

Monitoring Ecosystems and Biodiversity at a Continental Scale—A Proposal for South America

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***Abstract**—A monitoring system plan is being developed in South America to assess critically endangered ecoregions. The system will be based on a previous ecosystem and biodiversity inventory developed through a large gap analysis program in five South American ecoregions. The monitoring system will include three main elements: (1) Landscape Ecology: vegetation cover, fragmentation and deforestation, infrastructure (road, dams, pipelines); (2) Biological guidelines: species richness, endemism, endangered species and species of a particular interest; and (3) Conservation Policy and Socio-Economic guidelines: national protected areas systems, conservation policies, human population on important areas, main economic activities and other. Such a system is an important need for governments and private organizations in South America, especially to detect critical sites and socio-political issues before the environmental problems become too large.*

Introduction and Background

Environmental surveillance at a continental scale is an important conservation requirement in vast territories, such as in South America, where large and diverse ecoregions are being altered by a number of unsustainable development practices (Busch and Trexler 2003, World Conservation Union, IUCN 1992). Although deforestation, soil erosion and biodiversity loss have become the primary sources of poverty and social distress in the region, very few continental baseline studies are available for initiating a large scale monitoring program in South America.

A recent gap analysis project developed by UNEP (United Nations Environmental Program) and The Nature Conservancy (funded by the Global Environmental Facility, GEF), provides large amounts of data, maps and other types of information that should be used as a starting point for a monitoring system in five of the biotically richest ecoregions in the world (UNEP, The Nature Conservancy, NatureServe 2003).

The project was executed by local conservation/science organizations in Colombia, Ecuador, Peru, Bolivia and Paraguay, for five global priority ecoregions as described by Dinerstein E. and collaborators (1995) in a World Bank and WWF study. From north to south, the ecoregions are: the Choco Humid Forests (Colombian Pacific and Norwest Ecuador), three ecoregions on the eastern slopes of the Andes in Ecuador, Peru, and Bolivia, and the Dry Chaco in northern Paraguay and southern Bolivia.

Among the results, 6,473 species of flora and fauna have been analyzed (each one with a map indicating its potential geographic distribution), and over 6,500 thematic maps have been produced, indicating vegetation types, centers of high diversity and endemism, current and potential threats, forest fragmentation, infrastructure, location of protected areas, and basic socio-economical information.

During the project the best contacts with governmental agencies in each country were developed (Environmental Ministries and other agencies), as well those with international organizations and foundations and with local NGOs and local communities. More than a 100 organizations were contacted in the region, many of them collaborating directly with the project. As a result the Inter American Development Bank is currently funding the social and economic studies for the selected sites (Inter American Development Bank 2004).

With this basic inventory information, monitoring system plans are being developed. The goal of implementing such a system is based on the fact that governments, NGOs and local groups need to be able to rapidly develop conservation activities over precise areas of importance that may be detected by the system. In that way, the monitoring system will contribute to better conservation results using fewer monetary resources.

A number of elements will be considered first, such as the monitoring system structure from a technical, organizational, and political points of view. The three main planned elements for the system will be: Landscape Ecology, Biological guidelines, and Conservation Policy

/ Socio-Economic issues. These guidelines will include a variety of topics, such as vegetation cover, forest fragmentation, deforestation (rates & specific location), species richness, endemism, species of a particular interest (including economic interests), national protected areas systems, local conservation policies, human population over critical areas, main economic activities, and other issues (Pearce 1993, Dillon and others 1996).

The monitoring network structure is being planned to include different executing partners in different countries, all following the same basic monitoring philosophy and methodology. Executing partners and other partners related to the monitoring system will periodically make available critical information to environmental government offices, NGOs, local organizations, specific communities and other stakeholders in order to catalyze immediate action.

Remote sensing, GIS, and field monitoring activity will be integrated in the monitoring system. Basic field observations can be developed for implementation by local peoples, park guards, university students, and scientists. A set of indicators will be identified for different scales and levels of the monitoring system. Also, basic social and economical indicators are being integrated into the system. Coordination with other systems and databases in the region is also a priority, such as with Conservation International and the University of Maryland which are monitoring certain areas of the Amazon Basin.

Planned to be implemented in 2005, this will be the first continental-scale environmental monitoring system in South America.

Monitoring System Outline

Goals

The main goal of the Monitoring System in South America is to provide early detection and warning of emerging environmental problems in the region, especially at an ecoregional scale. This should catalyze conservation and environmental management processes and negotiations at national levels before the problem becomes more difficult to control.

