CATALYZING CONSERVATION ACTION IN LATIN AMERICA: IDENTIFYING PRIORITY SITES AND BEST MANAGEMENT ALTERNATIVES IN FIVE GLOBAL SIGNIFICANT ECOREGIONS (GEF/1010-00-14)

FINAL REPORT (September, 2003)

Executing Agencies:
Bolivia: TROPICO Foundation
Colombia: Cauca Valley Corporation, CVC
Ecuador: Jatun Sacha – Conservation Data Center, CDC
Panama: ANCON Foundation
Paraguay: Environmental Ministry, Conservation Data Center, CDC
Peru: La Molina University, Conservation Data Center, CDC
(See Executing Agencies Contact Information on Annex 2)

Xavier Silva, Ph.D., General Coordinator (xsilva@andinanet.net)
Marcelo Guevara, Geographic Engineer, Technical Coordinator

Note: The final report includes all information generated by the project, including maps, on CDs (attached)

ABSTRACT

The project entitled "Catalyzing Conservation Action in Latin America: Identifying priority sites and best management alternatives in five global significant ecoregions" was executed by conservation/science organizations in Panama, Colombia, Ecuador, Peru, Bolivia and Paraguay. The project provides to the international community a science - based selection of priority conservation sites and their management alternatives, in five global priority ecoregions: the Biogeographic Choco (Panama, Colombia and Ecuador), the eastern slopes of the Andes in Ecuador, Peru and Bolivia, and the Dry Chaco (Paraguay and Bolivia).

Among the results conducing to the site selection, 6,473 species of flora and fauna have been analyzed (each one with a geographic distribution map), 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, among other important topics.

The second phase of the project analyzes the environmental and socio-economic conditions of the selected sites and formulates alternative management proposals for decision-makers both at national and local levels. This project is characterized by the participation of different organizations at local and national levels. The project was administered by The Nature Conservancy, and technically supported by organizations such as NASA, the United Nations, NatureServe, the University of Maryland and the Center for Spatial Technologies, GRID, South Dakota.

INTRODUCTION

The main objective of this project is to identify, with a scientific basis, the high priority sites for conservation in five ecoregions of world importance in Latin America. Out of many important sites presented in the study for each ecoregion, the ones selected were those that showed the best possibilities for real conservation and were not Protected Areas. Practical alternatives are proposed for conservation and management of natural resources in each of the priority sites, which will be presented before the authorities and decision-makers at the local and national levels in Colombia, Ecuador, Peru, Bolivia and Paraguay. The project is characterized by the participation of national, governmental and local development institutions. The ecoregions are: the Biogeographic Choco (Panama, Colombia and Ecuador), the Eastern Slopes of the Andes (Colombia, Ecuador and Peru), the Peruvian Yungas (warm valleys) (Peru), the Bolivian Yungas (Bolivia), and the Dry Chaco (Bolivia and Paraguay). In order to select the ecoregions, the WWF and World Bank ecoregional scheme was used initially (Dinerstein et al., 1995).

During the first phase (identification of priority areas), the analysis involved three large components: (1) the biological-ecological study, based on the analysis of more than 4,750 species of flora and fauna (all the mammals, all birds, all amphibians, and all species of two botanical families per ecoregion), each with a distribution map. The objective of the biological-ecological analysis is to identify centers of high biodiversity and endemism, of threatened species, etc. (2) Then there is the analysis of the conservation state (as well as threats) and of forest fragmentation and natural vegetation, based on the analysis of satellite images from 1999 to 2002, and (3) the study of the National System of Protected Areas (SNAP) of the six countries, including the location of areas and management systems. The objective of the study of the SNAP

is to identify the zones that do not have any conservation status; those that have legal protection, and those that regardless of their status within the System, do not have good protection and need to be reinforced.

The integration of these three large axes (centers of diversity and endemism, etc. x fragmentation x truly protected areas) provide the necessary elements in order to identify sites that should be conserved as priority. Generally, they are sites with high diversity, endemism, with a certain amount of threat and, normally, do not form part of Protected Areas (except the areas which, regardless of their protection status, do not satisfy conservation requirements, such as natural areas representation and species protection).

During the first part of the project, the study was developed on a geographic scale of 1:500,000, and five priority sites were identified, one per ecoregion. Selection of the priority site per ecoregion, among many others identified as important for the study, was based on the analysis of values (or weights) assigned to the variables of biodiversity, endemism, threatened species, fragmentation, protection status and other biogeography characteristics.

