Catalyzing Effective Land-Use Planning in Southern Peru

Final Report to the Blue Moon Fund

By NatureServe

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Background

Southeastern Peru harbors some of the greatest reservoirs of biodiversity that remain on Earth. By almost any metric—species counts, endemism, plant diversity, animal diversity, ecosystem diversity—the eastern Andean slopes and adjacent Amazonian lowlands support unsurpassed biological richness. Until recently, the steep terrain and inaccessible lowlands, located far from human population centers, served as effective physical barriers to large-scale habitat alteration. Today, vast forestry, mining, and petroleum concessions, a nearly complete highway crossing the region to link the soybean fields of interior Brazil with Peruvian ports, and a proposed massive hydroelectric project threaten the ecological integrity of the region.

With the construction of the Interoceanic Highway, Madre de Dios has suddenly seen its economic potential multiply but at the same time become plagued by illegal, unregulated gold mining and logging. A newly proposed dam would flood a large area on the border with Cusco. Confusing and conflicting policies, including concessions for resource extraction and unclear land tenure laws, compound the problem.

Concurrently, the Peruvian government has granted departmental governments primary authority to enforce environmental regulation and mandated them to carry out land-use planning ("*Ordenamiento Territorial*"). *Ordenamiento Territorial* is a participatory political process in which stakeholders, including the government, colonist groups, indigenous peoples, and business interests, reach decisions about how land can be used and who can settle it where. Typically the process begins after the completion of a technical study ("*Zonificación Ecológica Económica*" or ZEE) that maps the economic and environment potential of the land using physical and socio-economic parameters. Typically, though, departmental governments do not have technical staff with sufficient training to gather baseline data, carry out spatial analyses, and lead stakeholder discussions for such large and remote areas.

The Interoceanic Highway crosses the Andes in the Department of Cusco, bringing with it the same benefits and perils as in Madre de Dios. The steep slopes of the Andes here are chock full of endemic plants and animals that are restricted to miniscule elevational ranges. The project focused on just one of the 13 provinces in Cusco, Quispicanchi, which is where the Highway is routed. The ZEE for Quispicanchi had already been completed, so this information was available for input into Vista scenario evaluation.

In this natural and social context, NatureServe worked with partners and government agencies in the departments of Cusco and Madre de Dios to build local capacity for the use of modern land-use planning tools to allow simultaneous assessment of social, economic, and biodiversity values. Much of the biodiversity information used as input had been developed during previous projects. However, to confirm predictions from modeled distributions of endemic plant and bird species, partners conducted on-the-ground field surveys. This effort also provided fine scale delimitation of the highest priority areas for protection.

Field Surveys

NatureServe worked with the Cusco-based non-profit Ecosistemas Andinos (ECOAN) to carry out the field work related to validating previously created predictions of the distributions of birds and plants that are endemic to the eastern slope of the Andes in Peru and Bolivia. ECOAN fielded a four-person team made up of staff, university students, and a crack local bird guide to carry out three two-week field trips to survey for target bird species in habitats adjacent to the path of Section II of the Interoceanic Highway. The team was augmented by local villagers hired to help locate accessible study sites and carry equipment.

From April – June 2008, the team spent 45 days in the field surveying 11 sites ranging from 250 – 4,750 meters elevation on the east slope of the Andes. The team searched for 40 target endemic birds that were predicted to occur in at least one of the sites. They walked trails, used playbacks of recorded songs, and set mist-nets to record species at each site.

Norma Salinas, a professor of botany at the Universidad Nacional San Antonio Abad de Cusco (UNSAAC) and Ph.D. candidate at Oxford University, led the botany field work. She and several UNSAAC students made three two-week trips to the field, with one additional follow-up trip to collect supplementary material. Their work focused on the same elevational transect along the Interoceanic Highway and during the same time period as the bird surveys. Similar to the bird surveys, the botanists targeted endemic species with previously modeled distributions. In total, they searched for 79 focal species representing 14 taxonomic families.

Findings

The ornithologists recorded 33 of the species predicted to occur, and 588 species altogether. Of the species not observed, several are difficult to detect due to their secretive habits and lack of vocal activity during the season of the surveys. Two species are rare, lowland taxa with specific microhabitat affinities that were not represented in the sites surveyed. In addition, the team discovered four Peruvian endemic species (Green-and-white Hummingbird, Masked Fruiteater, Inca Flycatcher, and Peruvian Black-capped Hemispingus) that were previously unknown to occur anywhere near the project area.

The modeled distributions made specific predictions about the occurrence of species at the 11 field sites. Because the distributions were modeled using data from localities up to more than a thousand kilometers apart, we expected the predictions to have some degree of error when examined at the small scale of the study area. Overall, the models made 374 predictions about whether the focal species would occur at the different field sites. The results showed that when the models predicted absence at a site, the species was indeed absent 94% of the time. For predictions of occurrence at sites, the species was in fact observed in 46% of the instances. This fraction increases when considering cases in which a species was not observed precisely at the sampling site but observed close by (within 2-4 kilometers) or when eliminated difficult to detect species.

What factors caused some models to generate more accurate predictions than other? We examined eight natural history, range, and modeling factors that plausibly could explain differences. Statistical analysis showed that only diet influenced modeling success. Models of insectivorous and nectarivorous birds were more accurate than those for omnivorous or frugivorous species, possibly because the factors influencing insect and nectar availability (such as vegetation complexity) were better represented in the environmental data used to generate the models than for the other diet groups. The number of records from near (within 100 kilometers) of the study area, number of unique localities, size of predicted range, north-south extent of range, age of records, degree of habitat specialty, elevational stratum, and location of study site relative to the range of the species all did not explain significant variation in the prediction success rate of the models.

Modeled distributions for endemic plants predicted 79 species to occur in the study area along the Interoceanic Highway. Before initiating field work, we predicted that the proportion of target plant species detected would be less than the proportion of bird species detected. Plants tend to have more localized distributions, requiring more area to be covered in surveys before sampling the majority of the diversity in a particular site. Also, plants are typically identifiable only when flowering or fruiting, an activity that often lasts less of each year than the period when birds are singing. Different plant species reproduce at different times of the year, in contrast to birds which have more synchronous reproductive periods. Additionally, the distance over which a singing bird is detectable by an observer is much greater than the distance at which a flowering or fruiting plant is visible.

At the conclusion of her surveys, Salinas and her colleagues had found 27 of the target species (34%). These species represent four principal families, the Acanthaceae (acanthus family), Cyathaceae (tree ferns), Ericaceae (heaths), and Onagraceae (fuchsias). The botanists found the greatest numbers of species between 2,000 and 3,000 meters elevation, highlighting the importance of mid to high elevation sites for endemic plant species. Because of the high probability of failing to detect species that actually occur in a site (for the reasons stated above), we did not analyze the findings as rigorously as for the birds. Nonetheless, the field survey for plants proved valuable to back up the bird data and emphasize the biodiversity value of the region for more than one group of organisms.

Support of Land Use Planning

Overall approach

After initial meetings with representatives of the Regional Governments of Cusco and Madre de Dios, to introduce the project and develop institutional cooperation agreements, we conducted introductory meetings in Lima and Cusco to bring together all partners and technical staff to define the study areas (Figure 1), the elements of interest for conservation, the data needs, and the different analyses that we were going to perform. This helped set the parameters for the in depth training workshops in NatureServe Vista, a commercial-grade GIS tool to support land use decisions and explore development scenarios.

During the development of the project both in Cusco and in Madre de Dios, we used the training workshops (four of them in total) to build the Vista project database with actual data from the regions and conducted the training and all the analyses using those datasets.