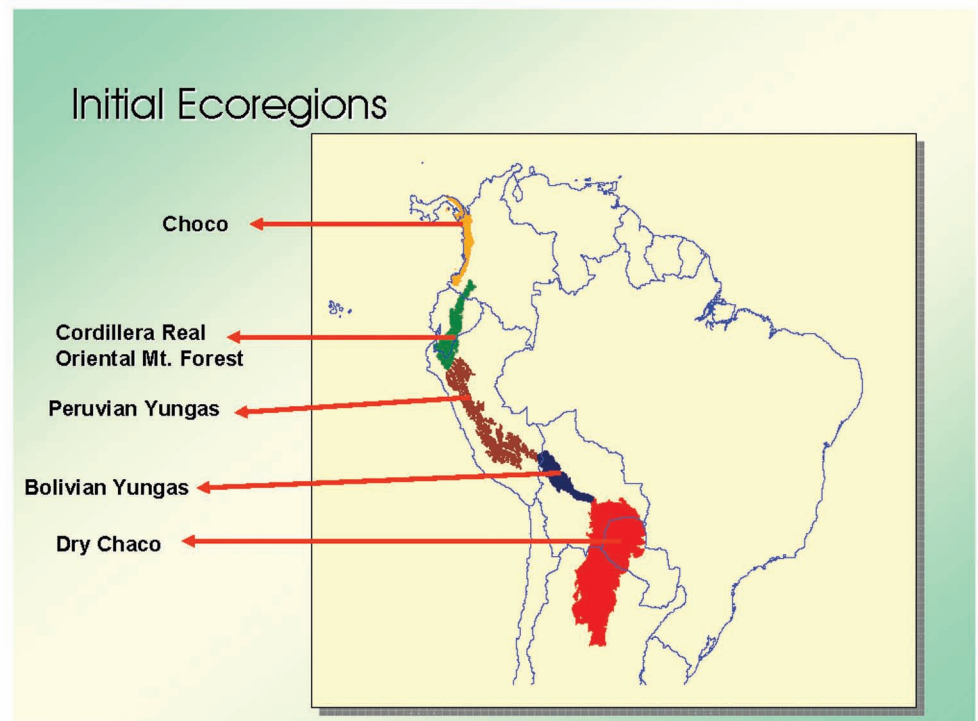
Other objectives will provide to the conservation/science community and to the general public a solid baseline of information about ecosystems, habitats, species, national conservation policies and basic socio-economic information related to the environment in South America.

Ecoregions Proposed

The aim of the Monitoring System is to work in the whole South American continent, although a first iteration of critical ecoregions should be addressed initially. This leads to an organized step-by-step process and the opportunity to test and improve the system before moving to other ecoregions.

A logical starting point is to work with ecoregions that already have solid sets of information, such as the ones that were addressed in the UNEP/GEF Gap Analysis project (UNEP, The Nature Conservancy, NatureServe, 2003) (fig. 1).

Figure 1.



Biogeographic Choco

Tropical humid forest along the Pacific Coast, from southern Panama to northwest Ecuador. Most of the ecoregion is located on the Colombian Coast. This is one of the most biologically diverse ecoregions in the world. The endemism rates are among the highest in continental ecoregions. This ecoregion also includes isolated dry valleys originating in the Andes. Main threats to this ecoregion are logging (both legal and illegal) in northwest Ecuador, and deforestation by the expansion of agriculture.

Eastern Cordillera Real Montane Forest

Cloud forest and forest foothills in the upper reaches of the Amazon Basin, mainly Ecuador eastern Andean slopes. Great variety of habitats, from the lower foothills (800 meters - 2,640 feet) to the highlands treeline (over 3,500 meters - 11,550 feet). High biological diversity. This ecoregion is threatened by clearing for new pastures (livestock) and agriculture.

Peruvian Yungas

Eastern Andean slopes in Peru. Combination of cloud forests and deep valleys (called yungas), some of them running parallel to the Andes. A great variety of habitats as in the previous ecoregion with high biological diversity. Main threats include clearing for new pastures (livestock) and agriculture, as well as coca plantations.

Bolivian Yungas

Similar to the Peruvian Yungas, but located towards the south where greater seasonal climatic variations occurs. Main threats are clearing for new pastures (livestock) and agriculture, and coca plantations.

Dry Chaco

Southern Bolivia and Northern Paraguay. The ecoregion is a combination of several dry ecosystems with unique flora and fauna, including wild peanuts (original genetic bank) and lowland guanacos. Main threats are vegetation clearings for new pasturelands, fires and burning of natural vegetation.

