Research in Tropandean Protected Areas of Ecuadorian Landscapes

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INTRODUCTION

Ecuador is a small country (270,670 sq km) located on both sides of the equator, in the crescent of the Andes in northern South America. It occupies the transition zone between lowland wet and dry tropical and Andean landscapes. Therefore, the whole country can be considered as a naturally heterogeneous ecotone that varies clinally among altitudinal and latitudinal domains (Sarmiento 1992). Ecuadorian landscapes extend from the beaches along the Pacific Ocean to the Chimborazo heights of 6,130 m above sea level, and down again towards the Amazon (see Figure 1).

As one of the "megadiversity" countries, it contains at least three main "hot spots" for biological diversity (Myers 1991); hence, rarity and endemicity indexes are presumed to be very high despite the dearth of inventories and information on the natural history of many species. In places where careful floristic studies have been done, astonishing numbers of species have been

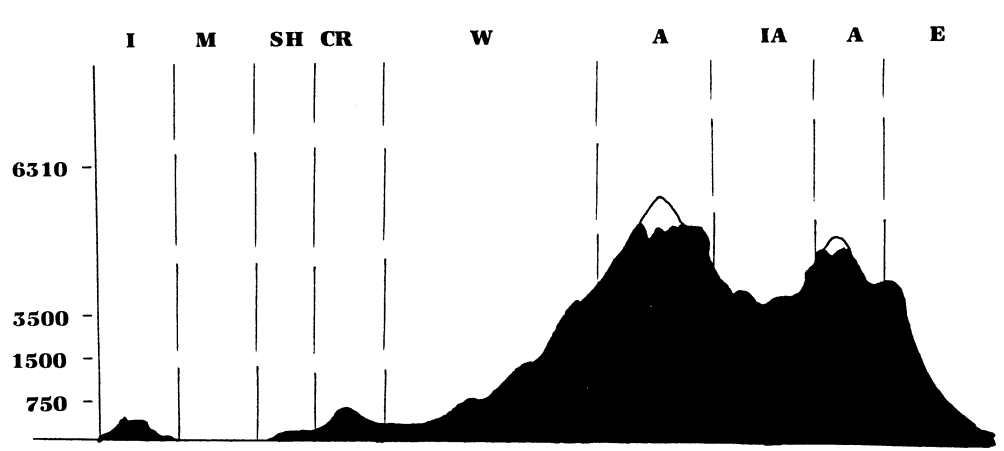

Figure 1. Transect relief of Ecuador

I = Insular; M = Marine; SH = Shore; CR = Coastal Range; W = Western (Costa); A = Andean; IA = Interandean (Sierra); E = Eastern (Oriente)

Altitude references in meters.

reported and show uniqueness in the phytogeography of the region (Balslev 1988). Río Palenque, for instance, was recognized as the world's single most species-rich place (Gentry 1982), even though it is a small patch of forest within a heavily used matrix of agricultural land in the piedmont of western Ecuador.

Two biotic provinces are endemic to the area: the Galapagos Islands, along with their surrounding marine environments, about 1,000 km off the coast, and the tropical dry deciduous forest of southwestern Ecuador, where a curious petrified forest (Puyango) is also located.

Another typical feature of the country is the sequencing of *hoyas*, or interandean valleys (Sarmiento 1986). This is a system of several plateaus at the bottom of intermontane catchment basins between the two main snow-covered mountain ranges that run in parallel, connected by transverse ranges, or *nudos*. This topographic feature has been regarded, since the time of the naturalist and biogeographer Alexander von Humboldt, as the "avenue of volcanoes" (note that northern Colombian valleys are extensive low plains below 2,500 m between the mountain ranges, and southern Peruvian valleys emerge to *meseta*-like extensive high plains *(altiplano)* above 3,500 m).

The western tropical forests of the Chocó Province and the eastern Amazon headwaters within the Napo-Ucayali drainage system share similar characteristics of luxurious diversity (Colinvaux 1989).

In summary, the unique combination of 26 life-zones (*sensu* Holdridge) interconnected by dynamic meteorological and geological processes (Cañadas 1983), supporting landscapes that have been modified by humans since prehistoric times (Sarmiento 1982), makes *heterogeneity* a key component of tropandean ecosystems.