Partners and number of trainees

Partners of the Project included Instituto de Investigaciones de la Amazonia Peruana (IIAP), Conservation Strategy Fund (CSF), Instituto del Medio Ambiente y el Agua de Cusco (IMA), and the Gerencia de Recursos Naturales del Gobierno Regional de Madre de Dios (MdD), all of them assigned staff for all the training sessions: 3 from IIAP, 1 from CSF, 3 from IMA and 1 from MdD.

The last training workshop was conducted in Puerto Maldonado and for this occasion, in addition to the wrapping up of the project for MdD, we implemented a shorter version of the Vista training in order to cover in an introductory fashion all the functions of the tool. This workshop lasted one day and a half and had the participation of 15 – 20 people from the MdD regional government programs, the conservation NGOs working locally, and the university.

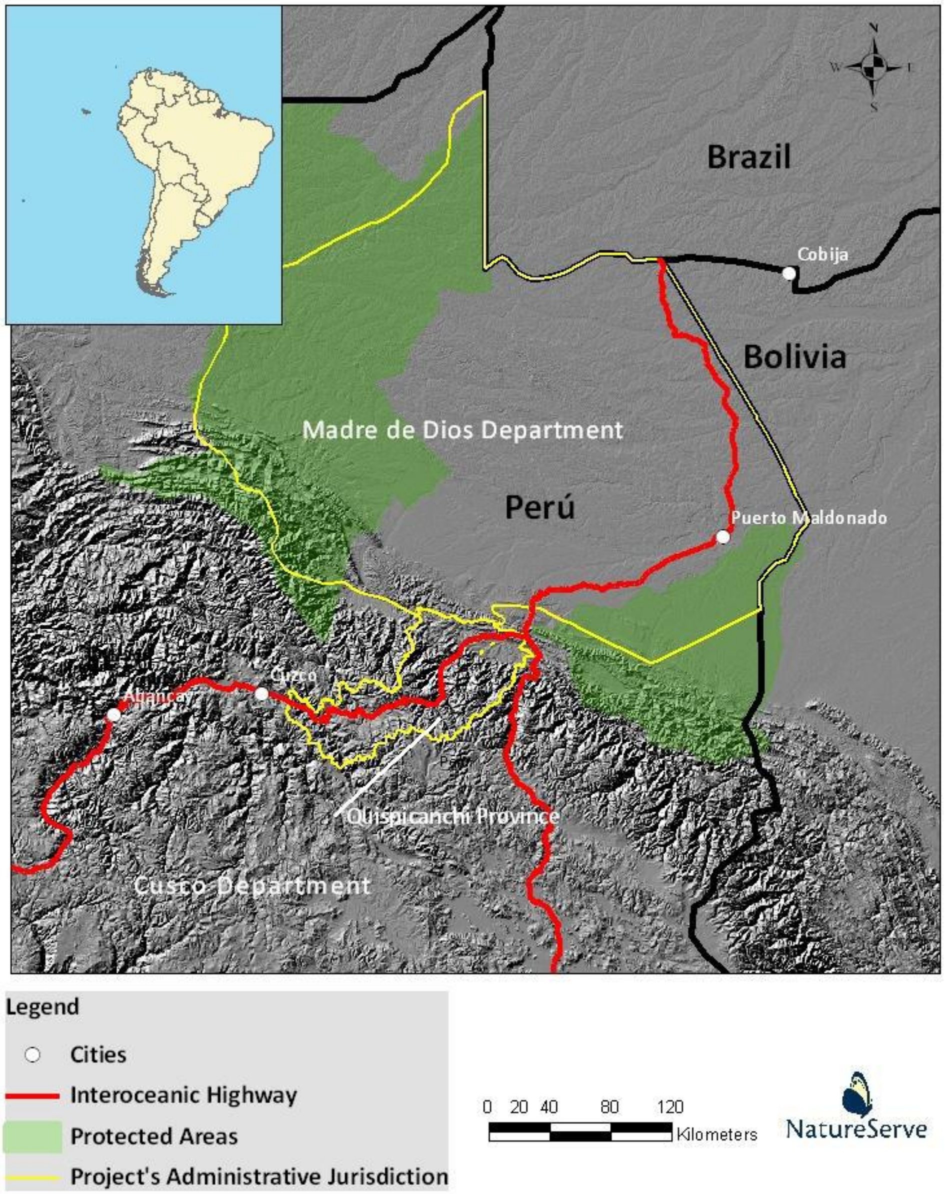
Political and institutional environment during project implementation

In Cusco we worked with IMA which is a regional government technical office that at the time of the start of the project was the only one with the technical capacity to receive the training and provide data. Additionally, it was the agency that had produced the ZEE for Quispicanchi province, a key input to develop the Vista scenarios. Unfortunately, subsequent leadership changes have resulted in this office falling out of favor with the Cusco department's influential environmental agency (Gerencia de Recursos Naturales).

In the case of Madre de Dios, when the project began, besides the presence of IIAP conducting the ZEE for the region, there was no local technical capacity for GIS and planning, thus we focused our attention in training IIAP staff. Later in the process, is that the regional office in charge of natural resources and planning and the local conservation NGOs started hiring technical staff.

These facts limited somewhat the impact of the project, in the sense that it was difficult to build a strong relationship with the regional governments to ensure a greater commitment in the application of the results.

Figure 1. Project area: Madre de Dios and Quispicanchi, Cusco



Application of NatureServe Vista

As shown in the map, we developed two Vista projects, one in the Quispicanchi province of Cusco and another one for the entire territory of Madre de Dios.

Madre de Dios Region

Conservation Elements spatial database

The elements of interest for the Vista analyses were set with the partners. In total 142 elements were selected: 39 endemic plant species, 36 endemic bird species, 20 endemic amphibian species, 10 mammals, including endemics and emblematic red listed ones, 23 ecosystem types and 14 elements of cultural and economic interest. For all these elements we used spatial distribution data, in the majority of species elements we used modeled predictive distribution maps and locality points for a few. In Vista, one can assign weights to the elements based on their conservation status (IUCN red lists or CITES) Appendix 1 has a list of the elements of interest with the assigned weights.

Regarding the elements of cultural and economic interest, the representative shapefiles were supplied by either the government of Madre de Dios, or its partners at IIAP. Two types of data were used to represent these factors. The first group of elements represents a more traditional land use description such as aquaculture (fish) or forest extraction products. A total of 8 elements represent these land uses. The second category of elements were based upon economic factors modeled and supplied by the project partner Conservation Strategy Fund and address potential agricultural, forestry and cattle raising production value (Table 1). The production layers supplied were utilized to attribute the results of the zone land use map (ZEE) for maximum cost per hectare to be used with the program Marxan.

Table 1 . Conservation Elements of cultural and economic interest.

Economic & Cultural elements:		
	areas de proteccion por pendiente y suelo	
	areas para proteccion por pendiente y suelo asociado con areas de produccion forestal	
	pesca comercial	
	pesca de subsistencia	
	zonas para produccion agropecuaria	
	bosques de produccion castanera	
	Bosques de produccion forestal	
	Cuerpos de Agua	
	Rentabilidad Carne -area	Modeled economic opportunity - beef
	Rentabilidad Maiz -area	Modeled economic opportunity - corn
	Rentabilidad Uso forestal -area	Modeled economic opportunity - logging
	Rentabilidad Castaña -area	Modeled economic opportunity - Brazil Nut
	Rentabilidad Soya -area	Modeled economic opportunity - Soy

The next step in Vista is to assign conservation goals for the elements of interest, and then decide which land use scenarios are going to be evaluated. After assigning for each element the conservation goal and the compatibility with the land uses of the scenarios to evaluate, Vista will perform a scenario evaluation whose outcome will inform for each element whether the goal was achieved and if not, what was the gap. The evaluation output generates both, maps and tabular reports and both formats provide detailed information, spatial and tabular, of what and where the gaps are.

