



Park Profile – México

Chichinautzin Biological Corridor Flora and Fauna Protection Area

Date of field evaluation: August 2002

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Location: State of Morelos and México, and the Federal District

Year created: 1988

Area: 37,302 ha

Ecoregion: Mexico transvolcanic pine-oak forests, Central Mexican grasslands

Hábitat: Conifer forests, oak forests and associated transitional flora of short evergreen forests.



Summary

Description

The Chichmautzin Biological Corridor is located in the Sierra Norte in the state of Morelos, in the region south of the Federal District and southeast of the state of Mexico. It was created in 1988 as a biological corridor to connect Lagunas de Zempoala and El Tepozteco National Parks. These parks were created in 1947 and 1937 respectively. Chichinautzin was also established to: (1) secure the biological processes and evolutions in the zone; and (2) to form a natural greenbelt boundary for the population growth of the Federal District and the city of Cuernavaca. The biological corridor itself is 37,302 hectares, but also incorporates Laguna de Zempoala National Park (4,790 hectares) and El Tepozteco Park (24,000 hectares). In this way, the total area of protected by the corridor and two national parks is 66,092 hectares. This region is important for rainwater filtration and is a very important factor improving air quality of the states of Morelos and the Federal District (Mexico City).

Biodiversity

Great biodiversity and endemism is found within the biological corridor. Several of the species endemic to the region include the volcano rabbit, “zacatuche” (*romerolagus diazi*), which is one of the smallest rabbits in the world; ajolote—an aquatic amphibian—(*Rhyacosiredon zempoalensis*); Mexican volcano mouse (*Neotomodon alstoni*); long-tailed wood partridge (*Dendrortyx macroura*); Sierra Madre sparrow (*Xenospiza baileyi*), which is endangered according to the IUCN Redlist (IUCN 2002); and cross-banded mountain rattlesnake (*Crotalus transverses*). More than 32 species of butterflies and 47 species of moths have been recorded.

Threats

Currently the biological quarter is threatened by changing use of soils, the sale of land, forest fires, poaching, deforestation, and the sale of earth and volcanic rocks. Owing to these things, ParksWatch classifies it as critically threatened. Though the administration of the protected area is working to obtain more human and financial resources, urgent solutions are necessary to ensure the protection and maintenance of the biodiversity. If no immediate action is taken, there is a very high risk that the protected area will fail to maintain its biological diversity in the immediate future.



Lagunas Zempoala National Park is connected to El Tepozteco by the biological corridor.

Description

Physical description

The protected area is located in the northern part of the state of Morelos, in the southern part of the Federal District, and in the southeast of the state of Mexico. The corridor is made up of other regions of the Sierra Madre del Sur and the Neovolcanic Transverse Axis (ENT), which is found in the central part of the country and contains some of the highest mountains in the Republic of Mexico, such as Popocatepetl and Iztaccihuatl, with an altitude of 5,465 and 5,230 m respectively. Within the biological corridor several geographical regions converge such as the Nearctic and



Neotropical of the North American continent. Volcanic activity in the area at the end of the relatively recent Pleistocene and Holocene ages produced over 300 volcanoes in the region (Bloomfield 1975, Ricketts et al 1999).

The biological regions of ENT and the Sierra Madre del Sur are important in Mexico. Within their borders, there is endemism and biodiversity for many organisms such as mammals, reptiles, and plants (Rzedowski 1991). The morphotectonic plate in the ENT crosses the country from coast to coast from its center in the Gulf of Mexico in the east to the Pacific Ocean in the West (Ferrusquia-Villafranca 1993).

The hydrology of the biological corridor includes recharge zones for aquifers in the regions of Chichinautzin and Zempoala. The Lagunas de Zempoala Park, named for the bodies of water present within it, is located very close to the intersection of three important hydrological systems: the drainage of the Lerma River in the west, the drainage of Mexico in the Northeast, and the drainage of the Balsis River in the South. Lagunas de Zempoala National Park forms part of Mexico's hydrologic region No. 18 and is made up of seven lakes, of which three have completely dried up. This desiccation is due in several cases to rapid infiltration and other times to over-exploitation by nearby towns (Contreras & Cazora 2002).