A System for Conserving Natural Areas

Ecuadorian national parks and protected areas represent about 11% of the territory, roughly 3.2 million hectares (see Figure 2). According to MAG [the Ministerio de Agricultura y Ganadería, or Ministry of Agriculture and Livestock], the current conservation system covers almost all representative ecosystems in each of the natural regions (MAG 1991). However, the strategy reviewed by MAG and Fundacíon Natura (1989) proposes an increase in the number of areas—and the establishment of new management categories to ensure the maintenance of the great variety of habitats have given the country such a rich biodiversity (Sarmiento 1987).

The Pululahua Reserve was the first of the officially declared protected areas, after its relevance with the French mission for establishing the latitude of 0 degrees 0 minutes 0 seconds. The colonial government declared the area a "national treasure" that all generations should care for. Later on, the independence movement brought new emphasis on protection and some of Simon Bolivar's environmental proclamations helped save Camelidae in the high *paramos.* Then, at the turn of the century, mangrove swamps and other wetland features disappearing around Guayaquil were given special treatment by the Congress in order to protect white herons and other waterfowl of the coastal swamps. In 1959, the Ecuadorian government declared the Galapagos Islands as its first national park, because of their strategic position.

It was not until the late 1970s that a core system of protected areas (the "Minimum System") was set under the legal administration of the MAG. It continues under the same agency, which administers an array of 15 management categories covering 45 existing and proposed areas for protection.

Current Threats and Outlook

Several reserves are at risk because of the pressure for economic development (Cabarle et al. 1988). The most threatened reserves are those located in areas now considered to be part of the frontier economy, because of the open-access resource structure maintained by the government in all degraded lands, where agriculture was not possible at the beginning of the definition of the conservation system. At that time, land tenure and developmental constraints limited the scope of the protection coverage to a Minimum System, with an ambitious plan to progressively include other areas into an Amplified System for the future (Putney 1976), which was to satisfy conservation needs into the next century.

Ecuadorian agrarian reform encouraged a fragmented redistribution of arable land, where the indigenous people were prevented from using good soils with appropriate drainage and pluvial regime, forcing locals to rely on unexploited forested watersheds nearby (Harden 1991). Clearly, poverty and urgency for short-term profitable exploitation drove deforestation, over-hunting and over-grazing to exacerbate the problem of erosion and land degradation (Southgate and Whittaker 1989). Furthermore, to compensate drought effects felt in the 1970s in the provinces of Manabí and Loja, an extensive colonization effort began in the last remains of continuous forest cover in the newly opened areas of the Oriente, where the oil fever was about to produce smoke, wildfires and spills, as well as promoting colonization of the jungle (Rudel 1983). An eloquent call to protect the western tropical rainforest, which is now undergoing the

