

# Mexico: Tehuacán-Cuicatlán Biosphere Reserve

[Summary](#)

[Description](#)

[Threats](#)

[Solutions](#)

[Conclusions](#)

[Photo Gallery](#)

**Date of most recent on-site evaluation:** February, 2002

**Date Posted:** June 2002

**Location:** The states of Puebla and Oaxaca

**Year Created:** 1998

**Area:** 490,187 ha

**Ecoregion:** Pine- Oak Forest of the Southern Sierra Madre, Cactus Scrubland of Guerrero, Dry Balsa Forest

**Habitat:** Low elevation deciduous forest, xerophitic scrublands, and pine-oak forest



## Summary

### *Description*

Tehuacán-Cuicatlán Biosphere Reserve, created in 1998, covers 490,187 ha. The Tehuacán-Cuicatlán-Quiootepec valley is located within the Mixteca Oaxaqueña Province, between the cities of Puebla and Orízaba, and is approximately 150-km southeast of México City. Massive mountain ranges delineate the boundaries of the reserve: the Sierra Mixteca, Sierra de Zongólica, Sierra Mazateca, and Sierra de Juárez ranges to the west, east, central, and south, respectively. The six rivers inside the protected area's boundaries, including the Tomellín, Chiquito, Las Vueltas, Salado, Zapotitán and Río Grande, are part of the Papaloapan watershed, which drains into the Gulf of Mexico. The biosphere reserve has drastic variations in both topography and annual rainfall, coupled with a geographic orientation at the confluence of the Nearctic and Neotropical biogeographical regions. These regionally geographic characteristics have created several unique microclimates that provide the reserve with a rich diversity of flora and fauna.

### *Biodiversity*

Rich in its diversity of flora, the biosphere reserve contains 910 plant genus and 2,700 vascular species. Plant endemism is estimated at 30% (Dávila-Aranda 1983, Arriága et al. 2000). Within the park there are approximately 102 species of mammals, 356 species of birds, including the conspicuous and endangered Green Macaw (*Ara militaris*), and 53 species of reptiles.

### *Threats*

The Tehuacán-Cuicatlán Biosphere Reserve is considered [threatened](#), as there is a high risk that the protected area will fail to protect and maintain biological diversity in the near future. Remedial action is needed. The lack of park personnel, and the resulting inability to monitor visitor activities within the reserve, is seriously threatening to the reserve's biological integrity. Both the illegal trafficking of cacti and the accumulation of trash on roads within the reserve are activities that must be controlled. Hunting, overgrazing, deforestation, and highways and secondary roads are other threats to the area.

## Description

### *Physical description*

## *Mexico: Tehuacán-Cuicatlán Biosphere Reserve*

The Tehuacán-Cuicatlán Biosphere Reserve is located in the extreme southeastern portion of the Puebla state and the northeast portion of the Oaxaca state, between 17° 39' - 18° 53' N latitude and 96° 55' - 97° 44' W longitude. The reserve is 490,187 ha, and altitude ranges from 600m-2950m. The Tehuacán Valley has a variety of rock deposits that vary in composition and geologic era. The rock deposits of the valley generally consist of sedimentary rock from the early Tertiary era overlaid by deposits from volcanic activity in the Pleistocene and Pliocene eras. Portions of the Sierra de Zongólica mountain range contain metamorphic rock outcroppings from the Paleozoic era. In the lower parts of the valley, Tertiary sedimentary rock and Quaternary sandstones and conglomerates are found (López-Ramos 1981).



*Tehuacán-Cuicatlán Biosphere Reserve, located in Puebla and Oaxaca*

The southern limit of the Sierra Madre mountain range is found in the northwest zone of the Meseta de Oaxaca sub-province, located within reserve boundaries. In the eastern portion of the park, the Sierra de Zongólica mountain range isolates the valley from the Gulf of Mexico. The mountain range intercepts humid winds and saturated clouds moving westward from the Gulf, resulting in an arid climate on the ranges leeward slope. Average annual temperatures range between 18°-22°C in the Tehuacán Valley, and increase to 24.5°C in Cuicatlán (INEGI 1981). Average annual precipitation in the valley ranges from 250mm-500 mm, falling from May through October, with the majority between June and September (Enge and Whiteford 1989).

Some specialists consider the isolated Tehuacán-Cuicatlán Valley, surrounded by mountain ranges, a center for speciation. Both the valley's geographic location and abrupt climatic changes create ideal conditions for diversity and endemism of flora. Reaching up to 15m tall, and comprising 10% of the total Agave species recorded in Mexico, the columnar cactus is an example of fauna unique to the area (Arias et al. 2001, Bravo-Hollis 1978).