In the second phase of the project, the sites selected were analyzed on a deeper scale (1:50,000 or 1:100,000). In this phase, the best alternatives for conservation and site management were identified. Socio-economic elements (workshops, decision-making together with the community, etc.) are integrated with conservation opportunities more emphatically than in the preceding phase. Moreover, the second phase bases its studies on the following: area delimitation, base maps, vegetation maps, main objective identification (species, habitat) for conservation (including maps), a definition of threats and their origins (even with maps), a zoning map for area management, and identification of the best alternatives for site conservation.

The sites selected are: the enclave of xerophytic vegetation of Dagua in the Biogeographic Choco; the Shuar zone of Tsurakú in the Eastern Slopes of the Andes; the high Huallaga spurs in the Peruvian Yungas; the Irupana zone in the Bolivian Yungas and the Chaco Dunes in the Dry Chaco. The management alternatives have been proposed for each site and all include local community participation (see the Results chapter).

During the project development, more than 70 Latin American technicians have been trained in the sciences for conservation, geographic information systems (SIG), remote sensor analysis, GPS, etc. The project executing institutions have become strengthened from both the technical and institutional viewpoint. The highly participative nature of the project has contributed to contacting more than 100 institutions in the whole region (governmental, private and local).

The executing agencies are: ANCON Panama; Corporación Valle del Cauca CVC, Colombia; Alianza Jatun Sacha/CDC-Ecuador; Universidad Agraria La Molina; Centro de Datos para la Conservación CDC-Peru; Fundación TROPICO, Bolivia, and the Secretaría del Ambiente, CDC-Paraguay. The administrative agency is The Nature Conservancy-Ecuador, the implementation agency is UNEP, and the financial agency is GEF. NatureServe provides the main technical support. Among other institutions providing technical support are, NASA, the University of Maryland, and the Center for Spatial Technologies, GRID, South Dakota. The Inter American Development Bank (IADB) will provide additional funds for the continuation of the Project, especially for developing feasibility studies of the proposed management alternatives in each selected site.

METHODOLOGIES

(see ANNEX 1)

The project has followed the most advanced methodologies from the cartographic-mathematical (models, etc.), biological, ecological, environmental variable analysis and socio-economic viewpoints. Due to the complexity of these models, a summary of the main methodological aspects is presented in the annexes. The methodology incorporates as well the most recent methods in the biology of conservation, such as "Ecoregional Planning" and "Planning for Site Conservation" (The Nature Conservancy, 2002).

RESULTS

(see maps, details and reports per country on attached CDs)

Sites Selected and Management Alternatives:

1. Xerophytic Enclave of Dagua and Loboguerrero

(see complete report and maps of the Biogeographical Choco, Colombia, on CDs):

Area Description:

Even though more than 90% of the Biogeographical Choco is made up of humid wooded formations, an enclave of dry vegetation was selected in this ecoregion, surrounded by humid vegetation (tropical rainforest to the west and different levels of cloudy rainforest to the north, south and east). The Dagua Valley has numerous altitudinal floors between approximately 2,000 m.a.s.l. and 400 m.a.s.l. in its most westerly part.

This selection responds to the unique nature of the Dagua Valley (for being an isolated valley), in which are found many endemic species, such as cactus (Frailea colombiana, Melocactus loboguerreroi, Opuntia bella) and Anthurium buenaventurae (Arácea), Tillandsia mima (Bromeliácea), and various subspecies of other plants and even animals, as is the case of an endemic race of white - tailed deer (Odocoileus virginianus daguae).

The valley has intense human population pressure due to agricultural expansion, which generates deforestation of the natural environment, extensive burning of vegetation and erosion of the soil, both of gullies and top soil.
The Corporación Autónoma Regional del Valle del Cauca (CVC) (Regional Autonomous Corporation of Cauca Valley) has been working in the zone for a number of years, basically to control soil loss. By means of this project, there is a focus on conservation of habitats, on endemic species and those endangered. The study area involves approximately 100,000 hectares.

Management Alternatives:

A. General Strategies:
   - Mitigation of threats: reduction of active sources of pressure on the environment.
   - Ecological Management and Restoration: maintenance, recovery, handling and increase of the feasibility of natural sites conservation.

B. Specific Initiatives:

- Recovery of the natural and cultural values of the subxerophytic enclave.
- Strengthening of community social actors for conservation and handling of the enclave.
- Scientific research and environmental education connected to the recovery, management and conservation of the area.
- Design and implementation of an incentives system for site conservation.
- Design and implementation of a system of biological and ecological indicators for zone monitoring.
- Legal formation of an official conservation representation for the zone.
- Restoration and recovery of subxerophytic forests.
- Property study, purchase and adaptation of lands.
- Recovery and maintenance of local fauna, with emphasis on endemic species and endangered species.
- Recovery and maintenance of local flora, with emphasis on endemic species and endangered species.
- Promotion of production alternatives in accordance with conservation purposes.