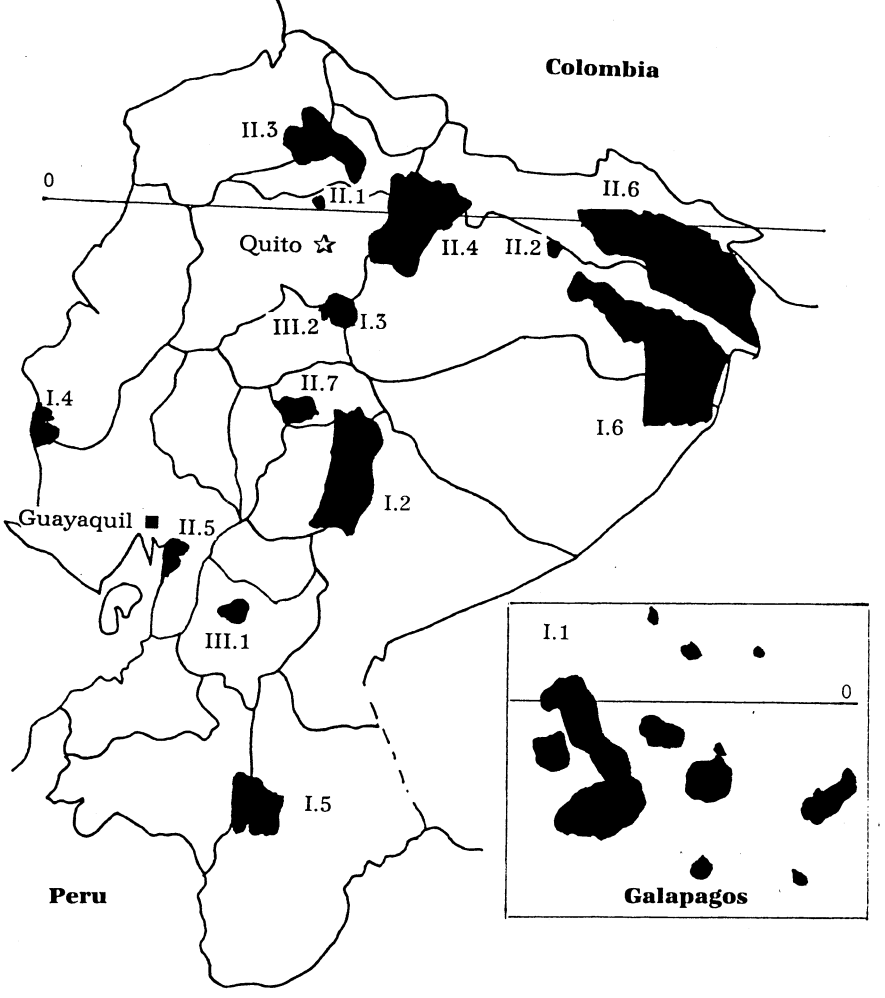

Figure 2. Location of the Ecuadorian Minimum System areas

I. National parks
- I.1: *Galapagos (also biosphere reserve)*
- I.2: *Sangay (also biosphere reserve)*
- I.3: *Cotopaxi*
- I.4: *Machalilla*
- I.5: *Podocarpus*
- I.6: *Yasuni*

II. Reserves
- II.1: *Pululahua Geobotanic*
- II.2: *Limoncocha Biological*
- II.3: *Cotacachi-Cayapas Ecological*
- II.4: *Cayambe-Coca Ecological*
- II.5: *Manglares-Churute Ecological*
- II.6: *Cuyabeno River Faunal Production*
- II.7: *Chimborazo Faunal Production*

III. National recreation areas
- III.1: *Las Cajas*
- III.2: *El Boliche*

same fate, is presented in Lipske (1992).

Lack of public funds for conservation and a lack of interest in the forestry sector for holding on to stocks that eventually could be used for production resulted in a weak presence of the national parks office within the more powerful and politically stronger units at the MAG (Fundación Natura 1988).

THE ROLE OF RESEARCH IN PROTECTED AREAS

After the rediscovery of Humboldt's insights into biogeography and the interest in Neodarwinian postulates to explain evolution, Ecuador has been the focus of studies in both natural history and systematics. As a preferred destination for long-term expeditions, the protected areas of Ecuador were always a magnet for great thinkers and pioneers of modern ecology. Moreover, earth sciences were the only ones dealing with those pristine environments, and the difficulties in logistics and communications were to account for research activities with very poor registered Ecuadorian participation. Few qualified national counterparts were chosen based upon their capacities for science, but rather on their ability to facilitate the collecting and exporting of specimens.

Almost all of the biological richness collected in those expeditions was shipped abroad. Even before Ecuadorian independence, the treasure in specimens collected by Don Pedro Franco Dávila, from Guayaquil, was brought to Madrid. Here, the Royal Museum of Natural History of Spain was created, and he became the empire's naturalist. Since then, unfortunately, most of the paleontological, archeological, botanical, and faunal archives are held by foreign natural history museums, academies, and other research institutions, therefore limiting in-country research and training of local scientists.

The lack of a clear policy regarding research in the country as a whole has made it even more difficult to establish this important activity within the protected areas themselves. However, not all areas have experienced the same pattern. The case of the Galapagos Biosphere Reserve (Sarmiento 1986) is different and has to be analyzed separately.