In Madre de Dios we evaluated six different scenarios based on different land uses and on different conservation goals levels. The land uses evaluated were the current land use and the land use resulting from the ZEE, regarding goal levels, we used three levels (30%, 15% and 5%). The primary land use applied in the Vista analyses, and for which the majority of the scenarios/evaluations are performed, was based upon the Zonificacion Ecologica Economica (ZEE) (Figure 2). This land use depiction contains 38 land use categories describing parks, reserves, mining areas and sustainable harvest and cultivation areas. Vista requires that standardized land use definitions exist prior to any scenario development.   To facilitate this process the Vista program includes a standardized land use list based upon the IUCN land use categories and requires the user to translate the land use applied in the analysis to the predefined list. Vista supplies a user friendly tool to facilitate this translation (NatureServe Vista -> Lists -> Translator Lists) and was applied to each of the land use layers used in the analyses.

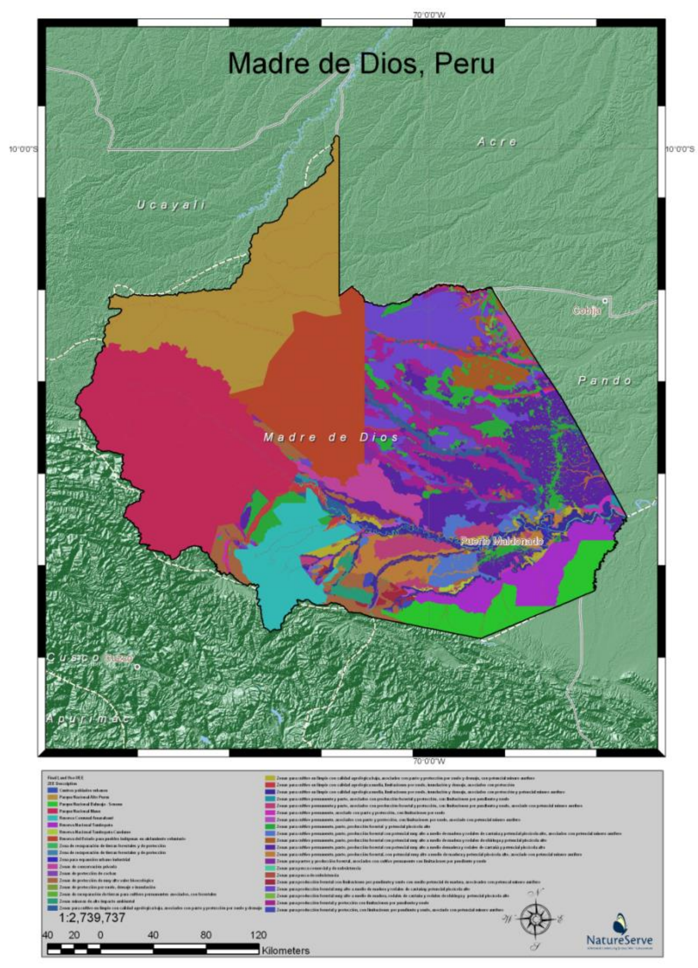


Figure 2. Zonificacion Ecologica Economica land use layer.

As an intermediate step in Vista, one can generate conservation value summaries (CVS), which are maps representing the overlap of conservation elements. Based on the distribution maps and the weights assigned, the map will show the places with highest richness of elements and/or presence of threatened ones. This representation of richness can be further modified by the use of another feature of Vista which is the landscape condition model.

This function allows to create a continuous surface of condition based on the categorization of land uses, and especially infrastructure features in the landscape (roads, dams, mines, etc), in terms of the intensity of the impact they generate both in site and as a function of distance. Thus, each species or element distribution map can be "filtered" or modified by the landscape condition, showing as a result the distribution of the element with varying levels of landscape condition. Once all such elements maps are overlaid to generate the CVS, this output will not only represent varying levels of richness across the area, but also the condition, which can be used as an approach to a viability criterion (Figure 3).

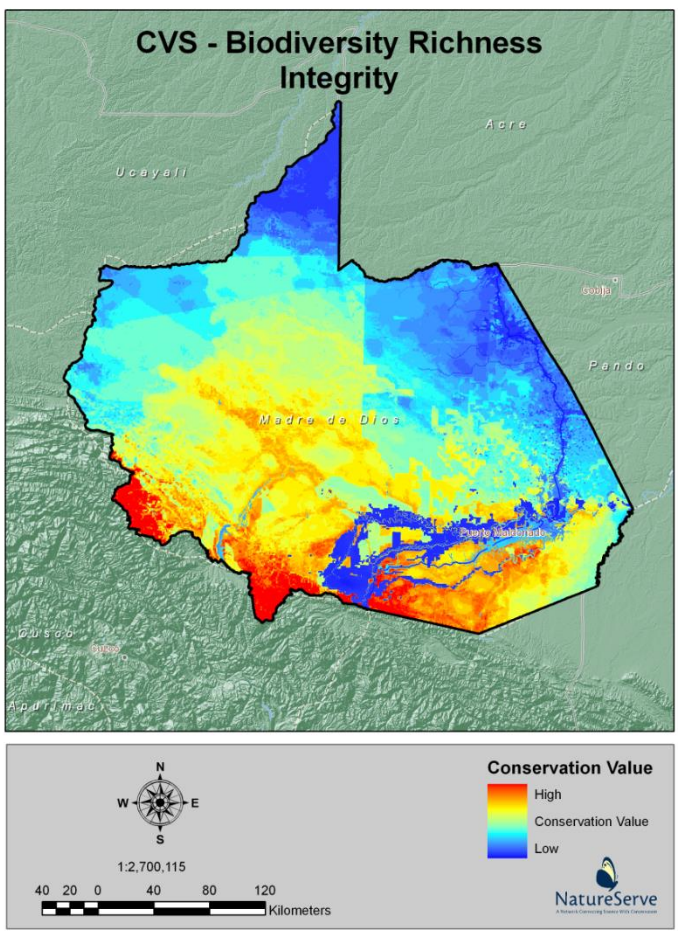


Figure 3. Biodiversity richness x viability/integrity.

Each of these analyses and all the spatial data inputs used to produce them, are stored as part of the Vista project for Madre de Dios. Digital copies of the project with all its data sets together with the NatureServe Vista program and license, and a project guidelines and results report (in Spanish), were delivered to at least: IIAP, the Gerencia de Recursos Naturales del Gobierno Regional de Madre de Dios, ACCA-Peru and Conservation Strategy Fund.

Results

The primary project evaluations were defined with the application of the Zoning land use model (ZEE). The three separate goals sets, defined previously, were used to examine the conflict pattern. Additionally, the results of the Marxan portfolio results were integrated at each goal level to represent how the protection of the element results would vary if the Marxan conservation portfolio represented the optimized land use (utilized as the Policy layer in the analysis). In each portfolio an additional 54 natural cover land use polygons were locked into the scenario evaluation based upon the intersection with the results of NatureServes previous analysis using CircuitScape to predict corridor movement for the Jaguar.