The biological corridor was created in 1988 to safeguard the biological processes of the area. Its highly permeable soils make it a recharge zone for aquifers. It also forms a natural boundary to the population growth of the Federal District and of the city of Cuernavaca. The biological corridor is 37,302 hectares. Taken with the parks it connects, Lagunas de Zampoala (4,790 hectares) and El Tepozteco (24,000 hectares), the total area protected is 66,092 hectares. Several vegetation types are found within the biological corridor including pine forests, with an average height between 20 and 30 meters; oyamel forests with an average height between 30 and 40 meters; oak forests with an average height of 20 meters; and pasture with an average height of 50 cm. The region is one of the principal zones for the capture and regulation of rainwater in the states of Morelos and the Federal District, and is a very important place for the improvement of air quality.

The climate ranges from cool, with an annual average temperature that varies between 5° and 12° C, to sub-humid with average annual temperatures between 12° and 18° C to semi hot with annual temperatures reaching at least 22° C. The annual average precipitation in the region is 1,200 mm.

Altitude varies between 1,250 and 3,450 meters above sea level and with a heterogeneous topography, geology and climactic histories generating a wide range of ecological conditions, which translates to a highly diverse habitats and species.

Archeology

The Tepozteco archeological zone is located on a hill called Ehecatepetl in Tepozteco National Park. The primary temple of the Aztec/Tlahuica culture has a platform of 9.5 meters and in one of the two levels of the upper section, a monolith representing Tepozotecatl, the principal deity of pulque (a fermented drink made from maguey) is found (Martinez 1994). Another site of interest is the ex-convent of Tepoztlan constructed by a Dominican order in 1570.

Biodiversity

Since the middle of the 20th century the region in the ENT was considered of great biological importance (Smith 1940). Other authors such as Goldman and Moore (1946) speak of the province as an area of great biodiversity and endemism. The physical characteristics of the region, such as the complicated topography and differences in altitude and climate, result in a diversity of environments, habitats, and microhabitats, creating a great diversity of sedentary and migratory species (Rzedowski & Rzedowski 1989). Of all known mammals recorded in Mexico, 50% are found in this region, representing 90% of the orders (Fa 1989).

Several studies have demonstrated that the mountainous zones around the drainage of Mexico shelter around 325 species of plants and animals (Rzedowski & Rzedowski 1989). This means that almost two percent of the gymnosperms worldwide are restricted to this area.

Fauna

Diverse studies show that the ENT is one of the regions in Mexico with the highest concentration of endemic terrestrial vertebrate genera and species. The corridor is one of the areas where the greatest number of endemic species has been recorded; in first place are the reptiles, then birds, mammals, and amphibians. Currently 56 species of reptile and 24 species of amphibians have been described in the region among which the most outstanding include the ajolote of Zempoala (*Rhyacosiredon zempoalensis*), which is threatened; the mountain tree-frog (*Hyla eximia*); cross-banded mountain rattlesnake (*Crotalus transversus*); and the Tlaloc frog (*rana tlaloc*), which is in danger of extinction. These last three species are also endemic to the region and protected by the Official Norms for Mexican Ecology 059 of 1994, which determines the species within the several categories of threatened within the national territory (NOM-ECOL-059-1994).

The avifauna in the region are represented by 211 species, of which the order Passeriformes is the best represented with 142 species, the Apodiformes with 22 species, and the Falconiformes with 6 species (Cipamex 1993, Cabrera-Garcia & Melendez-Herrada 1999). Seven species fall under the category of threatened such as the sharp-shinned hawk (*Accipiter striatus*) and great horned owl (*Bubo virginianus*); six species are considered rare including the mountain pygmy owl (*Glaucidium gnoma*) and the black robin (*Turdus infuscatus*). Two species are under special protection: the red-tailed hawk (*Buteo jamaicensis*) and the long-tailed wood partridge (*Dendrortyx macroura*). The Sierra Madre sparrow (*Xenospiza baileyi*) and Merriam's Montezuma quail (*Crrtonyx montezumae merriami*) are in danger of extinction according to the Official Norms for Mexican Ecology 059 of 1994 (NOM-ECOL-059-1994, Navarro & Benitez 1993).

Mammals are represented by 59 species, which comprise 13.1% of the total terrestrial species reported in Mexico (Cervantes et al 1994, Ramirez-Pulido et al 1996). The origin of the megafauna of the region at the species level is divided in the following way: 40 species have a

Neartic affinity and 19 species have a Neotropical affinity. The best-represented groups are the mice (22 species) and bats (16 species). Within the biological corridor, there are 14 endemic species, representing 10 % of the total in Mexico. In addition to these 14 species, 30% are exclusively found in the ENT (Monroy-Vilchis et al 1999). Some of the characteristic species of the region include the endemic volcano mouse (*Neotomodon alsoni*), endemic zacatuche rabbit (*Romerolagus diazi*), white tailed deer (*Odocoileus virginianus*) and the lynx (*Lynx rufus*).