GALAPAGOS: ANOTHER STORY

The presence of the Charles Darwin Foundation in the development of Galapagos National Park was crucial to building an outstanding tradition of research in this protected area. The role of the Charles Darwin Research Station in the definition of policies and management priorities has been essential for the Ecuador National Park Service. With rather limited access to islanders in the beginning, the research station has now opened a new option in science-oriented careers. It is used by students for training, thesis research, special short courses, workshops, and the like. International support and multiple funding sources have helped maintain different programs (such as introduced animals, introduced plants, marine bird colonies, geological monitoring and fisheries, and publications) and the development of new ones (environmental education, science training, reforestation and community forestry, pest management, and ecotourism), as well as the establishment of a reference library.

Although up to now no Ecuadorian biologist has had the distinction of directing the research station, the participation of local scientists has been growing slowly but steadily. The selection of an Ecuadorian secretary general of the foundation made community-driven expectations more equitable. Also, the appointment of an Ecuadorian admin-

istrator to the sub-directorship, as well as nationals to most of the staff and visiting trainee positions, has been much more appealing to the resident population in Puerto Ayora and the archipelago as a whole. Galapageians are also getting more involved in research; there are now several professional biologists, four graduate students with a master's-level degree, and one working for a PhD.

Research in the Galapagos National Park not only has been conducted under international standards of professionalism in science and education, but has provided living examples for other protected areas around the world, setting itself new standards and even more ambitious goals. This contrasts sharply with what continental protected areas face in regard to scientific activities.

CONTINENTAL RESERVES AS MELTING POTS

On the mainland, research was carried out by a few dedicated "apostles" of scientific methods. Without financial support, most of the field work was done privately with limited results.

In the early 1970s virtually no infrastructure was present at any reserve, other than small houses used for shelter or guard posts. Facilities built in remote areas for other uses were also used for research-related activities in protected areas, such as with the U.S. National Aeronautics and Space Administration (NASA) satellite tracking station (near the Cotopaxi National Park), whose presence encouraged extended visits by naturalists from Quito, the capital. Later on, the nearby area was declared a National Recreational Area and is now the number-one destination for internal tourism.

During this time, few universities had programs for biologists or conservation-oriented professionals; hence, involvement of academic institutions was sporadic and occurred mainly when a big expedition from abroad approached the targeted area. Therefore, there were no regulations with respect to the routines for collections, observations or field surveys. Expeditions were a very risky adventure with a flavor of individualism.

RESEARCH TAKES OFF

With the advent of nongovernmental organizations (NGOs), a renewed interest in research in protected areas appeared mainly in the form of biological inventories, censuses of wild populations and control of the alarming traffic of "exotic" animals.

During the period 1973-1983, departments of traditional universities became involved in long-term projects with a flavor of "cooperation" with institutions from abroad. Several natural history careers were created with the returning PhDs, and the "boom" of conservation was about to begin. An Institute of Natural Resources was created. There were also cases in which distinguished professors came to survey the country, conduct research, teach elementary courses, conduct workshops, etc. In the late 1970s the National Museum of Natural History was created, with the goal of facilitating scientific research, collection, storage, study, preservation, education, and exhibition of the astonishing Equatorial natural wealth. A separate Institute for Cultural Heritage was also created to normalize activities regarding archeological, paleontological, ethnographic, and linguistic research.

Following the awareness of environmental issues, a plethora of new organizations have been created to emphasize research in protected areas. Fundación Natura has been, by far, the most well-known Ecuadorian NGO, working together with the Office of National Parks to support research activities among other pro-

grams. Fundación Ciencia, Fundación Maquipucuna, Fundación Ecociencia, Fundación Trópica 2000, Ecuadorian Council for Bird Research and Conservation, Fundación Herpetológica del Ecuador, Fundación Botánica del Ecuador, Ecuadorian Foundation for Conservation and Development, Ecuambiente, Fundación Arco Iris, Grupo Ecológico Tierra Viva, AECOTAL Environmental-Ecological Consulting, Fundación Llanganates, Sociedad de Flora y Fauna, and Sociedad de Defensa de la Naturaleza are just a few examples of the growth of Ecuadorian conservation NGOs.