2. Shuar Zone of Tsurakú

(see complete report and maps of Andean Eastern Slopes, Ecuador, on CDs):

Area Description:

This zone is between 1,000 m.a.s.l. and 600 m.a.s.l. in the extreme spurs of the Eastern Andes, Pastaza Province, Ecuador. It contains a number of altitudinal floors of premountainous forest until the beginning of the tropical rainforest of the Amazon Basin, in its most easterly part. The highway crosses from north to south on the western side that goes from Puyo to Macas. The edges of the same show areas dedicated to subsistence agriculture and livestock. The rest of the 110,000 hectares is covered by good quality forest and has various isolated hamlets of Shuar communities. The area is located between the Pastaza and Copataza rivers.

This zone is characterized by having the highest concentrations of mahogany (Swietenia macrophyla) in Ecuador. The lumber companies are now present in the zone exploiting mahogany without any forest control. The standing trees are bought at a low cost from the owners (of non community plots) of the zone. Another threat is the intense hunting performed by the community members themselves. They identify various species that have been overexploited. Such is the case of 6 species of Cracids or wild turkeys whose populations are now quite reduced. Of these, perhaps the species named Mitu salvini still has stable populations, basically due to its nocturnal habits. Another species of overexploited birds because of hunting is the large toucan (Ramphastos tucanus). As far as hunted mammals are concerned, the peccary pigs (Tayassu spp.), mazama deer (Mazama americana), tapirs (Tapirus terrestris), and a number of species of monkeys, are also diminishing.

The strategic alliance between 2 organizations of science and organization, the Jatun-Sacha Foundation and the Centro de Datos para la Conservación (CDC-Ecuador, Conservation Data Center), has made various visits and meetings with Shuar community members of the zone, who are very interested in developing management alternatives that do not affect their natural resources.

Management Alternatives:

A. General Strategies:
   - Conservation of natural forests and reduction of threats.
   - Participative management of the area with Shuar communities.

B. Specific Initiatives:
   - Strengthening of capacities for conservation and management of zone communities.
   - Scientific research and environmental education connected to area management and conservation.
   - Incentive promotion in local communities for site conservation.
   - Design and implementation of a system of biological and ecological indicators for zone monitoring.
   - Officializing a legal status for conservation.
   - Environmental education program for hunting reduction.
   - Establishing a lumber exploitation control system.
   - Forming forest nurseries for reforesting degraded sites.
   - Establishing medicinal and cultural plant nurseries in general.
   - Family production programs: aviculture and pisciculture.
   - Creation of a biological station.
   - Implementation of ecotourism (community) in the zone.

3. Cloud Forests of Alto Huallaga

(see complete report and maps of Peruvian Yungas, on CDs):

Area Description:

A strip of cloud forest was selected in the Peruvian Yungas (as of 1.3000 ma.s.l. approximately, up to the water divide of the Eastern Andean Slopes). This strip is found in the center-north of the ecoregion in Peru. It is a unique zone and extremely important for conservation, since 3 species of monkeys inhabit it and are endemic in the zone (one of the world records in primate endemism). Alteration of this habitat would provoke extinction of this species.

The main threats here are agricultural expansion from the low parts of the Huallaga Valley, and mining exploitation, coming mainly from the higher zones. Some transversal sub-basins have now been colonized and used for this purpose.
This zone can be considered as a biological and ecological corridor between the Abiseo River Protected Area to the north and the Tingo María National Park to the south. Distance from this zone to populated centers where conservation organisms operate makes conservation activity development more complicated.

Management Alternatives:

A. General Strategies:
   - Protection of the cloud forest and the endemic species found there.

- Conscientization at the local and national levels regarding the importance of the site, based on the ecological services generated, such as water, soils, vegetal coverage and genetic resources.

B. Specific Initiatives:
   - Promotion of national conservation areas in the zone.
   - Generation of development alternatives at the local level.
   - Environmental education.
   - Generation of connectiveness (with legal status) to form protection corridors, especially between the Abiseo River Protected Area to the north and the Tingo María National Park to the south.
   - Reinforcement of the rational management of forest concessions.
   - Development of management participative projects for hydrographic sub-basins, including slope protection.
   - Promotion of agricultural extension for low impact crops in the environment, in certain hydrographic sub-basins.
   - Work on systems for reducing impact due to mining exploitation, especially in high parts, where this type of activity is concentrated.
   - Development of research activities and monitoring of endemic primate species and other conservation objects existing in the zone.

4. Irupana Zone

(see complete report and maps of Bolivian Yungas, on CDs):

Area Description:

The Irupana region in the eastern Andean slopes of the Department of La Paz, Bolivia, is most interesting from the ecological viewpoint, as a true mosaic of vegetation formations can be found there, from xeric formations (dry vegetation) to the most humid.