Main Guidelines

Three sets of guidelines are proposed for the Monitoring System database.

Landscape ecology elements

These guidelines include: (1) Vegetation Cover and Vegetation Classification. (2) Fragmentation and Deforestation, including form and size of fragments, location and deforestation rates. (3) Base Map & Main

Threats; threats include infrastructure such as new roads and agricultural frontier expansion, logging areas, pipelines, dams, etc. Landscape ecology issues will be based on the most up to date remote sensing images and GIS. Scale for the proposed maps would be 1:500,000.

Biological elements

The Biological Guidelines include 4 main topics: Species Richness, Endemism, Endangered Species and Species of particular interest (including economic value). For this element, all biological indicators (see biological indicators criteria below) will have a potential geographic distribution map, based on vegetation cover and habitat types. GIS management of potential distribution maps will show the important areas for biological diversity, endemism, endangered species and species with a particular interest (fig. 2).

Conservation policy & socio-economic elements

These address issues using basic information sets: (1) National Protected Areas Systems (scale 1:500,000); (2) National Environmental Offices and current Contact Representatives (6 month period update); (3) Principal Conservation/Science NGOs and other related organizations (6 month period update); (4) Principal National Projects, such as road construction, pipelines, dams, etc. (1 year period update); and (5) Socio-Economic Database, including several fields, like population (in the selected ecoregions), main economic activities, per capita income, local organizations, principal markets, distribution of products, and related datasets.

Indicator Species

The selection of biological indicators is an important procedure for the development and maintenance of monitoring systems. Several criteria are commonly used for selecting indicators (The Nature Conservancy, 2000). Given the fact that this monitoring system is based on an ecoregional scale, the three main criteria planned to be applied for both plants and animals are:

Representativity

The species selected should be representative of the ecoregions and should integrate well with the elements and topics that will be used in the monitoring system. In this particular case species selected should be representative of the chosen ecoregions (see description above) and of the following topics: endemism (the most important endemic species); endangered species (in this case, critically endangered species, based on IUCN criteria); species with a particular interest (the most important species related to economic activities) and species richness. For this topic, a sufficient number of species (providing

BIOLOGICAL ELEMENTS

- **Species Richness (Diversity)**
- **Endemism**
- **Endangered Species**
- **Species with a particular interest**

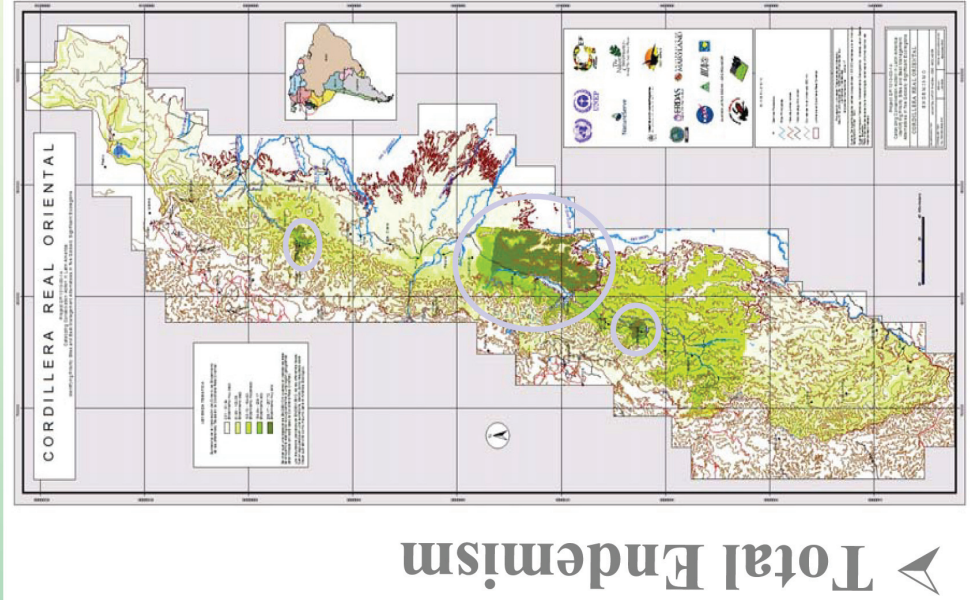


Figure 2.

statistical value) should be selected, based on the criteria covered by the next point.