PRIVATE RESEARCH INITIATIVES

Because of unreliable bureaucratic management of the reserves, data generated in those studies were poorly publicized. Most of the information on inventories, assessments and other evaluations was kept for MAG employees only. This motivated the creation of private reserves, accompanied by the owners' quixotic attitudes to go ahead with their own research activities in these *de facto* reserves. The Scientific Center "Río Palenque" is a good example: Callaway Dodson, who also started the program for naturalists at the Universidad de Guayaquil, segregated a patch of forest surrounded by tropical crops within his own property. The good maintenance of the area and the facilities that little-by-little were added, gave Río Palenque Science Center a unique appeal for field biologists in Ecuador, allowing inventories and permanent quadrants for long-term surveys. This circumstance allowed Río Palenque to survive and become known as the richest place for biodiversity of angiosperms on earth (Gentry 1982).

Another example is the Equatorial Garden in the San Antonio de Pichincha and his *finca* near Ambato, where Misael Acosta-Solis maintained samples of original vegetation and conducted research (Acosta 1977).

With the construction of the railroad from Ibarra through the northwestern forest towards San Lorenzo, a forestry station was built in the forest of Lita where the giant toad *Bufo bomblergii* was collected and continues to be exploited as a gastronomic eccentricity. Further north, the train station itself, at San Lorenzo, hosted expeditions and served as a base camp for field research.

On the western slope of the Pichincha volcano, Paul Feret, with support of the Friends of Nature Society, established "Las Palmeras" field site for research and ecotourism. Nearby, Jaime Jaramillo established his private research station "Guajalito" for cloud forest ecological surveys.

Limoncocha, created by the Summer Linguistic Institute (a missionary organization) in the Ecuadorian Amazon, is an exceptional type of private initiative. It attracted not only priests for evangelization of silvicolous tribes, but researchers from many disciplines related to the tropical rainforest. With its own fleet of aircraft, boats, and other modern technology, Limoncocha Research Station was easy to reach by flights from Miami or Quito. By the late 1970s, the Institute was running the best field station that Ecuador had ever seen, on the banks of the Napo River, with its headquarters in the capital city. The scientific production of the Institute was really impressive. Its newsletters, books, journals and other communication materials reflected a great variety of interests. Ornithological surveys, for instance, made the place famous as having the highest bird diversity on earth (Pearson 1972). Still, the station was primarily for evangelization, carrying out a mission of acculturating indigenous people. It put the jungle in contact with the west-

ern world. Today, even though Limoncocha was recently designated as a Biological Reserve, not much is left; oil exploration, tourist impact and social dislocation are few of the residuals from the once-sacred paradise for research in the tropical forest.

Attempts have been made elsewhere, with partial success, to achieve the same degree of efficacy. In the early 1980s, an idea to build a multimillion-dollar research station in Yasuni National Park (the proposed Research Station Napo, with support from the Smithsonian Institution) did not come about. A renewed attempt is being made with the assistance of the Catholic University of Quito.

Fundación Natura is managing a protected forest near Quito, in the last remnant of interandean or transandean (Sarmiento 1986) montane forest. Mostly used for environmental education and interpretation, the Environmental Education Center at Pasochoa has also supported research on a small scale.

The Maquipucuna Foundation is now operating the Richard Davis Research Station on his property at Nanegal. The Foundation for Conservation and Development operates a research station in Sacha-Pacha, Zancudococha. Ecuambiente operates a field site near Tiputini. Jatun Sacha Foundation is operating a research station in terra firme forest of the Amazon headwaters in Jatun Sacha, Puerto Napo, where some field courses are also offered. The Catholic University has a research station in Cuyabeno Faunal Reserve, one of the few areas in the Ecuadorian Amazon that shows the flooding dynamics of the Igapo and Varzea forest. The group Tierra Viva operates a field site in Mazan near Cuenca. The Antisana Foundation operates a field site in the paramos of Antisana. The University of Guayaquil operates its field site in Jauneche and Fundación Natura operates one in Capeira. The Arco Iris Foundation operates a field site in the Podocarpus National Park. Ecociencia is establishing permanent plots for continual censuses, within field studies sites for "La Perla" and "Baeza," The University of Esmeraldas operates a field site at the "Jardín Tropical," with emphasis on captive wildlife research. The Ecuadorian Council for Bird Conservation and Research is developing a suitability analysis for a private reserve in the Piedmont of Naranjal where the newly discovered El Oro parakeet (*Pyrrura orcesi*) has been reported (Ridgely and Robins 1988).