The most comprehensive portfolio was represented in the analysis by the portfolio in which all parks, Jaguar corridor sites, and the Reserva Nacional Tambopata were locked into the final portfolio (Table 2). A total of 55,012 Km^2 (64.6%) of the total study area were represented in the final portfolio (Figure 4). The Parks and Reserva Nacional Tambopata accounted for 33,789 Km^2 (39.73%) of the study area. In addition to the locked in Parks a total of 21,223 Km^2 were required to be added to the portfolio to meet the Low Risk goals. Since the portfolio was generated for the low risk goal of all conservation elements including biodiversity elements and elements of cultural/economic interest, part of the additional 21,223 Km^2 was required for accomplishing the goals for elements of cultural/economic interest.

Table 2. Marxan Portfolio results.

Risk/BM (KM2)	Boundary Mod = 0	Boundary Mod = 0.001	Boundary Mod = 0.01	Boundary Mod = 0.001 Locked*	Boundary Mod = 0.001 Parks**
High	26171.4	24251.8	18692.5	24251.8	n/a
Medium	30512.6	32117.6	20531.9	39864.8	n/a
Low	36709.8	44966.8	40454.2	44223.5	55012.4
* Locked = Jaguar Corridor locked in					
**Parks = All Parks, Jagurar Corridor, Reserva Nacional Tambopata					

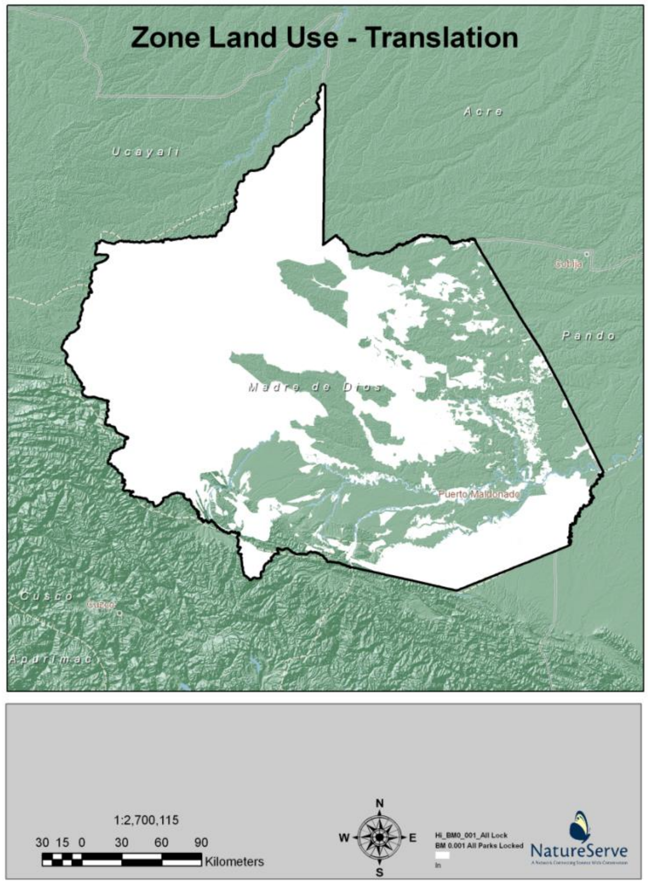


Figure 4. Low risk portfolio results (white areas of map) for all conservation elements (biodiversity and economic) with all parks locked in.

To clarify how much area in addition to existing protected areas, is required to protect only the biodiversity elements targeted in this project at a low risk level and in a cost-effective way, a second Marxan portfolio was run that resulted in the selection of 16,000 Km^2 in addition to the Parks, to meet the goals for biodiversity (Figure 5). The majority of this area overlaps with indigenous areas with null rent potential for agriculture and very low for forestry activities. Minor areas would coincide with forestry and Brazil nut concessions and would need important investments in conservation since they overlap with parcels of high opportunity cost, even with deforestation risk.

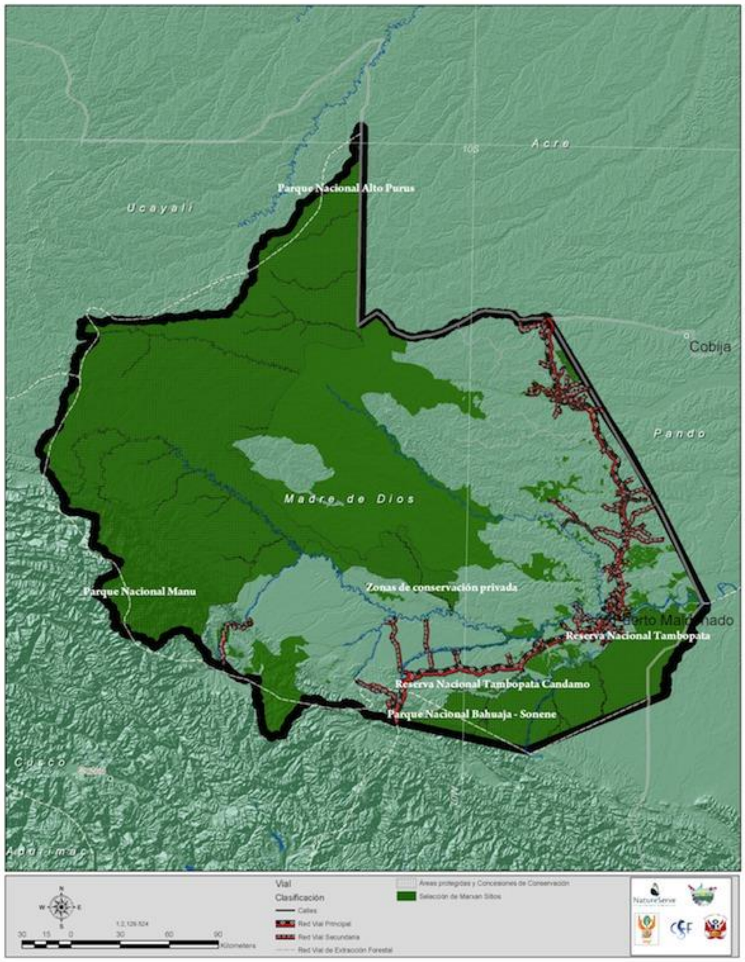


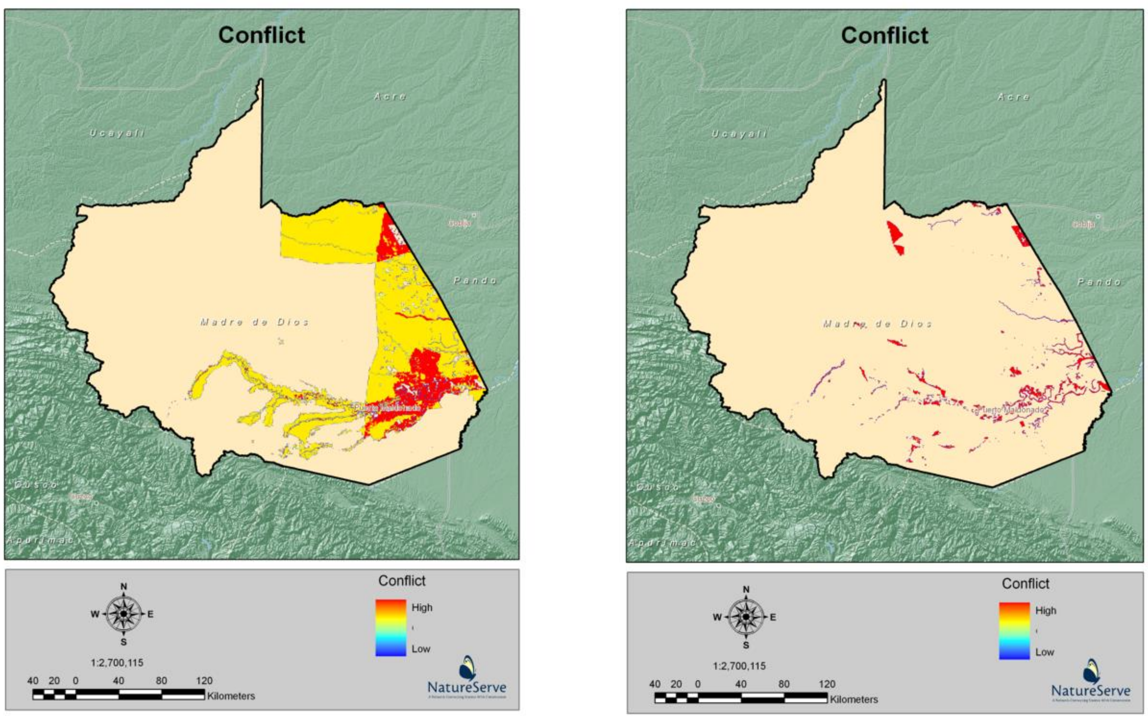
Figure 5. Low risk portfolio results for biodiversity elements with all parks locked in.

