector because it integrates technical support with the strengthening and empowering of local organizations (Ambrose et al. 2006). Similarly, La Corporación Grupo Randi Randi (CGRR) designed management plans incorporating community participation and the Plan de Manejo para la Reserva Ecológica El Ángel in Cantones Mira and Espejo (CGRR 2005). All of this work is a model for this sector.

The Universidad Técnica del Norte (UTN), with headquarters in Ibarra, opened a campus in Cantón Huaca, on land given by the municipality in 2005. The hope is to establish a multipurpose farm on the property for educational and research purposes, as a demonstration of technologies suitable for and adapted to regional conditions. Today there are two schools in operation: one is a full-time (Monday through Friday) agricultural school with 60 students; the other offers accounting and auditing in a part-time format (classes on Saturdays from 8 to 4) and has 90 students. One of the newest professors of UTN-Huaca is Geovanny Suquillo, a long-time engineer and researcher at the Instituto Nacional Autónomo de Investigación Agropecuaria (INIAP), who has worked for more than 15 years in Carchi. Suquillo has significant experience in drafting proposals for the integrated management of potato diseases for Carchi, and he incorporates these issues and practices in his classes at UTN.

**Southwestern Sector**

In Monte Olivo Parish, we observed a distinctive mixture of patterns of natural resource use compared with the Southeastern and Northern sectors. Agricultural production varies according to the altitude and slope of the land, and use of irrigation. Flat land is very scarce, and because most of the terrain is highly sloped, there is a great risk of landslides. Cultivation patterns have changed in recent decades, according to local informants, because of changes in rainfall patterns and the growing shortage of laborers due to the emigration of residents looking for economic opportunities. People talk about a time not long ago when considerably more corn, beans, wheat, barley, peas, varieties of potato, *morrocho*, and edible tubers, such as carrots, *melloco*, and *oca*, were cultivated. These crops are still found, but in much
fewer quantities and primarily for local or family use. In the upper zone of Raigrass, rye seed used to be sold. Blackberries, considered native to the region, could demand high prices, but they are already scarce and are more fragile than other crops in transport to market.

Today, in the lowest altitudes of the parish, especially around Pueblo Nuevo, there is more relatively flat land with cultivable soils because of the riverside terraces and wider valleys, and a warmer climate. In this zone, generally between Pueblo Nuevo and Aguacate, there is commercial production of vegetables (especially onions), tomatoes in greenhouses and outdoors, and fruit trees such as citrus and avocado. This area also takes advantage of the irrigation canals coming down from the upper zones.

In the middle and upper zones, the predominant commercial agricultural products during the past decade have been tree tomatoes and onions, although granadilla is also beginning to be more common (in Motilón). In Manzanal, potatoes are produced and marketed in the province. Tree tomatoes are said to be profitable in this area, and along with the other commercial crops, they provide a source of work for residents without their own land. But as in the other sectors surveyed, tree tomatoes are grown under a heavy regimen of agrochemicals, without much technical advice. Some farmers are experimenting with combining the tree tomato with beans or morocho (corn later processed into dried, cracked kernels to make beverages). We were told that other crops in the region have been grown for at least one or two decades with the use of agrochemicals, and that farmers can clearly see the decline in soil productivity over time.

Cattle are also raised in the parish, on a small scale, with low-intensity management and an emphasis on milk production. Milk curds are produced in Palmar Grande and Monte Olivo, with a mainly local market.

There appears to be much less commercial wood extraction in the parish than in the Southeastern Sector. According to residents of Palmar Grande and Monte Olivo, it serves as a source of income for some families with few resources during periods when paid agricultural work is scarce. Estimates of the number of local inhabitants involved vary between three and eight families in Palmar Grande, for example, and up to 25 families in the entire sector. One of the parish officials estimated that loggers could be removing some 140 boards of lumber, each ~3 m by 25 cm, every three months, taking them on horseback down to the roads. The low-intensity extraction is not always carried out legally. One of the residents involved said he would be interested in doing it legally but estimated that the expense of going through the procedures and following the management plans was not justified by the amount of income generated. Some residents commented that there is no road between Monte Olivo and Palmar Grande because the cantón does not want to encourage logging.