There are a number of human impacts present in the zone, among which is the expansion of mining activity, that involves intense colonization activity, with the consequent cutting down of the forest for agriculture, excessive erosion of the existing strong slopes of the zone, sedimentation and especially, pollution of the waters.

The TROPICO Foundation of Bolivia has worked intensely with zone communities to promote sustainable use of the natural resources and forest conservation, as slope protection areas and protection of the region´s biodiversity. The response of the local communities has been very positive up to the moment.

Management Alternatives:

A. General Strategies:

   - Community management and conservation of the different ecological systems of the study area and of its environmental services.
   - More active incorporation of the environmental variable (and theme) in communities involved in the zone.
   - Reduction of pressures, such as mining, expansion of the agricultural border, slope erosion, etc.

B. Specific Initiatives:

- Strengthening of local organization capacities for conservation and sustainable management of natural areas.
- Integration of long term recovery techniques of affected zones, and the maintenance of areas that are still in a good state from the ecological viewpoint, and in generating environmental services.
- Establishing of private conservation areas.
- Training for external community financing action.
- Identification and protection of water sources and springs.
- Rational management of forest wood and non wood resources.
- Research and monitoring of species identified as objects of conservation.
- Development of ecotourism activities handled by the communities.
- Training for adequate handling of artisan mining.

5. Chaco Dunes

(see complete report and maps of Dry Chaco, Paraguay on CDs):

Area Description:

A zone was selected in the Dry Chaco ecoregion (north of the Gran Chaco) that showed an interesting and rich variety of ecological systems of dry vegetation, from tropical savannahs to dense spiny underbrush, and even open vegetation on dunes.

The zone chosen is found in the extreme north-west of Paraguay, near the Bolivian border. There are unique vegetation varieties in dry Chaco, such as the Rosa (Rose) del Chaco (Cordia bordasii, Schinopsis cornuta) and the Palo Papel (Paper Stick) (Cochlospermum tetraporum), as well as some animal species, such as the recently "rediscovered" Pécari Taguá (Peccary) (Catagonus wagneri), and even an endemic species (in the zone) of Tinamú (Tinamou) (Eudromia Formosa). Moreover, this zone has an exceptional abiotic characteristic, in that it contains one of the largest aquiferous sub-soils (from 50 to 200 meters deep) of South America; the water comes from the Bolivian Yungas and filters in progressively in the sandy region of the Dry Chaco.

Management Alternatives:

A. General Strategies:
   - Reduction of the sources of impacts and threats on fragile habitats.
   - Protection of conservation objects in the long term and of other important species.

B. Specific Initiatives:
   - Development of environmental education in the zone.
   - Promotion of local community participation in monitoring activities, conservation and management of natural resources.
   - Promotion of agricultural uses of low impact in certain areas.
   - Development of scientific research and monitoring.
   - Establishing specific improvement programs and recovery of degraded habitats, with biostatistical projections.
   - Establishing a conservation plan and rational taking advantage of the Yrenda aquiferous.
   - Promotion of the formation of action committees at the local level.
   - Formation of strategic alliances with organizations within and outside of the zone.

- Promotion of coordination between the private sector and military sector for conservation of important sites.
- Delimitation of a forest-pastoral management program with low impact in certain specific zones.
- Establishing a concrete scientific research program regarding objects of conservation and other themes of interest.

DISCUSSION

It is important to consider the fact that the areas chosen in this project are not more than one per ecoregion. This is because of practical reasons, especially due to the complexity that the study of every zone means, and then formulation of proposals of conservation and management alternatives. Out of many important sites presented in the study of each ecoregion, the ones selected were those that showed the best possibilities for real conservation. In this sense, the conservation opportunity factor played a significant role at the moment of choosing the site within the whole ecoregion.

The sites selected in this study represent those that were identified as such within the framework of this project. For this reason, we advise other national, local and international organizations to use the information produced in this project to choose other important sites, in accordance with the criteria of each institution. One of the important products of this project was that of offering the conservationist community solid scientific data, both for identifying priority areas, as well as for developing practical actions for conservation within the same.

Moreover, thanks to the information produced, cartographic parameters have been redefined in accordance with the preceding studies. Such is the case of adjustments made in the ecoregional limits proposed by Dinerstein et al. regarding the ecoregions studied here. The Dinerstein study was made on a scale of 1:1,000,000, while the actual project was based on a study of 1:500,000, which in cartography means four times more of preciseness. In the same way, data bases were updated referring to the entire group of: mammals, birds, amphibians, and all species of two plant families per ecoregion.