GOVERNMENTAL INPUT

As a result of the Forestry Law, passed in August of 1981, and the revision of it as the Forests and the Conservation of Natural Areas and Wildlife law of 1990, rules and regulations now govern research in protected areas (MAG 1990), providing a legal framework for these activities.

Tax incentives, reduced tariffs on equipment imports, and other benefits for promoting research are encouraging. However, the current system, with few professionals working in research and development, is still limiting. Chapter VIII of the regulatory listings deals with research and training, in which a research committee is created as an advisory board to cope with the needs of research-related issues, made up from the department heads of the Forestry sector. A formal office for Authorization and Licenses is now in full operation and establishes guidelines for scientific research, including collecting, maintenance, treatment and exporting (Ecuador is a member of CITES, the Convention on International Trade in Endangered Species of Wild Fauna and Flora), collection, and experimentation activities.

During the years 1979-1982, governmental protected areas (*de jure* reserves) were getting delineated.

Some areas had to be designated as "security zones" to prevent invasions by settlers and other interventions. Remote places were reached with the help of the local military that served as liaisons and, sometimes, guides to such distant areas. The military, therefore, played a big role, because, in most cases, it was the only way to reach faraway reserves. A chronicle of the expedition to Puruhanta Lake (Sarmiento 1988) gives an example of their contribution.

The infrastructure now available at most parks is still weak. There are attempts to organize a better system for research in the country, where the National Council for Scientific Research would have a key role, as recommended by the Ecuadorian scientific community (Romo 1986). However, in most cases, research in protected areas must still be conducted rather conservatively.

A few public scientific institutes have done field research in protected areas; e.g., the National Institute for Agricultural Research has developed forestry-related projects in field sites at Payamino Forest and San Carlos Research Station. The facilities of the Ecuadorian Institute for Electrification (INECEL) at the "Reventador" has also served scientific purposes by studying the San Rafael waterfall area and the eastern slope of the Andes in Cayambe-Coca Ecological Reserve. Municipal and provincial facilities (such as those related to irrigation programs, potable water, electrification and so on) have provided base camps for research in most of the protected areas.

The Ecuadorian Museum of Natural Sciences, realizing the limitation of personnel, has taken a rather interesting approach. It has promoted research in protected areas by contacting world class scientists to work towards the completion of the biological inventory of the country.

By having advisory boards from the universities, other governmental agencies, the Biological Society and the Ecuadorian Academy of Biological and Natural Sciences of the Ecuadorian Culture House, a variety of collaborative programs have been facilitated. Italian researchers have helped prepare the paleontological chart of Ecuador; French systematists have compiled butterfly and cricket listings; Swiss workers have gathered information on frog parasites while including new species in the amphibian listings. Denmark has helped initiate botanical collections; The Netherlands, with ornithological training.

The U.S. Academy of Natural Sciences continues working on developing the avian inventory and supports institutional strengthening and training of personnel. The Western Foundation of Vertebrate Zoology of Los Angeles prepared a list of nest and eggs of Ecuadorian birds and also trained employees. Ohio State University carried out paleoecological studies as well as botanical expeditions. The University of Wisconsin-Madison helped to initiate osteological collections. Northern Kentucky University helped organize limnological references. The Smithsonian Institution has completed surveys of aquatic insects. The Missouri Botanical Garden has helped to establish the National Herbarium, which supports field training, research and collection management, and training of local botanists. With a different agency (UTEPA) the Smithsonian Institution has recently developed a collaborative project to support research in the western tropical rain forest, through the technical unit for the Awa Binational Reserve.

The Navy controls big areas offshore. Along with the Oceanographic Institute and the Institute of Fisheries, it helps to provide logistics for research in marine reserves around the Galapagos and Machalilla National Parks. They have even gone to Antarctica twice in research-related journeys.

RESEARCH RESULTS

Most research results in protected areas are concentrated in inventory work and few, if any, of the outcomes have been evaluated. Most of the knowledge generated over the years has not been available to Ecuadorian students and researchers due to financial constraints to obtain scientific literature and professional journals. In addition, the low pay at research institutions in the country has not helped to motivate a demand for research-related careers, hence creating an elite of science-oriented scholars.