Flora

The studies of the corridor region have identified approximately 860 species of plants, of which the families represented with the greatest number of genera are Asteraceae, Poaceae, Brassicaceae, and Fabaceae (Silva et al 1999, Bonilla-Barbosa & Viana 1997). The flora identified as of special importance includes 128 species of which 66 are classified as at some category of risk such as the *Angelica nelsoni*, in danger of extinction, *Furaceae bedinghausii*, described as vulnerable and endemic, and *Bursera cuneata*, a vulnerable species. Some species are apparently extinct, such as *Tillandsia prodigiosa*, *Bidens laevis*, *Arenaria paludicola*, *Cuphea procumbens*, and *Potamogeton illinoensis*. Within this group of 128 species, 44 are considered characteristic of the corridor and 30 are endemic to Mexico. Within the corridor 315 species of mushrooms have been identified of which the most numerous are: *Tricholomataceae*, *Strophariaceae*, *Amanitaceae*, *Boletaceae*, *Polyporaceae*, *Clavariaceae* and *Sclerodermataceae*. In the protected area a great variety of mushrooms exists, of which more than 80 species are extracted for local consumption and commercial consumption in the markets (Reygadas et al 1995).

The area shelters a great variety of types of vegetation and associations, listed below are some of the most prevalent (Silva et al 1999, Bonilla-Barbosa & Viana 1997).

Pine forest: This type of forest is found in the areas of temperate climate and is dominated by a variety of species of pine such as *Pinus montezumae*, *P. leiophylla*, *P. teocote*, *P. pseudostrobus*, and *P. patula*. At altitudes greater than 3,500 meters, low-density groups of vegetation comprised entirely of *P. hartwegii* are found. *P. hartwegii* is a species that resists low humidity and low temperature.

Oyamel forests: This forest is found in areas with deep soil and a humid temperate climate between 2500 and 3200 meters. The Oyamel (*Abies religiosa*) sometimes grows at altitudes greater than 3500 meters in groups comprised entirely of this species. In the lower parts of this forest, the oyamel shares dominance with pines and other latiferous species.

Oak Forest: This forest is found in the immediate vicinity of the pine forests and is limited to between 2500 and 2800 meters in altitude. In some parts *Quercus rugosa* and *Q. laurina* dominate, but other species present include *Q. centralus*, *Q. crassipes*, *Q. lanceolata*, *Q. obtusa*, and *Q. robusta*. In other cases, there are pine-oak and oak-matorral communities present.

Pastures: This type of vegetation is characterized by grains and is recognized as pasture or hayfields. Pastures are of the sub alpine variety and characteristic of the forested zones in cold dry climates. Generally, the vegetation is secondary. The dominant species are *Festus toluensis*, *Calmagrostis toluensis*, and *Muhlenbergia macroura*.

Dry matorral: This community is usually established in volcanic terrain generated by landslides from the Chichinautzin Volcano. This is a successional community, floristically differentiated,

in which the primary species have desert affinities such as *Agave horrida*, *Hechtia podantha* and *Yucca* sp.

Transitional associations of the low caducifolia, pine and oak forest: Located in the areas of lower elevation within the protected areas and where both temperate and tropical vegetation meet. Within these transitional zones, the outstanding species are cazahuate (*Ipomea arborea*), mesquite (*Prosopis* sp.), bonete (*Jacaratia mexicana*) and the cuajote colorado (*Bursera morelensis*).

Management

On November 30, 1988 the area for the protection of the Biological Corridor of Chichinautzin (CBC) was established to connect Lagunas de Zempoala National Park and El Tepozteco National Park. This corridor also serves as a barrier to the urbanization of the populations in the north of Morelos and in the south of the Federal District.

Both private and public opinion supported the creation of the protected area, even all three levels of Mexican government (federal, state, and municipal) agreed. The initial objective was to contain Mexico City's urban growth and contain other growing cities within the Morelos and Mexico states. With this in mind, the final goal of natural resources conservation within the corridor was pursued.