Due to the use of recent satellite images, analysis of the status of forests and natural vegetation is quite updated, providing a more exact vision of fragmentation processes and general threats, such as the advancement of conversion of natural areas into pasture, agricultural zones or another type of soil use. Studies have been made of the (large) remains of natural vegetation from these parameters in order to evaluate their edge effect, etc.

During the project, important centers of biodiversity and endemism have been identified, which have not been taken into account previously. Also, the significance of other sites known to be biologically important was confirmed. As well, areas in which more sensitive species exist (vulnerable to habitat change), plus specialist species (dependent on only one type of habitat), and species with some classification within the table of the UICN threatened species, were analyzed.

Another of the project intentions was that of strengthening local executing organizations regarding its institutional and technical capacities. Thanks to the direct training processes, all the technicians of these institutions were trained in: conservation biology, SIG, remote sensors, etc. As well, some technicians from other institutions were trained, including governmental and local institutions. Moreover, this has been a project with a frankly participative style. During its development, contact was made with more than a hundred organizations of all kinds (governmental, private, national, local, international), which has been very enriching in terms of technical and political objectivity (conservation opportunities).

We intend that this project be one in which all data produced be absolutely precise, among other reasons, due to the volume of information already produced, since more than 6,470 species (especially their distribution) have been analyzed, and more than 6,500 thematic maps have been made in the 5 ecoregions. We invite all specialists in biology, ecology, conservation biology, geography, cartography, etc. to provide us with any corrections and comments.

GRATITUDE

In this project, some 100 people participated (more or less directly) plus a large number of institutions. It would not be very practical to name each person and institution, but we would like to thank especially those organizations which from the beginning provided support, so that the project become a reality. These are 6 executing agencies in each country (see contact information on Annex 2), the GEF, the institution that generated the funds, UNEP, The Nature Conservancy, NatureServe and NASA. Moreover, we wish to express our very special gratitude to governmental and local organizations in each country, without which the project would not have been successful.

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ANNEXES

ANNEX 1: METHODOLOGICAL SUMMARY

A. Main Cartography

1. Base map. Scale: 1:500,000

. Hydrography

. Highways and roads.

. Populated centers.

. Level Curves: every 100 meters.

. Political Limits of third level: (eg. Country, Province, County).

. Quadrille of one degree.

2. Present Vegetation Maps:

They come from the interpretation of satellite images. They identify natural and anthropic vegetation.

3. Vegetation Classification Map (different types of natural vegetation).
4. Protected Areas Map.
   Protected Areas legally recognized by the government of every country.
5. Biological Data Bases and Species Distribution Maps

The Distribution Data Bases come from trustworthy sources (published material or revised registers). The following groups have been considered for every ecoregion: all mammals, all birds, all amphibians; moreover, two plant families have been included per ecoregion. The data bases contain the following fields in each ecoregion:

a. Order
b. Family
c. Genus or Species
d. Country
e. Department or Province
f. Locality
g. Altitude (m. above sea level)
h. Longitude and Latitude (minimum degrees and minutes) and/or Plane Coordinates
i. Habitat or other ecological information
j. Report or collection date
k. One Responsible for observation or collection
l. Bibliographical source
m. Collection reference (Museum and catalogue number)

This information is for elaborating SPECIES DISTRIBUTION MAPS. The distribution map of a species is based on a polygon in which the external limits of the occurrence area are determined, based on altitude ranges and/or on other geographic limits such as rivers, mountain chains, etc.
A second base, the Species Data Base, incorporates information regarding each of the species under consideration, and contains the following fields:

a. Order
b. Family

c. Genus and Species

d. Number of registrations accounted for in the Data Base

e. Endemism, where: 0= wide distribution species
1= entirely or partially in the ecoregion study plus another ecoregion
2= only in the ecoregion study

f. Conservation status, based on the UICN categories, where:

CR (critical danger) = 3
EN (endangered) = 2
VU (vulnerable) = 1
Other categories = 0

g. Sensitivity, where the species is: Very sensitive to habitat destruction = 2
Moderately sensitive = 1
Little or no sensitivity = 0

B. Creation of Alfanumerical and Cartographic Information

1. Biological Criteria

1.1- Diversity and Maps

As the analysis is the Raster type, using pixels with the tentative size of one kilometer, the number of species is emphasized that is potentially found in each square kilometer. The distribution maps of all species can be visualized simultaneously. Wherever many polygons converge, these will obtain greater values in diversity.

1.2- Endemism and Endemism Maps

Two fundamental aspects are considered:

- the range of global distribution (RDG) of the species, where it is valued in the Species Data Base and,
- the size of the distribution area (TAD) of the species in the ecoregion under study.