To examine the most comprehensive scenario option we defined the Scenario Evaluation based upon the Zonificacion Ecologica Economica representing the land use and the Marxan policy with all parks, Jaguar Corridors, and Reserva Nacional Tambopata describing a reliable land policy. The Scenario properties for describing this relationship was applied with a single combined layer obtained for Madre de Dios where the sites layer used in Marxan was the same boundaries as the Zonificacion Ecologica Economica land use and each polygon was attributed with reliable, or un-reliable policy type, in addition to its land use attributes.

The Biodiversity results for the comprehensive analysis met land use goals for 105 of 128 elements, and met policy goals for 101 of 128 elements (Table 3). The differences in land use and policy results represent the elements whose minimum goals could be met with compatible land use, but cannot meet stewardship goals based upon the current protected area configuration. The difference represents those conflicting land use sites that were included in the optimized portfolio design (Figure 6).

Table 3. Results for the comprehensive scenario evaluation. Protected & Compatible column refers to policy and Compatible column, to land use.

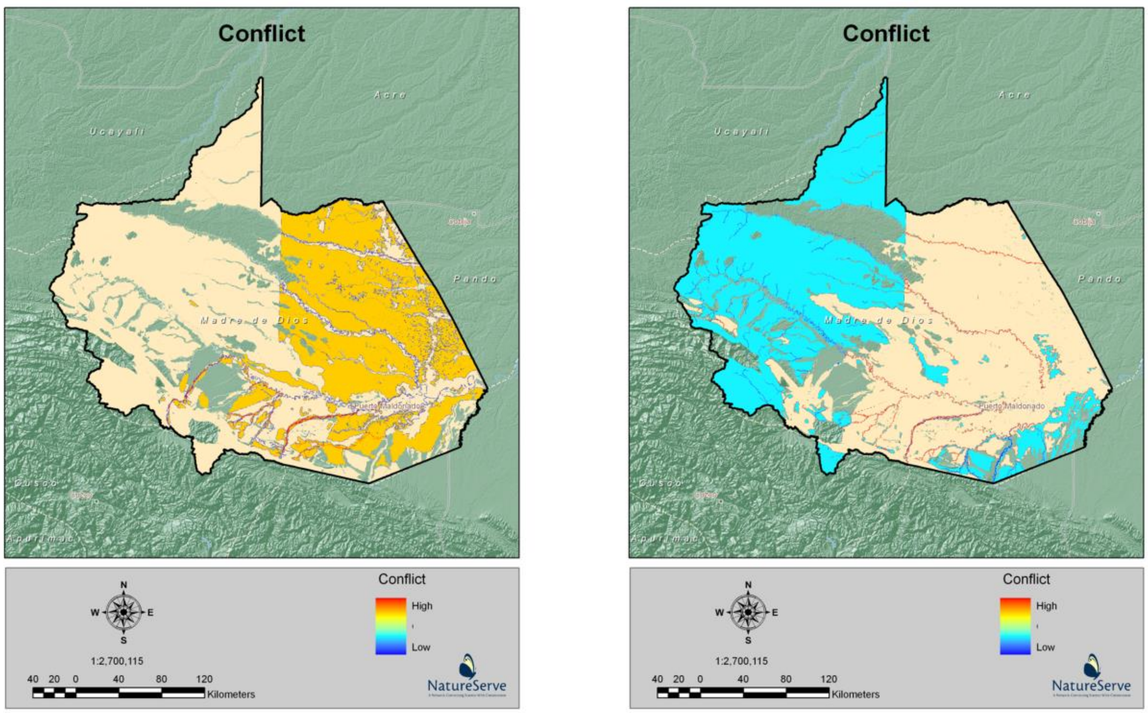
	Biodiv and ZEE Landuse Low Risk with Parks				Cultural and ZEE Landuse Low Risk with Parks			
Name	**Protected & Compatible Met**	**Goal Unmet**	**Compatible - Goal Met**	**Goal Unmet (3)**	**Protected & Compatible Met**	**Goal Unmet**	**Compatible - Goal Met**	**Goal Unmet (7)**
Critically endangered (5 elements)	5 elements (100%)	0 elements (0%)	5 elements (100%)	0 elements (0%)				
Data deficient (44 elements)	26 elements (59.09	18 elements (40.91	27 elements (61.36%)	17 elements (38.64%)	5 elements (62.5%)	3 elements (37.5%)	8 elements (100%)	0 elements (0%)
Endangered (9 elements)	7 elements (77.78%	2 elements (22.22%	8 elements (88.89%)	1elements (11.11%)				
Least Concern (41elements)	48 elements (94.12	3 elements (5.88%)	49 elements (96.08%)	2 elements (3.92%)	0 elements (0%)	1elements (100%)	1elements (100%)	0 elements (0%)
Near threatened (7 elements)	5 elements (71.43%	2 elements (28.57%	6 elements (85.71%)	1elements (14.29%)				
Not evaluated (5 elements)	4 elements (80%)	1elements (20%)	4 elements (80%)	1elements (20%)	4 elements (80%)	1elements (20%)	5 elements (100%)	0 elements (0%)
Vulnerable (7 elements)	6 elements (85.71%	1elements (14.29%)	6 elements (85.71%)	1elements (14.29%)				
Total	78.91%	21.09%	82.03%	17.97%	64.29%	35.71%	100.00%	
Vulnerable or Higher	82.14%	17.86%	89.29%	10.71%				



(a) Land use (b) Land policy

Figure 6. Land use and policy biodiversity conflict representation from the comprehensive scenario evaluation.

Elements defined as having cultural or economic value displayed similar results to the biodiversity (Table 3). In the comprehensive Scenario Evaluation 100% of these elements met land use goals, but 35.7% failed to meet policy goals (Figure 7). The dichotomy of results is the result of the optimization results in which the cost of the Zone parcel may have a higher value (see Conservation Strategy Fund), but the overlapping elements contained in the parcel are sufficient in meeting cost-benefit goals and the parcel is included in the optimized portfolio.



(a) Land use (b) Land policy

Figure 7. Cultural and Economic conflict in the comprehensive scenario evaluation.

Within NatureServe Vista the Site Explorer Tool is an interactive planning utility that allows users to point-and-click on parcels within the project and view the presence and condition of targets.

To demonstrate the functionality of the Site Explorer tool in this project we identified several parcels representing high cultural conflict in the Scenario Evaluation (Figure 8). As seen in the example, the target element Zonas Para Produccion agropecuaria had substantial conflict in protected occurrence (red bar) but had 2,495 Hectares of compatible land use. The user may then choose to modify either the land use or policy types at this time and apply the override. The results will be reflected in the summary section of the tool.