Significant extensions of the forest in the parish are being conserved, however, and the paramo in the zone is also well-conserved. Consequently, another activity in this sector related to the environment is tourism. Tourists from other parts of the country travel to the parish to go up to the paramo above Palmar Grande and fish in the nearby lake, which has been stocked with trout for about 14 years. According to local informants, the lake has been threatened by harmful fishing methods, such as dynamite, used by people from outside the area. As previously mentioned, an association in Palmar Grande is dedicated to developing an ecotourist attraction in the paramo, which would offer guides and cabins while protecting the environment. This group, which has already invested much of its own money and effort in the enterprise, expressed the need for more training and support to create a truly ecological yet profitable project. Some residents of Monte Olivo are also interested in developing tourism on a small scale, focused on other lakes and possibly pre-Hispanic or premodern sites, and they are looking for advice on the project.

Just as in the Northern Sector, the municipality is involved in projects and procedures for zoning (with support from PRODERENA), supporting more-sustainable agricultural alternatives, and reforestation. The municipality receives contributions from government agencies and institutions, such as the Ministerio de Desarrollo Urbano y Vivienda (MIDUVI), which supports water boards and irrigation associations.
In Monte Olivo and Palmar Grande, we heard expressed a strong connection with the area and the landscape, a fervent desire to have a protected area of forest and paramo of their own, and significant support for the activities of our Rapid Inventory and its conservation proposals. Residents have noticed environmental changes in the parish, such as shifts in rainfall patterns and soil fertility, and are conscious of the vulnerability of their production activities in an environment so prone to landslides, floods, and possible competition for water resources.

Residents of Monte Olivo and Palmar Grande, especially older ones, generally had greater knowledge about and relations with the forests and paramos than those in the Northern Sector. Several of the seniors told of their excursions in the paramos and forests of Cantón Sucumbíos. Many families go to the lakes to walk and fish (one of the lakes was stocked with trout about 14 years ago). Some consider the lakes to be sacred sites and make pilgrimages to pray for rain.

Social and institutional assets
Social assets include patterns of organization, practices, customs, perceptions, and knowledge related to the ability and will of people in the area to involve themselves in the management and protection of the environment. Identifying these assets facilitates the design and implementation of conservation interventions and helps ensure that people around the protected area can actively participate in the process of conservation for the long term. In this region, despite many changes in the cultures and practices of the residents, we discovered relevant social and institutional assets, including practices and attitudes linked to the life of pioneers in a border zone. With respect to the entire zone, the characteristics of the population make this area unique and could also be an asset for conservation. The bonds of kinship and friendships between families are common throughout the region because of the historical patterns of colonization. In fact, families in the Southeastern Sector have many relatives in the Northern Sector, in Carchi, and even in Colombia. Families in Mariscal Sucre have connections to families in Monte Olivo, and those in Monte Olivo have relatives in Cantón Sucumbíos. The pioneer-adventurer character evident here has resulted in a broad knowledge of the region among the residents. For example, an elderly man in Monte Olivo told us about his 26 journeys by foot in eastern areas as far as Lake Agrio before there were roads. Finally, the active participation of women in community management and economic affairs is an important asset.

The three sectors share many other social and institutional assets, but they are expressed in different ways and differ in importance. Below, we mention the most important ones for conservation in each sector.

Southeastern Sector
The most notable asset in this sector is that residents now value the forests and water resources in their environment and want to protect them. In all the communities, participants began drawing rivers when the maps were made. In the communities of Rosa Florida Parish, people valued the place’s “tranquility.” Among people who had lived a long time in the region—in every community there was a nucleus of families descended from the original founders—the value they placed on the environment was related to a large extent on the “love for their land,” which is intimately linked to community identity. Many people told us enthusiastically how their parents or grandparents arrived, and remembered the minga traditions (for community work) that united the families. They showed us the places or “icons” in the countryside that had special histories or significance for them or for the community. We noticed this asset most in Parroquia La Sofía, maybe because it was the most remote community and had retained the most original families. For the more-recently arrived residents, the value they placed on the area came precisely from their experiences of deforestation and land fragmentation in their original locations (e.g., Carchi, Colombia, or other parts of Sucumbíos).

While the regional economy has long been dominated by extractive activities, in recent years residents have started to take steps to protect forest and water resources. Although they continue activities that degrade the
environment, there is curiosity and interest among the people in sustainable alternatives and in potential benefits that conservation measures can bring.