The Management Plan was created in 2001. The National Commission on Natural Protected Areas (CONANP) is now in the process of revising the plan and verifying the protected area's boundaries. CONANP administers and directs the protected area. Specific sites, such as the archeological zone of Tepozteco, are administered by the National Institute of History and Anthropology (INAH) because archeological sites fall under their jurisdiction. The primary cities are Tepoztlan and Huitzilac, which are some of the largest urban areas within the protected area and are administered by their corresponding municipalities. The biological corridor has the basic staff who are also responsible for Tepozteco and Lagunas de Zempoala parks. There is a director, subdirector, administrator, a departmental manager, and a technician. There are also 14 park guards assigned to Lagunas de Zempoala to guard the installations and offices. These personnel are permanent staff of the Secretary of the Environment and Natural Resources (SEMARNAT) of Morelos. Equipment for the protected area consists of three pickup trucks, a three-ton cargo truck, a boat, and computer equipment.

Lagunas de Zempoala National Park is supported by Mexico's state government (the state of Mexico) and provides salaries for the 4 people responsible for its maintenance. The federal budget for the biological corridor is approximately one million pesos annually (\$100,000) and starting in 2001 funds from the Fund for the World Environment (GEF) it was 18 million pesos or \$1.8 million. With funds from the government of Mexico provided by SEMARNAT, and private funds such as those from the Fund for Mexican Conservation and Nature (FMCN), the consolidation of the protected areas is planned with the creation of a Fund for Natural Protected Areas. The biological corridor has generated annual interest for the year 2002 of 830,000 pesos or \$83,000.

Lagunas de Zempoala's infrastructure consists of two buildings. At the time of ParksWatch visit to the area, we found that they were underutilized—they were being used for storage or not at all. These buildings are equipped with solar panels, which are currently not in use but could serve an

administration office or an information center. A forest fire observation tower is built off the buildings and is periodically utilized by the park guards in the dry season when forest fires are most frequent. The national parks have informative signs about the protected area, but they have deteriorated with age. In Tepozteco and Chichinautzin the signs are more recent and less damaged.



The biological corridor is made up of three core areas: Chalchihuites (783,140 ha), Chichinautzin Quihuistepec (2,873.11 ha), and Las Mariposas (1,740.86 ha). The rest of the area (approximately 31,905 ha) makes up the buffer zone, which connects Lagunas de Zempoala National Park with El Tepozteco National Park. No activities, except scientific research and conservation, are permitted within the core areas. Within the buffer zone some productive activities are permitted such as agriculture, livestock, and forest extraction as regulated by the management program. The national parks are for public use and permitted activities include recreation. The boundary coordinates of the protected areas that formed the biological corridor are as follows:

Lagunas de Zempoala National Park: 19 01' 30" & 19 06' N and 99 16' 09", 99 21' 01" W;

Chichinautzin Biological Corridor: 18 53' 32" & 19 07' 55" N and 98 51' 56", 99 19' 54" W;

El Tepozteco National Park 18 53' 39", 19 05' 23" N and 99 02' 29", 99 10' 57" W.

Human influence

There are approximately 50,000 inhabitants living within the protected area (INEGI 1996). The land is within the following municipalities: Huitzilac, Cuernavaca, Tepoztlan, Jiutepec, Tlalnepantla, Totolapan, Yautepec, Tlayacapan, and parts of the Delegation Milpa Alta and Federal District. There are four towns that are important population centers: Tepoztlan, Huitzilac, San Juan Tlacotengo, San Jose, and Amatlan. Tepoztlan is the municipal capital, whose urban center is found within the borders of the protected areas. In Tepoztlan and Amatlan there is a considerable influx of national and international tourism. Ownership of the land in the region is 95 percent municipal, with a few small property owners, and 2 percent national areas.

Large towns exist within the reserve, in particular in Tepoztlan, Amatlan, Tlayacapan, and Huitzilac. These need basic services and adequate planning for population growth. Additionally in the first three towns, there is a transient population, made up of weekend vacationers coming to their country homes from the Federal District. The lands used for the country homes are generally sold to people from the Federal District, who do not know the regulations of the protected areas. In addition to the questionable legality of the land of which these homes are built, many also use materials illegally collected from the protected areas to construct the homes.

The biological corridor is well-connected, in particular by the highway 95 (Mexico-Cuernavaca) which unites the town of Tepoztlan with the Federal District in just 45 minutes. Federal highway 95 is a freeway and runs parallel to another highway. Another access route is federal highway

Xochimilco-Oaxtepec to the southeast of the biological quarter, and numerous secondary highways and rural unpaved roads.

Eighty percent of the productive activities are livestock, agriculture, and to a much lesser extent fishing; service activities occupy around 15 percent (tourism, transport, commerce, and construction).