The species that are only found in an ecoregion have a greater value of endemism. The smaller the distribution area of the species, the greater the endemism value of that species. Therefore, our valuation is: (RDG x TAD).

The values obtained are assigned to each polygon (distribution area of the species).

The convergence areas of many polygons obtain high endemism values.

1.3- Endangered Species and Maps

Each of the polygons corresponding to distribution area of every species is valued based on the threat category: wherever species in critical danger (CR) have three points, endangered species (EN) two points, vulnerable species (VU) one point, and the other categories receive zero points.

The values obtained from this categorization are assigned to every polygon (distribution area of the species). The convergence areas of many polygons obtain high threat values.

1.4- Sensitivity (vulnerability of a species facing habitat disturbances) and

Maps

As in the previous case, each species is valued from 0 to 2, and the sum of the values of all species of the group is considered for each pixel. The pixels with greater values take on a characterization of 5 points, and subsequently until one point.

1.5- Specialist Species and Maps

Specialist species are those that reside in a certain type of habitat, and are important because the loss of their habitat has a direct impact on their survival.
In order to determine which and how many habitat specialist species there are, it is necessary first to work on a cartographic model that represents the different habitats. The following information should be contained in the Habitat Map:

- Vegetal Classification Map
- Geomorphology and Slopes Map
- Soils Map

Afterwards, the distribution maps of distinct species will be placed and the number of species will be counted that live in each of the habitats. The specialist species will be present in only one habitat, and the generalists in various habitats. The first will be assigned a high value (3), and the last a value of zero.

The polygons analyzed represent different habitats. Each habitat, added together, will have greater values in relation to the number of specialist species it has.

1.6- Biological Criteria Valuation

Each of the criteria explained previously under this point is qualified (diversity, endemism, endangered species, sensitivity and specialist species). A fixed weight is designated for each criteria:

$$(a \cdot x)+(b \cdot x)+(c \cdot x)+(d \cdot x)+(e \cdot x)$$

The result of the added up total of the weighted Biological Criteria corresponds to the first result of the analysis: BIOLOGICAL CRITERIA.

2. Landscape Criteria

2.1- Remnants Map

Remnants means the amount of natural vegetation of any kind existing at present, in relation with the original total. The cartograph must contain the following in order to obtain the Map:

- Vegetal Classification Map
- Vegetation Map (produced by the interpretation of satellite images)

In order to appraise this criteria, it is assumed that those kinds of vegetation that have lost a high percentage of coverage obtain high values (up to 5).

2.2- Fragmentation Map

To conserve the vegetation remnants, there are some parameters to be evaluated: it is better to conserve large areas than small ones, it is better to conserve areas with regular edges than areas with irregular edges, it is better to conserve areas with a wide appearance than those with a thin appearance, etc.
Using the Present Vegetation cartography (remnant vegetation), each one of the fragments has been analyzed and appraised based on its form.

2.3- Habitat Diversity

This analysis tries to evaluate those places where various different kinds of habitats converge, since in those places where numerous units of landscape can be found, a high diversity usually exists.

For this process, it is necessary to cross the basic cartography produced in the Habitats Map with the Present Vegetation Map (remnants). The forest fragments, or polygons of vegetation remnants, that represent different types of habitats, are analyzed afterwards by means of a Raster model of the Kernell type, which calculates the presence and closeness of distinct types of habitat, for each pixel. The pixels of a certain habitat type that are close to other different habitats will obtain high values.

2.4- Edge Effect due to Human Pressure

The zones with edges of natural vegetation patches are more affected than the internal ones. The areas that are morphologically irregular show more perimeter than the regular ones, so, regardless of having the same surface extension than a regular patch, the portion of intact vegetation is evidently less.
The total perimetral area of all the polygons with the same type of vegetation will indicate (approximately) how much pressure exists on it.

2.5- Landscape Criteria Appraisal

In this point, each of the criteria previously explained is qualified (Remnants, Fragmentation, Habitat Diversity and Edge Effect). The most important criteria are defined and weights are assigned to them:

$$(a \cdot x)+(b \cdot x)+(c \cdot x)+(d \cdot x)$$

The result of the sum total of the Landscape Criteria corresponds to the second result of the analysis: LANDSCAPE CRITERIA

3. Conservation Political Criteria. Representation of Vegetation Types and Protected Area Maps

The Criteria Representation refers to the amount of each type of vegetation protected by a SNAP. In some cases, it could be that a certain kind of vegetation is represented extensively, whereas another is underrepresented. For UICN in 1992, protection of at least 10% of each of the different habitats making up the natural landscape of a country or region is adequate.