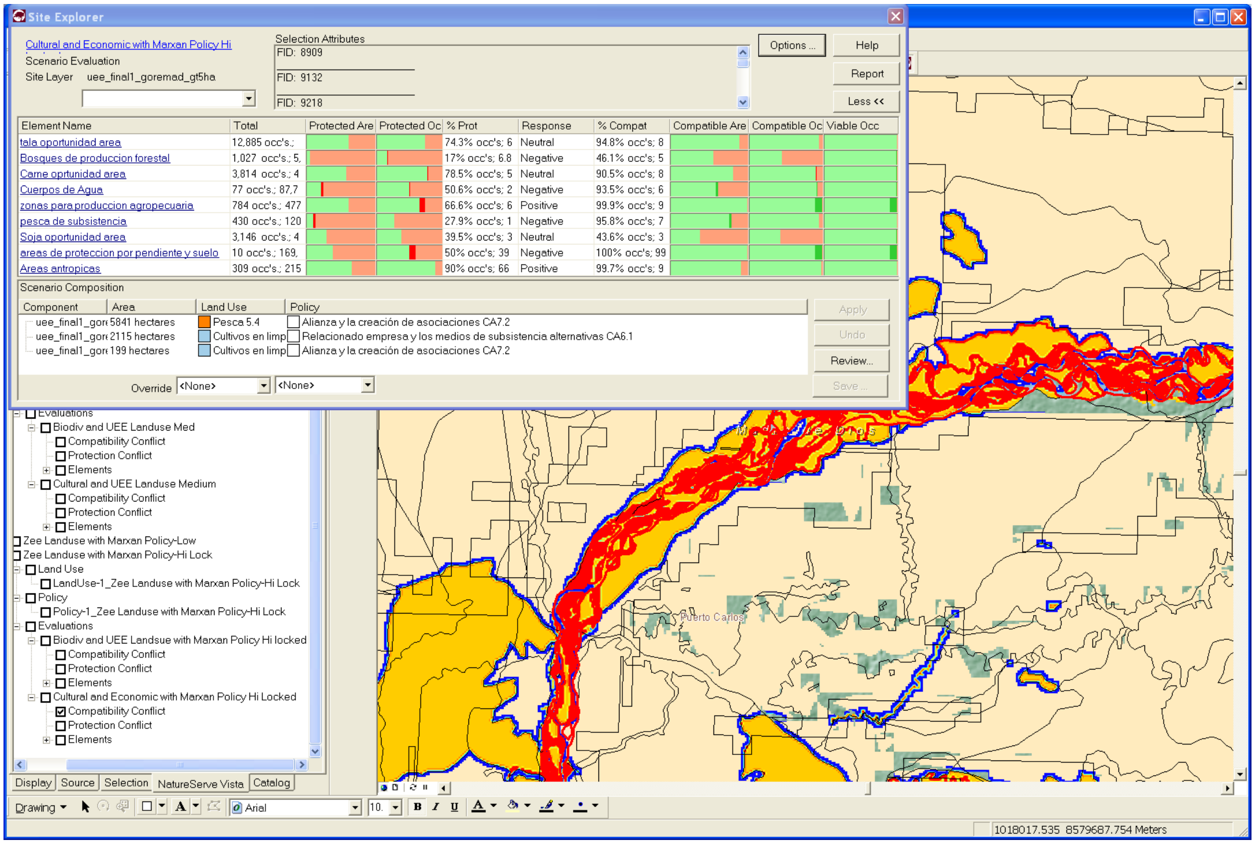


Figure 8. Site Explorer tool and parcel results.

More in detailed technical reports and the Vista project itself contain the complete results of the six scenario evaluations performed in the project.

Discussion

The elements of conservation interest selected for this project in conjunction with the land uses chosen to represent the scenarios against which to evaluate the accomplishment of a set of different levels of goals, resulted in relatively few sites of conflict. The most remarkable results are probably the fact that for some parcels, the recommended land uses resulting from the ZEE are in conflict with the attainment of goals for both biodiversity elements and economic elements. Secondly, the realization that the very large area set aside for protection in Madre de Dios region, is not enough to guarantee the protection of the biodiversity elements analyzed in this project (see Appendix 1), most of them endemics or endangered species, at a goal of 30% of the area used to represent their distribution in the study area.

The first issue would be easy to address given that the regional ZEE used for the analyses is a recommended land zoning that can be adapted for particular places during the process of meso or micro zoning for specific districts of the region, precisely using the results of this project's scenario evaluation results as well as the land use opportunity cost models that were generated by CSF based on the assumption of changes in the rent of selected economic activities as a result of the completion of the Interoceanic Highway.

More importantly though, this Project has served to collect, integrate and organize spatial data in a way that can be applied for district level planning or help in the delineation of conservation corridors across the region.

Since often it is difficult to obtain detailed distribution data of biodiversity elements, we see a direct application of the species and ecosystems distribution data currently in the Vista project, in order to evaluate other potential economic activities of interest for the region, province or districts. In such cases the area extent and location for these activities can be more precisely defined based on land tenure and volumes of the good estimated to accomplish some specific sustainable goal of production; such land use plans can then be evaluated as a land use or a policy against the existing information on biodiversity and help in the *a priori* identification of potential conflicts. Likewise, in the case of any major infrastructure project proposed for the region, it would be easy to assess its potential for conflict using the Madre de Dios Vista project framework of analysis.

Regarding the integration of economic cost opportunity models of CSF with biodiversity data, using the framework of NatureServe Vista, it was possible to evaluate scenarios of conservation where sites with high opportunity cost were excluded, unless absolutely required to meet a pre set conservation goal. More about the outcomes and applications of the integration of biodiversity and econometric models in Land use Planning can be found in Fleck at al. 2010 (*Estrategias de Conservacion a lo largo de la Cerretera Interoceanica en Madre de Dios, Peru. CSF, GRADE & NatureServe*).

Quispicanchi Province

Conservation Elements spatial database

In this case 91 elements of biodiversity were selected for analysis: 16 types of ecosystems, 38 bird species, 11 amphibians, 2 mammals, and 28 plant species. Other elements classified as of cultural and economic importance were: headwaters, snowcaps (sacred sites for indigenous communities), lakes or lagoons, archeological sites, and best quality land for forestry, annual crops and cattle.

Here too, we evaluated scenarios of current land use (Figure 9) and that of the proposed Zonificacion Ecologica Economica for the province (Figure 10).