Tourism

Tourist activity in the protected areas is regional, national, and international, and is best developed in Tepozteco National Park. Visitors use the city of Tepoztlán as a jumping off point because it has infrastructure for medium-scale tourism and offers all the services. In Tepozteco National Park there is an archeological region located in the Sierra de Tepoztlan. The mountains are peculiar in shape and the top of the Tepozteco Hill has a pyramid in honor of Tepoztecatl, the principal deity of pulque (Martinez 1994). The archeological area is administered by INAH. According to residents and frequent visitors, these mountains are a great source of positive and spiritual energy, which makes the area of site of great interest for national and foreign tourists.



The lagoons are used for fishing and kayaking.



Large groups of people visit the protected areas on the weekends, coming from Mexico City and Cuernavaca

Lagunas de Zempoala also receives a considerable influx of visitors primarily on the weekends. Inhabitants of Mexico City, people from Cuernavaca, and the state of Mexico visit the protected area to rest in its forests and lagoons. The Chichinautzin Biological Corridor has less infrastructure and therefore is used mainly as a means of connecting the two parks.



This is one of the lagoons where tourists visit on the weekends.

Ecotourism has also begun throughout the protected area. The principal activities available include horseback riding, mountain biking, and hiking through the forest. Horseback riding has been taking place for more than 15 years as a service offered by residents to tourists in almost all the parks located close to Mexico City. Only now this service has a new image as an ecotourism activity, one that is considered to be both a productive activity and one that does not affect the environment.

In the protected areas (Laguna de Zempoala, El Tepozteco, and Chichinautzin) there are basic infrastructure, such as bathrooms and cabins. On the weekends, food vendors sell traditional foods to visitors such as corn, quesadillas, and mushroom soups. The inhabitants of the protected area commercialize some other traditional products such as vases and carvings.



Conservation and research

A consortium of several institutions is developing seven research projects investigating geographic characteristics of the protected areas, widening our knowledge of species of conservation priorities, and developing new technologies for agricultural production. Included in the consortium are SEMARNAT, the Autonomous University of Morelos (UAEM), the State Government of Morelos, the Regional Center of Interdisciplinary Research (CRIM) of the UNAM, Action and Ecological Development AC, and the Autonomous Metropolitan University (UAM). Their projects include:

- Defining the priority areas for conservation in the biological corridor. Manager: Biologist Javier Martinez Sanchez
- Soil improvement, evaluation, and sustainable management in the biological corridor. Manager: MS Rogelio Oilver Guadarrama
- Ecological studies of aquatic angiosperm populations in the national park Lagunas de Zempoala with the goal of management and conservation. Manager: Dr. Jaime Raul Bonilla-Barbosa
- Evaluation of the state of conservation of *Rhyacosiredon altamirani* and *R. Zempoalensis* in Lagunas de Zampoala. Manager: Biologist Ruben Castro Franco
- Structure and composition of ichthioparasite communities in Laguna de Zampoala. Manager: Biologist Francisco Javier Sotelo Rivera
- Evaluation of the toxicity in cepa gp3 *Bacillus thuringiensis* and *Hemisia tabaci* (Homoptera:Aleyroridea) under summer conditions. Manager: MS Guadalupe Pena Chora.
- Control of the larva of *Phyllophaga* spp in corn under different management systems in Tepoztlan, Morelos (spring-summer cycle). Manager: Dr. Julio Cesar Garcia Montalvo.

The State Government of Morelos supports the following projects:

- Training in community organizing to design and operate productive projects. M. S. Rafael Monroy, MS Hortensia Colin, and MS Topiltzin Contreras MacBeath
- A nursery of useful plants in Tepoztlan. Manager: MS Hortensia Colin
- Evaluation of the production of organic amaranth. Manager: MS Rogelio Oilver Guadarrama
- Rustic model for the production of mushrooms in Santa Catalina, municipality of Tepoztlan.manager: Biologist Daniel Portugal Portugal, Biologist Elizar Montiel Arcos
- Rustic model for the production of mushrooms in Amatlan, municipality of Tepoztlan. Manager: Biologist Noe Bautista Ramos.
- Urban rehabilitation of the historic center of Tepoztlan. Manager: MS Rafael Monroy, MS Hortensia Colin, MS Rafael Monroy-Ortiz, and Archeologist Victor Henry Vezquez Rios.
- Training center for the production of compost, municipality of Huitzilac. Manager: Biologist Atahualpa Caldera, GAIA, AC.