A SNAP cartography of every country is required for this analysis, crossed with the Present Vegetation Remnants Map. The so-called “parks on paper” will be considered as unprotected. The underrepresented types of vegetation will obtain high values.

C. Final Appraisal and Prioritization (Selection) of Sites

This consists of giving weight (weighting) to Biological, Landscape and Political Criteria (of conservation), and integrating all layers of information to obtain polygons considered as the following:

PRIORITY CONSERVATION AREAS = (BIOLOGICAL CRITERIA ·X) + (LANDSCAPE CRITERIA ·X) + (POLITICAL CRITERIA ·X)
Flowchart Model Phase 1: Graph 1.
Cartographic Examples: Graph 2 from now on.

D. Phase 2: Case Studies and Management Alternatives

Guidelines:

- Base Map (1:100,000 or 1:50,000)
- Vegetation Map
- Field Verification
- Various Meetings with Local Communities
- Objects of Conservation and Maps
- Threats, its Sources and Maps
- Zoning Map for Management
- Identification of the Best Management Alternatives (final result)

1. ANALYSIS OF AREAS SELECTED

This analysis specifies (deepens) and definitely shows the value of each area selected, based on biological, ecological, landscape and environmental services criteria. Moreover, these criteria should be reinforced with an analysis of the main threats that influence these areas.

1.1 *Biological Objects (or objectives) of Conservation*.

One or some of the following characteristics:

- Biodiversity
- Endemism
- Presence of endangered species, threatened, etc.
- Presence of emblematic species
- Presence of useful species
- Presence of important species for science
- Other characteristics

An area generally presents various biological objects of conservation. The distribution of these objects (habitats, species or groups of species) can include the whole area or be located in certain zones of the same. An area can be characterized by not only by its high diversity, but also includes species in danger of extinction, as well as species that are very representative for the country or the region (emblematic species), etc.

1.2 Ecological Objects of Conservation:

One or various of the following characteristics:

- Diversity of habitats and of ecological systems
- Presence of habitats or representative ecological systems
- Presence of habitats and unique ecological systems

- Presence of fragile habitats (with difficult recovery)
- Presence of endangered habitats
- Other ecological characteristics

An area can present one or various ecological objects of conservation, including habitats representative of other zones of the country or the ecoregion (which is important in itself), as well as unique habitats on the national or continental plane, etc. Every ecological object of conservation should be delimited cartographically (see chapter referring to cartography).

1.3 Environmental Services:

The importance of an area regarding the main environmental services:

- Production and conservation of water
- Conservation of soils and protection against erosion
- Protection of slopes
- Conservation of landscape
- Maintenance of touristic and educational potential
- Stablization of climate
- Barrier against introduced species
- Maintenance of genetic banks
- Other environmental services

1.4 Threats:

The most important threats (and their influence) existing in the selected area. Note: some threats can be represented on maps (this will be in accordance with the criteria of the executors).

Threat examples:

- Agricultural colonization and opening of roads (Consequences: deforestation, fragmentation, loss of biodiversity, erosion, river sedimentation, soil and water pollution, etc.)
- Lumber exploitation (Consequences: similar to the above)
- Mining exploitation (Consequences: water and soil pollution, excessive sedimentation, deforestation, biological loss, etc.)
- Construction of hydroelectric infrastructure, dams, etc. (Consequences: disappearance of valleys, change of river volume, colonization, etc.)

2. CARTOGRAPHIC REPRESENTATION AND ZONING

2.1 *Base Cartography*

- **Field visit** to confirm the limits and important **geographical elements** of the area of study. Field verification regarding the **classes of vegetation** (see chapter on vegetation formations) and other criteria for cartography, such as threats, environmental services, etc. Moreover, the field visit is essential for **political, social and economic analysis** of the area selected.

- **Elaboration of the base map** (Scale 1/50,000 or 1/100,000, or another scale, according to available cartography).

2.2 *Thematic Cartography (Objects of Conservation)*

Distribution of Biological Objects of Conservation

In order to make maps of Biological Objects of Conservation, the species distribution is represented (distribution polygons), on a scale of 1/500,000 or 1/100,000 (or another scale, according to available cartography), depending on the areas selected and their physiographic characteristics.

Representation of Vegetal Formations (vegetation)

A map (scale of 1/50,000 or 1/100,000, or another scale, according to available cartography) representing vegetal formations of the area and if the case deserves it, the main habitats or ecological systems (it is understood that within the framework of this Project, an ecological system is a set of similar habitats – generally, an ecological system is larger than a habitat and smaller than an ecoregion; also, an ecoregion constitutes a set of similar ecological systems. The habitat is a landscape unit that represents a biogeographic physiological and well-defined vegetation type).
For this reason, it is necessary to make an analysis of the satellite image or other sensors (radar images, air photography, panachromatic, color, infrared, etc.) corresponding to the area of study. Moreover, during the field visit, recognition is done of the main units of vegetation and of their general location (the precise location is obtained by crossing field visit information with analysis of the sensor used).