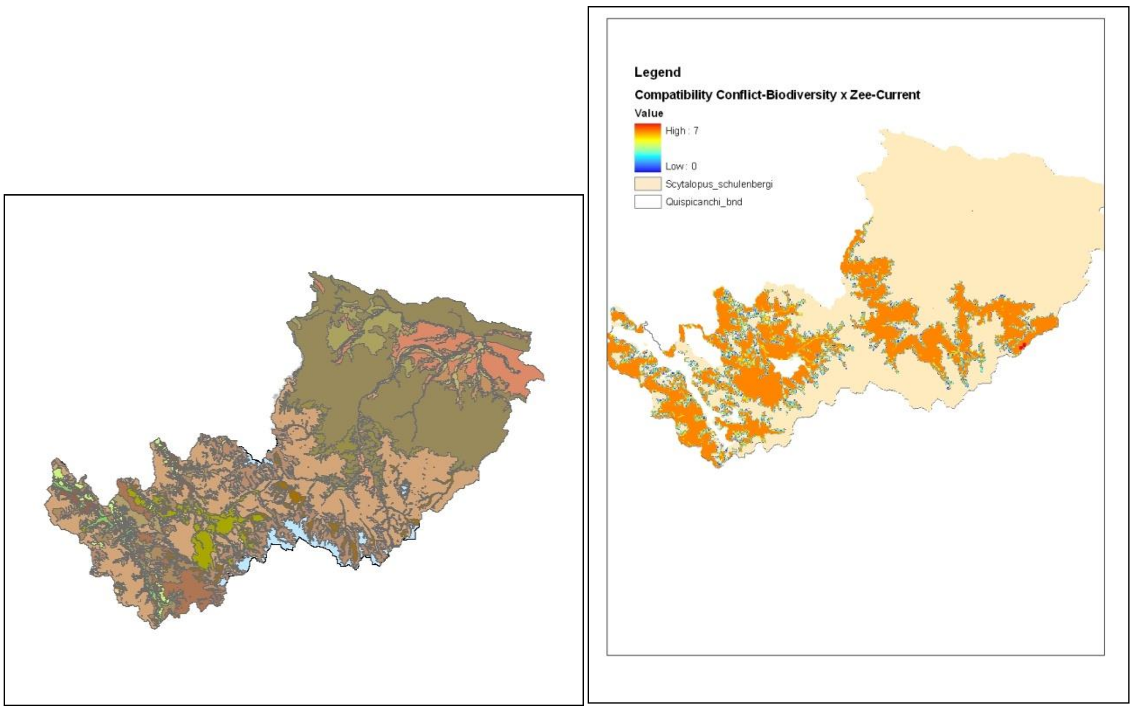
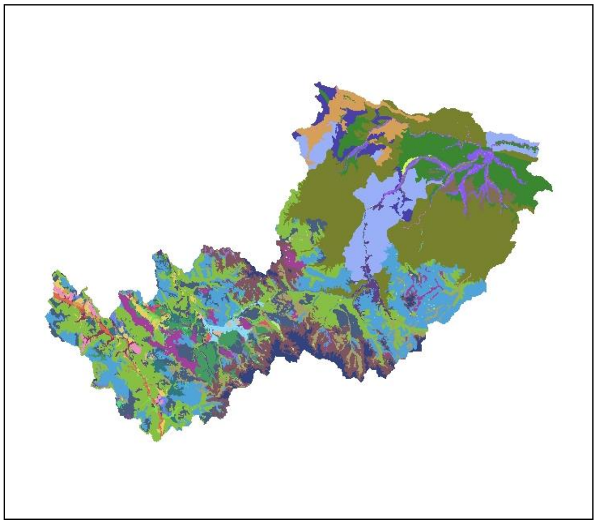


Figure 9. The map on the left represents the current land use in Quispicanchi province in Cusco. The map on the right shows in orange the areas of conflict between biodiversity elements and current use.

The current land use shows conflicts with biodiversity conservation elements, up to a maximum of 7 elements for the red spot towards the edge of the area, and less for the orange polygons.



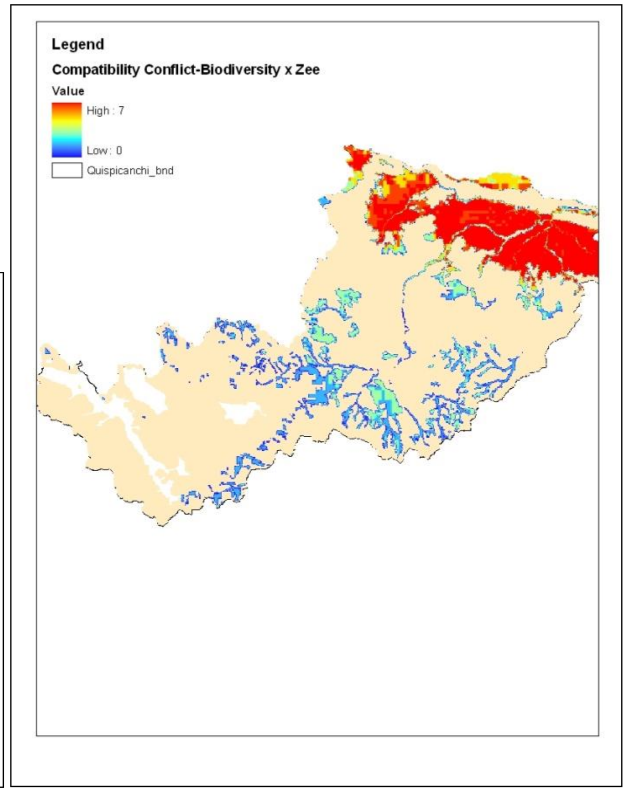


Figure 10. The map on the right depicts conflicts between biodiversity and proposed land uses (map on the left), with red indicating areas with high conflict potential (up to seven species and/or ecosystems).

The results of the evaluation of the ZEE scenario show a displacement of the location of conflict for biodiversity elements, towards lower elevations areas (Figure 10), where two new conservation areas have been proposed as a result of the project's groundtruthing of sites rich in bird and plant diversity (Figure 11).

The map in Figure 11 shows also the approximate location of a new dam (Inambari Dam), which if constructed would contribute to the increasing environmental conflicts down the river and certainly would also affect the biodiversity elements already showing conflict according to Figure 10, right map.

Proposal for Conservation Areas along Section II of the Interoceanic Highway

The field study of endemic birds and plants highlighted the importance of Section II of the Interoceanic Highway (the area where the field studies were conducted) for biodiversity conservation. Including the 33 targeted endemic bird species, the ornithological team identified 588 species of birds along this section after just six weeks of field work during a single four-month period. They discovered four species of Peruvian endemic species not previously know from the region, suggesting that our knowledge of even the best-known group of organisms occurring there is still incomplete. In addition, 14 of the 27 endemic plant species recorded in the region have very reduced distributions, an indication that the study area is one of the only places where they can be preserved.

Based on these observations and the results of the Vista analyses, our partner ECOAN identified two relatively small areas that are high priority candidates for protection. These areas have very low rates of human habitation and together protect approximately 80% of the biodiversity known from the region. These areas, named for the watersheds where they occur, are:

> **Cadena-Saucipata** – This watershed from the Camanti District measures 450 hectares and covers an elevational range of 900-3625 meters. The area is home to approximately 400 species of birds as well as other important elements of biodiversity. This area corresponds to the smaller bright green polygon on Figure 11 below.
>
> **Cocha-Capiri** — This watershed lies in the Marcapata District, measures 1,038 hectares, and ranges in elevation from 1,250-4,400 meters. The area has less total biodiversity (approximately 250 species of birds), but includes significant populations of endemic species. This area corresponds to the larger bright green polygon on Figure 11 below.

ECOAN has already begun negotiations with government agencies to lobby for the designation of protected status, perhaps at the municipal level, for these areas. The field data and planning exercises provide a sound justification for their proposal.

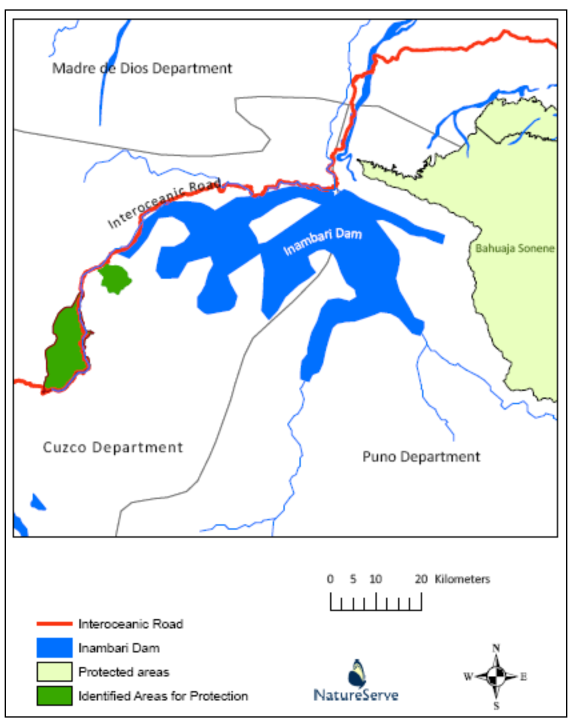


Figure 11. Approximate location of proposed conservation areas Cadena-Saucipata and Cocha-Capiri (bright green) and their relative proximity to a dam planned to begin construction in 2010-2011.