Knowledge

The species selected should have a sufficient set of information (based on previous scientific studies and historical data) to provide adequate information on general geographic distribution and habitat preference; and basic ecology like habits, interaction with other species, food, etc. For some animal species there is sufficient baseline information, as in the case of several vertebrates, including most birds and mammals, and some amphibians and reptiles. Invertebrate data (except some insects, such as butterflies) is comparatively poor and not useful for a continental scale system, because of the lack of data. There is a similar situation for plants. Vascular plants have more information than the non-vascular ones.

Ease of observation

Even though some species have good basic information, their accessibility on the field can be difficult. For an ecoregional scale system it is better to choose species that are relatively easy to observe in the field, except perhaps in the case of endemic and endangered species. Basic field observations can be developed for implementation by local peoples, park guards, university students, and scientists.

Organizations and Governance

There are three levels of organizations that need to be considered for the development and the management of the Monitoring System

Executing organizations

These are the organizations that maintain the system's information database at a national level and also develop the early detection process and awareness of environmental problems. The executing agencies are in charge of the following main activities: remote sensing analysis, cartography & GIS, database structure & data population, field work (coordinate with local peoples, park guards, university students, and scientists) and data distribution through web pages and specific information to government agencies. These agencies should be in close contact with other conservation/science organizations, such as NGOs, universities, museums, local groups, etc. For the implementation of the monitoring system, it is suggested that the same five organizations (one in each country) that developed the databases (cartography, species and socio-economic data) for the previous UNEP-GEF gap analysis be utilized (fig. 3).

Recipient organizations

These are the principal organizations where the information should first be routed, especially in the case of an early warning process. Among these organizations, are the government agencies for environmental issues. This includes environmental ministries and other high level government organizations related to the environment, land use planning, agriculture, oil exploration and exploitation, logging and national infrastructure (roads, pipelines, dams, etc.). The proposed national executing agencies have already initiated contacts with these type of organizations in each country. Other recipients of the information are NGOs, local communities, universities and the general public (using internet technology).

Coordinating organization

The Coordinating Organization oversees the general functioning of the monitoring system and has an international communication role. This organizational body provides high level representation to the executing agencies and helps to maintain good relations with the recipient agencies. It also is charged with managing and maintaining a sufficient level of funds for the system's functioning. The coordinating organization interacts with international organizations, such as the World Bank, Inter American Development Bank, Andean Corporation (CAF), Andean Community of Nations (CAN), European Community, and with other organizations developing ecoregional scale databases and monitoring systems; as is the case with The Nature Conservancy, Conservation International, and the University of Maryland for the Amazon Basin.

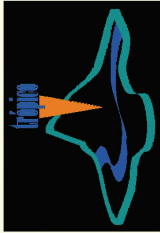
Discussion

Working on an environmental monitoring system at a continental scale is a very ambitious task, especially in South America where biological and ecological knowledge is still rudimentary in many cases. The system proposed in this paper will follow several iterative steps; the first one is to concentrate activities in key ecoregions, especially the ones that are important because of their biological richness and for their level of threats. The first set of ecoregions selected for the monitoring system all have sufficient baseline information to initiate the monitoring process, thanks to a previous UNEP-GEF gap analysis, from which several indicator species and ecosystems can be chosen. With a current IDB project providing the social and economic follow-up for the ecoregions, integrating socio-economic information is also reinforced.

Proposed Executing Agencies



Corporación Valle del
Cauca, Colombia



Trópico, Bolivia



Secretaría del
Ambiente, Paraguay



Universidad Nacional
Agraria La Molina,
Perú



Alianza Jatun Sacha
CDC-Ecuador



Figure 3.

Working with a disparate set conservation/science organizations, both at national and international levels, is a challenging task and needs to be considered from the beginning of the system's development. This includes the main national and international conservation/science organizations, universities, museums, and others. Also, recipients of the information, such as government agencies should be active partners of the monitoring system. International agencies, like the World Bank, IDB, European Community and bilateral agencies such as the USAID, need to be involved as well.

A crucial factor for developing the monitoring system as a permanent source of information and early warning detector, is to maintain a high level of professionalism both from the technical side (biological, ecological, socio-economic, informatics) and from the administrative point of view. The executing organizations' experience and technical competence, as well as the coordinating organization and partner's efficiency are key to the development of the system.

Finding resources, including human resources and funds, is another critical task for the development and structuring of the monitoring system. All system's partners and especially the coordinating organization should provide the necessary means to maintain a sufficient flow of resources through the development of relationships with international organizations, local governments and other types of funding organizations.

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