Lack of communication between the researchers themselves and between institutions (Sarmiento 1984) has promoted local rivalries for scarce resources. This is exacerbated by the fact that peer review is not well practiced and criticisms have traditionally affected personalities and prides. Only recently has the Ecuadorian Society of Biologists established an annual meeting; now in the *Jornadas de Biología* it is easier to find research contributions on protected areas and endangered species.

There is no continuity in the publication of professional journals. Almost every scientific magazine with articles dealing with protected areas has suffered the impact of a crisis economy, where the first activity to experience budget cuts has always been publications. The influence of medical research on the *Boletin de Informaciones Científicas Nacionales* is overwhelming. The sequencing of the *Revista del Museo Ecuatoriano de Ciencias Naturales* is aperiodical. Nor has the National Parks and Protected Areas Division maintained a publishable account of hundreds of scientific reports that, by law, must be given to the forestry authority after the finishing of a study. Annals of certain universities show few contributions in the field and some academic units have not even published a list of theses or other projects associated with protected areas.

ALTERNATIVE OPTIONS

The Ecuadorian scheme for science and conservation is in flux. There is a new breed of field biologists, ecologists, and environmental professionals, with better training and expertise, that must be supported with suitable working conditions.

Research in protected areas is mainly stimulated by the presence of basic lodging facilities. It is of primary importance that infrastructure to support field research in Ecuadorian protected areas be built accordingly. The training of local scientists is also crucial. Much more emphasis has to be given to completion of graduate studies at the doctorate level for Ecuadorians so they can become leaders in research and conservation. Programs for international studies have traditionally offered fellowships only at the Master's level. On the other hand, doctorate-level training is undermined in local universities by political activism and outdated materials and curricula.

MAG should give much more attention to the Division of National Parks and Wildlife Resources. Its intrinsic value for protecting national forests is opposed to the attitudes of the traditional forestry sector, which would like to use the reserves as timber mines. However, protection alone will not suffice. A much more dynamic current approach is needed to cope with the needs of research (both basic and applied) as well as those of sustainable development. If we expect protected areas to persist, the value of biodiversity protected inside reserves must be internalized within the formal economic structure of the nation.

In this regard, the traditional approach of selecting big areas of untouched ecosystems has to change towards a more realistic and man-

ageable scheme of smaller conservation units (Sarmiento 1990) selected for their role in connectivity among patches of rather isolated remnants of primary vegetation supporting metapopulations of rare animals. This is particularly important in the cloud forest belt of the western Andean slope and extremely urgent in southwestern Ecuador (Robert Ridgely pers. comm.). Research should be directed toward priorities encompassing sustainable development and rural empowerment by means of non-traditional forest resource usage, as is being demonstrated by the Tagua Initiative™ of the NGO Conservation International in northwestern Ecuador (Tangley 1992).

SUITABLE APPROACHES

An independent administrative structure of protected areas within the framework of governmental hierarchies dealing with natural resources management is needed. A much more realistic approach to regulating collections and export of natural specimens should be developed with the goal of helping build internal Ecuadorian research abilities in protected areas, especially by creating infrastructure for science development at the national level. Publication of scientific literature as means of professional development, encouraging peer-reviewed contributions and refereed editions, is a must.

Also, new concepts for utilizing extractive reserves (*sensu* Instituto de Biodiversidad in Costa Rica) to bolster local villagers and the overall economy of the region are needed, with adjustments geared toward Ecuadorian realities. Establishment of privately owned reserves should be encouraged through the consent and co-participation of the communities. Financial incentives should be directed towards private research facilities and programs.

International cooperation in developing mutually beneficial projects between Ecuadorian research institutions and foreign counterparts is needed; not a mere strengthening of the physical plant and machinery, but a whole change in attitude regarding scientific activities (including professional training). Inclusion of local principal investigators with shared budgetary responsibilities will help, as will the activation of overheads at Ecuadorian institutions and fees for administrative collaboration and technical assistance to foreign researchers.

The participation of industry (timber, pharmaceutical, oil, transportation, etc.) to provide incentives for conservation through the sponsorship of scientific research in protected areas is also desirable. So too is a new approach to natural areas management, including research-extension programs supported by local enterprises that provide real benefits to nearby communities. If biodiversity is to be maintained, its benefits to the people must be demonstrated.

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