The projects of the Center for Biological Research on the Biological Corridor of Chichinautzin are used in the implementation of educational, recreational, and productive activities in the area are the following:

- Design and construction of a web page that contains complete information on natural, cultural, and administrative elements of the protected area.
- Design and development of a series of posters which contain complete information on the development of programs in the transfer of technology and basic topics of environmental education.
- Recording and production of a series of documentaries on the flora and fauna of the protected area.
- Recording and production of a CD of the bird songs of the protected area.
- Editing of the visitor's guide to the biological corridor.
- Production of a manual for Visual Identification for the biological corridor.
- Implementation of an environmental education program directed at elementary students within the biological quarter.
- Editing and production of a radio program The Game of Leaves.
- Production of a CD with basic information on the corridor.

Threats

Current Threats

- Conflicts with the communities
- Lack of human and economic resources
- Changing land use
- Lack of inter-institutional coordination
- Deforestation
- Forest fires
- Illegal hunting
- Illegal sale of earth and volcanic rock
- Illegal sale of land

Conflicts with the communities

The primary conflicts that have developed in the municipalities such as Huitzilac are due to restrictions on the use of natural resources in the protected area. The community of Huitzilac is located very close to Lagunas de Zempoala National Park and the creation of the biological corridor in 1988 integrated the municipality into the buffer zone of the corridor, which had regulatory implications on its extractive activities. Now the residents of the area cannot extract products from the forests, hunt, or sell earth except in an illegal fashion. The inhabitants of the area have manifested in their annoyance and resentment due to the regulations and they have continued illegal activities such as the cutting and sale of timber. Huitzilac has the highest rates of deforestation.

Lack of human and economic resources

The administration needs at least 10 additional people to be able to function adequately. During the week, personnel for monitoring Lagunas de Zempoala National Park is lacking, and there are no park guards for any of the core areas. The current number of staff is not sufficient to cover all the scheduled activities such as educational workshops and community projects. A new regional office is planned, but would require at least two additional staff members in order to function properly (one secretary and one project coordinator). For operations, more equipment and a larger budget are necessary for restoration, environmental education, and marking the boundaries of the reserve. From a legal perspective there is very little presence from personnel from the Program for the Procurement of Environmental Justice (PROFEPA), as there are only four inspectors for the entire state of Morelos. This is not enough to prevent the illegal sale of products, timbering, and poaching, and the illegal sale of land.

Land use change

There is great pressure on the land due to population growth and urban development in the region north of Cuernavaca, in the south of Federal District, and also near the town of Tepoztlán. These problems are exacerbated by the illegal sale of products from the region for the construction of houses. Yet, even though it's illegal, the number of houses has proliferated and with them the problems of water contamination from organic wastes, and other problems owing to the lack of urban services such as water, electricity, and roads.

Lack of inter-institutional coordination

The politics and activities of other institutions, such as the Secretary of Social Development (SEDESOL) and the Program for the Country (PROCAMPO), pay agricultural producers who can demonstrate that they have planted in corn. This creates incentives for deforestation and for land conversion from forest to agriculture.

The Secretary of Agriculture, Livestock, Rural Development, Fishing, and Food (SAGARPA) offers credit for livestock, which also promotes deforestation for pasture creation. These governmental programs contradict conservation goals of CONANP creating a discord and ultimately leading to poorly protected reserves and natural areas.

Deforestation

Deforestation is one of the greatest threats to Chichinautzin Biological Corridor. Through the field evaluations we have realized that illegal logging is a common activity for the local inhabitants. Within the park, one can easily spot trees damaged from harvesting the resin “ocote.” And, one can see trucks hauling tree trunks away from the area. The landscape shows evidence of increasing pasture lands and it appears as if forests are becoming isolated on the mountaintops.



Photo: Juan C. Gutiérrez



Forest fragmentation is due to be cultivation of forage. Photos: Juan C. Gutiérrez

Deforestation resulting from cultivation in the biological corridor.