In this sector, especially in the Rosa Florida and La Bonita parishes, the change in attitude appears due to a combination of factors. First, as we described above, the Ministerio de Ambiente is taking strong actions to control illegal logging. A second factor is the fear that rivers and streams will dry up. Residents of the two parishes observed that the rivers were not as they were before, although they still maintained sufficient flows to satisfy human water needs. A third factor is the expectation of new programs of the national government to encourage environmental conservation. Residents of this region were openly favorable to the creation of the municipal conservation area; but at the same time they expressed their uncertainty about the limits of the area and whether there would be restrictions on resource use on their own properties. However, there appears to be much hope that the area can bring alternative work opportunities or other benefits.

The ability to organize and unite the community is another notable asset in this sector. The five communities mentioned their initiatives to have electric lights, plumbing, and sewage systems. They also mentioned that they still hold mingas (community work days) to open roads, clean up public spaces (like soccer fields), and do maintenance work. In three of the communities (Rosa Florida, La Barquilla, and El Paraíso), some residents thought there was good social cohesion (e.g., there were no arguments between neighbors or serious conflicts), and in all of the communities residents perceived that the local government was capable of taking action and had honest leaders who followed through on government programs. In communities where it was perceived that cultural life was strong (El Paraíso, La Barquilla, and La Sofía), the sense of organizational ability was even stronger. Also contributing to this cohesion was the low degree of economic disparity relative to other regions or urban zones. It is interesting that this asset is in contrast to the weakness of the legally established producers’ associations discussed in the previous section. Finally, we observed in these communities that the young people (15–35 years old) wanted to stay in the area and are looking for opportunities to invest in economic alternatives to illegal logging. Recently, 15 people, mostly young and primarily from La Bonita, were trained as forest rangers in a course at ICCA (Instituto para la Capacitación y Conservación Ambiental, affiliated with La Fundación Sobrevivencia Cofán). Some young families are growing vegetables for sale, and other young people study subjects such as agro-ecology and agroforestry through distance-learning schools.

**Northern Sector**

In this sector, the greatest asset is organizational ability, especially related to water resources. Bonds established on the basis of family and place of origin, although not as strong as in the Southeastern Sector, create an exchange network for information and family resources. Residents of Charchi, El Playón, and Santa Bárbara are proud of being pioneers or border-dwellers. This attitude makes them open to experimenting with new crops or methods. Although mutual-assistance practices (such as the minga), which characterize Andean culture, are disappearing, working communally on local projects continues. Women, both older and younger, participate in communal organizations (such as the water boards) and producers’ associations. In Mariscal Sucre, the president of the Club Ecológico is a young woman, and in El Playón, there are two prominent women’s associations, one established 8 years ago and the other 13 years ago, which have persisted despite the failure of several projects (involving livestock, growing crops in greenhouses, and potatoes). The oldest of these associations has more women from the original families of the area, whereas the newer one has women with more education but without property.

The Northern Sector also shows an openness toward conservation, as in the Southeastern Sector. One of the important factors is concern about water use and possible shortages in the future. In El Playón, for example, there is worry that intakes for water destined for cantones in

*The perceptions of community members were expressed during “The Good Life Dynamic”. This dynamic is subjective and reflects the opinions of the participants. A future, more-in-depth study, would be required to validate those perceptions.*
Carchi may affect residents of the parish adversely. The strong link between water and its management, which connects higher zones with lower ones, has resulted in the formation of organizations (such as the water boards mentioned previously) and other authorities. The irrigation system of Cantón Montúfar is one of the largest systems in the northern part of the country. It has 3,000 registered concessions, which supply water to some 1,800 individuals. In the past, the irrigation board has contributed $1,000 per year to the municipality of Montúfar to support measures protecting water sources. Recently the board has discontinued their support (for unknown reasons) but said that it was important to continue protecting this resource. Of what we have seen during our survey, this is the only example of a payment by irrigators to conserve resources in this mountain region.

**Southwestern Sector**

In this sector, the greatest asset is the initiative on the part of the residents to look for better sustainable alternatives to the advancing agricultural frontier. Here, as in the Southeastern Sector, there is a strong connection with the area and pride in the environment. Knowledge of the environment is transmitted across the generations. Also, young people who decide to remain in the parish (or who return after having left to work or study) are interested in participating in local programs, such as the ecotourism project. Another notable asset is the presence of teachers in the school and college who are natives of Monte Olivo; they are very dedicated, organized, and committed to improving the area and the town, and they have ideas, for example, for connecting students with the environment and with the rapid inventory.