Representation of Threats

In some specific cases, it is possible to produce cartography of environmental threats in a determined area.

2.3 Area Zoning

The zoning map is the essential element with which different alternatives for area conservation and management are made. This map is the product of the cross of the information layers indicated previously (Biological Objects of Conservation x Vegetation x Threats).
Scale: 1/50,000 or 1/100,000, or another scale, according to available cartography.

3. ANALYSIS FOR DEFINING MANAGEMENT ALTERNATIVES

3.1 *Legal Study of the National System of Protected Areas and their categories in each country*

Analysis of the different categories of the National System of Protected Areas, recognized by the laws of every country.
Within these categories are included those of a national (National Parks, Biosphere Reserves, etc.) and private nature (Protective Forests, Private Reserves, Biological Stations, etc.). In some cases, the constitution accepts a mixed management (national-private).

3.2 *Analysis of the political situation in each country regarding area conservation*

The study of political trends (not only those on the legal plane) facing conservation in every country, is basic. The details are analyzed, through meetings, in the different ministries (Environment, Agriculture, Industries, Petroleum, etc.), other government instances, NGOs, grassroots organizations, communities and other social actors.

3.3 *Analysis of the social and economic situation regarding conservation in each of the zones (by means of workshops)*

There are social and economic factors that are essential for achieving success or failure in area conservation. These factors should be analyzed carefully; among others, it is possible to mention the level of acceptance of the local population facing conservation activities and biodiversity management of the areas involved.
Moreover, the real possibilities are considered regarding any kind of management in the zone, such as, for example, from the economic and social viewpoint.

3.4 Proposals of management alternatives based on zoning (biogeographic aspects) and on the political-social characteristics of each selected area

A definition of the management alternatives after integration of the parameters mentioned previously. This exists thanks to participative processes, including the authorities and other important actors for beginning concrete conservation actions.
National and local authorities, local community and grassroots representatives, national and international NGOs involved in the zone (or in the management theme of protected areas) and other actors that, in one or another way, have something to do in the selected area.

4. DESCRIPTION AND PRESENTATION

OF MANAGEMENT ALTERNATIVES

The alternatives are described under various important parameters, such as for example:

- Real probabilities of implementation (national and local acceptance; real preparation and potential of those who will execute and administer area conservation activities; area size regarding potential human and financial resources; accessibility; potentiality of self-financing and for generating resources – national and international tourism scientific research, certain species use, etc.-; probabilities of generating projects, etc.).

- Short and medium term objectives (conservation of ecological and environmental services systems – water, soils, vegetation, genetic banks, etc.-; protection of species; endangered, endemic, emblematic, for human use, etc.-; environmental education; scientific research; recreation and tourism, etc.). Proposal for area administration, considering the local and national laws.

- Potential national and international financing, and probabilities of self-financing.

- Development stages (Management Plan; obtaining national and local political support; making the administrative system work; development of basic infrastructure; personnel training; stage of search and obtaining of funds, etc.).

- Development and monitoring of long term activities.

ANNEX 2: EXECUTING AGENCIES, CONTACT INFORMATION

Bolivia

TRÓPICO
Asociación Boliviana para la Conservación
Patricia Ergueta S.
Executive Director
Tel.: 591-2-242 34 95
E-mail: tropico@acelerate.com

Colombia

CORPORACIÓN AUTÓNOMA REGIONAL
VALLE DEL CAUDA, CVC-COLOMBIA
Vida Silvestre y Áreas Protegidas
Eduardo Velasco Abad
Tel: 57-2-3310100
E-mail: velascoae@cvc.gov.co

Ecuador

ALIANZA JATUN SACHA / CDC ECUADOR
Dr. Michael McColm
Executive Director
Tel: 593-2-2453583

E-mail: mccolm@jatunsacha.org

Panamá

ANCON
Asociación Nacional para la Conservación
Departamento de Ciencias
Ernesto Ponce
Tel: 507-3140060
E-mail: ciencias@ancon.org

Paraguay

SECRETARÍA NACIONAL DEL AMBIENTE
Centro de Datos para la Conservación, CDC-Paraguay
Nélida Rivarola
Tel: 595-21-615812

E-mail: nelidarivarola@hotmail.com

Perú

UNIVERSIDAD NACIONAL AGRARIA
LA MOLINA
Centro de Datos para la Conservación, CDC-Perú
Ing. Pedro Vásquez
Tel: 511-3496102
E-mail: cdc@lamolina.edu.pe