Forest fires

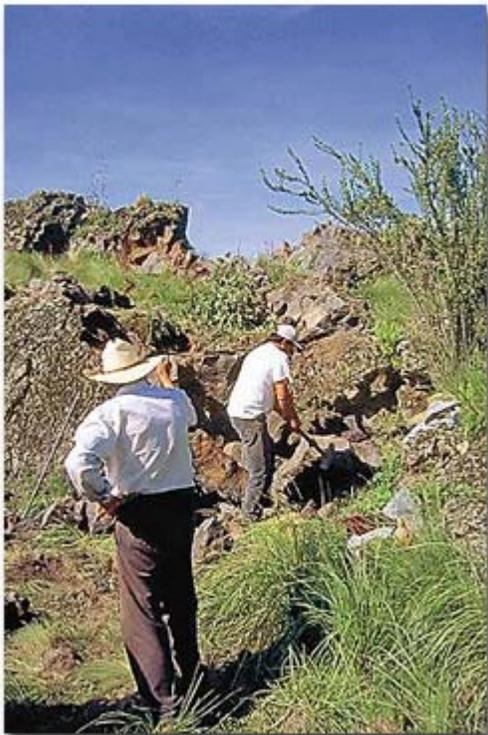
The region of the biological corridor is very vulnerable to forest fires due to the great extent of pastures, prolonged drought, and the number of tourists that camp and make bonfires, many of which are not well put out. 1998 was a particularly bad year for forest fires due in part to the El Niño climatic event.

Illegal hunting

Locals engage in illegal hunting. Primary prey include the Spanish rabbit (*Sylvilagus floridanus*), the wild rabbit (*S. canicularius*), the white tailed deer (*Odocoileus virginianus*) which is already rare in the region, the coati (*Nasua narica*), the lynx (*Lynx rufus*), the coyote (*Coyote montezumae*), the wild chicken (*Dendrortyx macrouura*) and the codorniz (*Cyrtonyx montezumae*). These species and many others are hunted indiscriminately all year. In the region hunting is not allowed, but owing to a lack of vigilance, the illegal hunting continues to diminish the populations of wild animals.

The illegal sale of earth and volcanic rock

Several studies, such as that of Lopez-Paniagua et al. (1996), have documented activities such as the sale of volcanic rock, which is transformed into asphalt in local factories. The extraction of earth has been observed around Pelado Volcano in Chichinautzin Biological Corridor and in Lagunas de Zempoala National Park on the edges of the highway. Due to the large areas of earth left open and exposed, we can conclude that earth extraction occurs in great quantities. This illegal activity destroys the herbaceous layer and the possibility of regeneration since it eliminates the soil.



Illegal extraction of volcanic rock in the biological corridor. Photo: Juan C. Gutiérrez

Illegal sale of land

In the biological corridor, there are 40 towns with an approximate population of 50,000 inhabitants (INEGI 1995). The greatest population centers correspond to the municipality of Tepoztlan, located on the eastern edge of the protected area with 26,000 people (54 percent of the total), the municipality of Huitzilac with 9,000 people on the extreme western edge of the corridor, and over 100 other population centers of up to 2,500 people. The rapid population growth in the biological corridor is due in large part to the illegal sale of land in the municipalities of Tepoztlan and Huitzilac. It should be pointed out that the town of Tepoztlán had itself a decreasing population, but the demographic increase in the last two years has been due to an influx of immigrants, mostly from the Federal District.

Future threats

The primary future threats include population increase in Tepoztlan and Huitzilac, where land is sold illegally for home construction. Forest fires also represent a future threat as these are predicted to worsen.

Recommending solutions

Conflict with the communities

Communities need to be included in more work projects such as environmental education, conservation, and restoration. These programs would help instill an environmental consciousness and help the inhabitants feel they have also benefited from protecting the reserve. Communication between the biological corridor's Technical Advisory Council and local inhabitants should be established.

Lack of human and economic resources

The administration of the reserve received economic resources generated from the fund for the patrimony for \$1.8 million dollars provided by the World Bank through the GEF in June of 2002. This support was received thanks to the collaboration of the Technical Administration of the biological corridor. With these funds, the administration could cover several costs, such as equipment and hiring more personnel. This support is a great achievement for this protected area but other sources of support through the federal and state governments and private businesses should be pursued. The universities could be a source of human resources support to volunteer, provide social services and conduct thesis research that would support existing programs and workshops.

There are other ideas being discussed to generate funds for the park. The first idea is a green tax proposed by the state government of Morelos. The second idea is to develop museums for both national parks.

Land use change

To control the problem of illegal human settlements within the reserve and population growth in Tepoztlan and Huitzilac, land use planning and development plans are needed. Tourists should have to pay a fee to visit the protected area as well as those people and groups offering services tourists within the reserve (this type of fee is already applied to marine protected areas). The income obtained could be used to contract personnel for monitoring and maintenance in the area, to implement more effective environmental education programs, to better control and prevent the problem of the illegal sale of land.