In Parroquia Monte Olivo, as in the other sectors, we observed a strong interest in protecting neighboring forests. During the informational workshop in the community of Monte Olivo, the 54 participants expressed unanimous support for protection of forests in the parish. They said, “The forest is ours,” and some spoke of the importance of forests, not only for them but for the world. In “The Good Life Dynamic,” they rated the role of nature in their lives at 4 (on a 0–5 scale), recognizing that some soils were exhausted and forests were being cut down, but also thinking of the intact forests and paramos that remain in the area. The president of the Junta Parroquial de Monte Olivo described his efforts to seek protection through creation of a community forest (pursuing support from Montúfar’s department of the environment) and his complaint with COSINOR (the agency charged with installing and maintaining the irrigation system in Cantón Bolívar) about their lack of support for the protection of forests around the water intake (Fuente San Miguel). In this parish, as in Cantón Sucumbíos, the value placed on forests and water arises from the long history of connection with the area.

Some members of the community of Palmar Grande have formed an association to promote ecotourism in the paramo around the Laguna de Mainas. Members of the association spoke with us for a long time about their desire to maintain the paramo and ensure that their tourism program would be ecologically compatible.

As in the communities of the Southeastern Sector, we observed a social cohesion that could be an asset in environmental conservation in the area. Residents told us about the almost nonexistent crime rate, mutual-help practices, and communal measures for carrying out public works. Here, in contrast to the other places, civic associations seemed to last longer. The women’s organization had an especially good experience, beginning with the founding of FUNDELM (Fundación de la Mujer Campesina) in 1995 as a savings bank and rotating fund for the raising of guinea pigs. At one point the association accumulated $30,000. This organization, now called the Asociación para la Gestión Comunitaria Monte Olivo, currently has 105 members—95 women and 10 men—and provides loans for raising cattle. There are two other women’s associations: one under the auspices of the church (Promoción de la Mujer Luz y Verdad) and the other supported by the Perfectura Provincial (Mujeres Unidas al Progreso).
PRIMARY THREATS

- The continuation of illegal logging in all sectors and industrial mining near La Sofía (despite the suspension of concessions)
- Deforestation at the headwaters of the rivers and streams, potentially creating water supply problems, droughts, and other ecological impacts
- Possible conflicts over water use between “up-river” and “down-river” communities (where water is used for irrigation) in Provincia Carchi
- Increasing inequality due to lack of viable, ecologically sustainable economic alternatives for young people, families, and Colombian immigrants who are unemployed, have limited resources, and have no land or little access to land; and the general lack of investment in the development of sustainable alternatives that are compatible with ecosystem preservation
- Fluctuations in prices of goods produced—for example, for potatoes and milk—which can cause pressure on other resources when prices are low

PRIMARY RECOMMENDATIONS

- Delimitation and zoning of the protected area in Cantón Sucumbíos (the Reserva Municipal La Bonita), in a way that encourages participation and adequate understanding on the part of residents
- Strengthening and monitoring of local management of development and environmental measures, and the creation of local corps of forest wardens, guides, and “native scientists” (with the local secondary schools) that can support the monitoring, study, and maintenance of regional ecosystems and conservation areas
- Consolidation of collaborative efforts between Cantón Sucumbíos and the adjacent cantones in Carchi (e.g., the Mancomunidad between Cantones Sucumbíos and Huaca) for the protection of the Chingual River and proposed conservation areas
- Consolidation and continuation of collaborative efforts between the Cofan nation and Cantón Sucumbíos (such as support for the creation of the Reserva Municipal, and support of the municipality for infrastructure in the new Cofan territory)
- Creation of a regional space or forum of exchange and coordination that permits local, regional, and national institutions, along with relevant civil organizations and associations, to develop and influence policy and actions supporting the conservation of proposed protected areas and the sustainable development of neighboring communities
- Urgent support for Parroquia Monte Olivo’s attempt to clarify parish boundaries and create guidelines for the creation of a community forest
- Urgent support for improving the planning and implementation of the ecotourism project of the Asociación de Palmar Grande