Appendix 1. Biodiversity Conservation Targets.

Elements by Category:

Category Name & Total	Element Name (*pt designation for point occurences)	Element Alternate Name

Terrestrial Ecological System : (23)

	CES408.543 Bosque siempreverde subandino del suroeste de Amazonia	
	CES408.570 Bosque del piedemonte del suroeste de la Amazonia	
	Bosque altimontano pluvial de Yungas	CES409.043
	Bosque basimontano pluviestacional humedo de Yungas	CES409.054
	Bosque de arroyos de aguas claras del suroeste de la Amazonia	CES408.528
	Bosque inundable y vegetacion riparia de aguas mixtas de la Amazonia	CES408.571
	Bosque montano pluvial de Yungas	CES409.050
	Bosque pantanoso de palmas de la llanura aluvial del sur de la Amazonia	CES408.573
	Bosque siempreverde estacional de la penillanura del suroeste de la Amazonia	CES408.544
	Complejo de bosques sucesionales inundables de aguas blancas de la Amazonia	Co02Amazonia
	Complejo de vegetacion sucesional riparia de aguas blancas de la Amazonia	CES408.550
	Herbazal pantanoso de la llanura aluvial de la alta Amazonia	CES408.552
	Pajonal arbustivo altoandino y altimontano pluviestacional de Yungas	CES409.059
	Bosque con Bambu del suroeste de la Amazonia	CES408.549
	Bosque inundable de la llanura aluvial de rios de aguas blancas del suroeste de la Amazonia	CES408.531
	Bosque inundable y vegetacion riparia de aguas negras del suroeste de la Amazonia	CES408.535
	Bosque pantanoso de la llanura aluvial del oeste de la Amazonia	CES408.569
	Bosque de tierra firme depresionada del sur de la Amazonia	CES408.576
	Bosque y palmar basimontano pluvial de Yungas	CES409.048
	Pajonal arbustivo altoandino y altimontano pluvial de Yungas	CES409.058
	Palmar pantanoso subandino de Yungas	CES409.061
	Complejo de sabanas del sur de la Amazonia	Co01Amazonia

	Bosque aluvial de aguas negras estancadas del sur de la Amazonia	CES408.526
Mammal : (10)		
	Lestoros inca	Musaraña Marsupial Incaica
	Sciurus sanborni	Ardilla de Sanborn
	Ateles chamek pt*	Peruvian Spider Monkey
	Dinomys branickii pt*	Pacarana
	Lagothrix lagothricha pt*	Common woolly monkeys
	Myrmecophaga tridactyla pt*	Giant Anteater
	Pteronura brasiliensis pt*	Giant Otter
	Priodontes maximus pt*	Giant Armadillo
	Tapirus terrestris pt*	South American Tapir
	Tremarctos ornatus pt*	Spectacled Bear
Bird : (36)		
	Anairetes alpinus	Torito Pecho Cenizo
	Asthenes urubambensis	Canastero
	Atlapetes canigenis	Chacchara
	Atlapetes melanolaemus	Chacchara
	Cacicus chrysonotus	Cacique
	Cinnycerthia fulva	Cucarachero
	Conirostrum ferrugineiventre	Mielerito
	Cranioleuca marcapatae	Cola-Espina de Marcapata
	Creurgops dentatus	Tangara
	Cyanolyca viridicyanus	Urraca
	Delothraupis castaneoventris	Tangara
	Entomodestes leucotis	Solitario
	Eubucco versicolor	Barbudo
	Formicarius rufifrons	Gallito Hormiguero
	Grallaria erythroleuca	Tororoi Rojo y Blanco
	Hemispingus trifasciatus	Hemispingus
	Iridosornis jelskii	Frutero
	Lepidothrix coeruleocapilla	Saltarín de Gorro Cerúleo
	Metallura aeneocauda	Colibrí
	Myiophobus inornatus	Mosqueta
	Myiotheretes fuscorufus	Atrapamoscas
	Nannopsittaca dachilleae	Periquito
	Nothocercus nigrocapillus	Tinamú
	Odontophorus balliviani	Porotohuango Cara Rayado

	Pauxi unicornis	Southern Helmeted-Curassow
	Phaethornis stuarti	Picaflor Ermitaño Frente Blanca
	Phylloscartes parkeri	Atrapamoscas
	Picumnus subtilis	Carpinterito de Barras Finas
	Pipreola intermedia	Granicera
	Poecilotriccus albifacies	Pico-Chato de Mejillas Blancas
	Psarocolius atrovirens	Coeche Verde Negruzco
	Schizoeaca helleri	Piscuiz
	Scytalopus parvirostris	
	Scytalopus schulenbergi	Tapaculo
	Terenura sharpei	Hormiguerito
	Zimmerius bolivianus	Atrapamoscas Boliviano
Amphibian : (20)		
	Eleutherodactylus toftae	
	Bufo inca	
	Eleutherodactylus danae	
	Dendrobates biolat	
	Gastrotheca ochoai	
	Gastrotheca excubitor	
	Eleutherodactylus imitatrix	
	Eleutherodactylus mendax	
	Scinax pedromedinae	
	Dendropsophus joannae	
	Altigius alios	
	Telmatobius timens	
	Atelopus erythropus	
	Epipedobates simulans	
	Dendropsophus allenorum	
	Dendrobates_biolat_pt*s	Rana Venenosa
	Dendropsophus_joannae_pt*s	
	Eleutherodactylus_imitatrix_pt*s	
	Eleutherodactylus_toftae_pt*s	
	Scinax_pedromedinae_pt*s	
Vascular Plant : (39)		
	Adelphia macrophylla	
	Aphelandra cuscoensis	
	Aphelandra eurystoma	
	Aphelandra limbatifolia	

	Aphelandra macrosiphon	
	Aphelandra peruviana	
	Brunellia cuzcoensis	
	Caiophora madrequisa	
	Diogenesia vargasiana	
	Fuchsia austromontana	
	Fuchsia chloroloba	
	Fuchsia inflata	
	Fuchsia vargasiana	
	Heteropterys fulva	
	Inga porcata	
	Justicia cuzcoensis	
	Justicia ruiziana	
	Mendoncia gigas	
	Nasa ferruginea	
	Pachystachys ossolae	
	Pachystachys rosea	
	Passiflora ferruginea	
	Ruellia rauhii	
	Ruellia tarapotana	
	Ruellia yurimaguensis	
	Sanchezia tigrina	
	Stenostephanus crenulatus	
	Suessenguthia vargasii	
	Thibaudia rauhii	
	Thibaudia regularis	
	Adelphia_macrophylla_pt*s	
	Aphelandra cuscoensis pt*	
	Heteropterys_fulva_pt*s	
	Justicia_cuzcoensis_pt*s	
	Mendoncia_gigas_pt*s	
	Pachystachys_ossolae_pt*s	
	Passiflora_ferruginea_pt*s	
	Ruellia_yurimaguensis_pt*s	
	Suessenguthia_vargasii_pt*s	