The administration of the reserve has a project for the near future that consists of working with compensation funds. The economic resources destined for this project would function as an incentive for conservation: the land owners would receive cash payments for respecting natural resources. For example, they would receive compensation for not selling land, for not deforesting, for not dumping garbage or for not extracting other natural resources. This program would be contradictory to programs from other governmental offices, such as SAGARPA, SEDESOL, and PROCAMPO which provide economic incentives to conduct agricultural activities within the reserve.

To control the problem of land conversion from forest to farming or grazing, there are options. One is a temporary work programs that could be implemented in the region that offer alternative activities to livestock and agriculture. The problem of changing land uses requires better communication and coordination within the different governmental offices, so as not develop programs which adversely affect the protected area's conservation.

Lack of inter-institutional coordination

Better support for the reserve on the part of the local authorities, the federal government, and the Technical Advisory Committee is necessary to solve the problem of different programs within the Secretaries that promote activities detrimental to the biological corridor. The local authorities and Secretaries need to communicate and coordinate their different actions conducted in the region.

Deforestation

In order to effectively address illegal logging, an adequate number of park guards must be employed, trained and equipped. It is recommended that the park guards have a presence throughout the corridor because the most inaccessible places shelter loggers and poachers. Horses could be used as transportation because they can access areas that are inaccessible to other vehicles and offer better patrolling coverage.

Forest fires

The corridor's management plan should include a permanent campaign to prevent forest fires. Tourists need to receive information on forest fire prevention, especially for those tourists camping and vacationing. Local farmers also need to be included in the program as they frequently use fire in their farming and livestock activities; fires that sometimes get out of control and affect the protected area. In 1998 after the devastating fires, private companies such as Ford donated equipment to combat the forest fires and promote reforestation in the affected areas. Currently the responsibility for the forest fires falls to the National Forest Commission (CONAF). It is imperative that the reserve's own administration develop forest fire prevention plans.



Observation tower to detect forest fires

Illegal hunting

Illegal hunting exists in the biological corridor mostly due to the lack of a monitoring program. With economic resources received from GEF, the administration of the reserve hopes to overcome the lack of personnel and develop training programs. Projects for research into flora and fauna, and on the current status of the species inhabiting the different ecosystems should be promoted to develop effective conservation methods.

The illegal sale of earth and volcanic rock

Although permissions are granted for the extraction of earth, the people who conduct this exploitation do not respect the regulations required by SEMARNAT, such as respecting site selection, and the depth of extraction. Additionally they do not follow up with necessary actions important to promote soil recovery, such as reforestation. Rock extraction is generally realized in an illegal manner. Actually, the threats these activities pose have not been studied and their impacts on the ecosystem should be studied. Once better understood, an adequate management plan for the areas affected could be created. Monitoring needs to be conducted by the respective permitting authorities: SEMARNAT, CONAP, and PROFEPA.

The illegal sale of land

Rapid population growth in several areas along the corridor is due in part to the great influx of immigrants from metropolitan areas like Mexico City and Cuernavaca. Today, there are still errors in the geographic limits that define the protected area and work must be started verifying the land and geographically demarcating the boundaries of the reserve with more precise geographical information systems. This information could then assist communities and municipalities located within the reserve to better develop its land use plans.

Conclusion

Without a doubt the ENT region where the biological corridor is located is of great importance in order to maintain ecological processes that began thousands of years ago and which today provide environmental services such as capturing 75 percent of the water consumed by Mexico City, its 20 million inhabitants, and the inhabitants of the city of Cuernavaca. This region is also of great importance to Mexico due to the great quantity of endemic species present and the diversity of flora and fauna. Nevertheless, the principal threats to this protected area such as a lack of monitoring, deforestation, forest fires, and human activities are the same as those that affect other protected areas of the country. The biological corridor is threatened even though it is very close to the principal governmental organizations responsible for conservation of natural resources. The corridor should be considered as critically threatened because it requires immediate action to maintain the diversity and ecological processes of the region.

The current situation in the biological corridor has potential to improve and reinforce its operating capacity, monitoring, and management. The recently acquired funds for the reserve, both from the GEF and federal sources, should help to address some of the most pressing needs. Nevertheless, achieving the reserve's conservation depends in large part on working with the community and on environmental education. Sustainable development for the reserve's inhabitants is needed in order to hope for Chichinautzin Biological Corridor's conservation.

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