## *Mexico: Tehuacán-Cuicatlán Biosphere Reserve*



*Columnar cacti in the Tehuacán - Cuicatlán valley*

The high river basins of the Balsas and Papalopan watersheds are located within the reserve. Permanent surface water exists near Coxcatlán, at the confluence of various water sources, including the Zapotitlán River. This area is the largest source of seasonal rainwater in the highlands (Davila y Herrera-MacBryde 1994-1997).

Archeological discoveries in the Tehuacán-Cuicatlán Valley are 7,000 years old. This historic period corresponds with the domestication of corn (*Zea mays*) and the development of sedentary lifestyles, which mark the beginnings of development of culture (MacNeish 1972). Yet, the region's paleontological and archeological sites are infrequently studied and promoted. Both the human vestiges and representations of the Popoloca culture exist at the top of the Máscara or Cuthú hills.

Ethnic groups currently presiding in the area include Mixtecos and Popolocas, both descendents of the Olmecas. Mazatecos, Chinantecos, Nahuas, Chocholtecos, and Cuicatecos are also present in the region (CONANP 2000).



*Deposit of marine fossils in San Juan Raya, Zapotitlán Salinas municipality*

### *Biodiversity*

The regions' large variety of habitats and vegetation can be attributed to the areas extreme variations in topography, altitude, geological deposits and climate. The presence of plant communities is most notably affected by the seasonality of precipitation; between the months of November through April, the fauna of the region must survive six months of drought. Nevertheless, there is a rich diversity of flora within the biosphere reserve. Among the 910 genus of plants located in the park, there are 2,700 vascular species. Plant endemism is estimated at 30% (Dávila-Aranda 1983, Arriaga et al. 2000). The southeast portion of the Tehuacán Valley is

## *Mexico: Tehuacán-Cuicatlán Biosphere Reserve*

considered to be one of Mexico's three richest centers for occurrences of cacti within the taxonomic group Agave. Of the 250 species in the genus endemic to Mexico, 10% are found within the region.



*Cacti, like the Quiotilla, occupy 8% of the reserve's land*

Principle vegetation types within the protected area and the main terrestrial region of the Tehuacán-Cuicatlán Valley include low elevation deciduous forest (29%), oak-pine forest (21%), short xerophitic scrubland with predominantly spiny shrubs and cactuses (10%), crasicaule scrublands with vegetation dominated by big cactuses (8%), and other types (10%). The remaining 22% of the land cover has been modified by agriculture, grazing, and forest exploitation (Arriaga et al. 2000).

In the northern part of the reserve, the Sierra Madre Oriental separates the states of Puebla and Veracruz. It terminates at the volcanic belt that traverses Mexico and extends east to the Atlantic Coast. The Sierra Zongólica and the Sierra de Jauréz Mountains are located in the southern portion of the reserve.

For thousands of years, these mountain ranges have influenced the regions facilitation of plant and animal dispersion (Smith 1965). Categories of fauna include more than 100 species of mammals, 16 of which are endemic to the area. Representative species of the zone are the puma (*Puma concolor*), the white-tailed deer (*Odocoileus virginianus*), the collared peccary (*Tayassu tajacu*), the lynx (*Lynx rufus*), the racoon (*Procyon lotor*), the free tailed bat (*Tadarida brasiliensis*), the moustache bats (*Pteronotus parnellii*), and the vampire bat (*Desmodus rotundus*). There are 356 recorded bird species, including the endangered green macaw (*Ara militaris*), the harpy eagle (*Aquila chrysaetos*), and both the northern aplomado falcon (*Falco femoralis*) and the peregrine falcon (*Falco peregrinus*). There are an estimated 53 species of reptiles in the reserve, among them the only venomous lizard in the world, the Mexican beaded lizard (*Heloderma horridum*), the rattlesnake (*Crotalus* sp.), the coral snake (*Microrus laticollaris*), and the Mexican vine snake (*Oxybelis aeneus*) (CONANP 2000, Salas et al. 1995). Scientists have cataloged more than 268 species of insects.

### *Management*

The National Commission of Natural Protected Areas (CONANP) is in charge of the administration and management of Mexico's Natural Protected Areas program (NPA). CONANP is a separate entity governed under the Secretary of the Environment and Natural Resources (SEMARNAT). As of 2001, CONANP is also responsible for implementing the Program of Sustainable Regional Development (PRODERS) in the country's NPA's, zones of influence, and designated priority regions for conservation (RPC) not currently protected (CONANP 2001). In order to establish a real and efficient administration and increase the number of community development projects, the CONANP NPA's 2001-2006 Work Program states that the biosphere reserve must incur additional fiscal resources, increasing current investments in conservation per hectare by two. Suggestions for obtaining money to increase the parks budget include charging fees for user access and

## *Mexico: Tehuacán-Cuicatlán Biosphere Reserve*

environmental services including water availability (CONANP 2001).

The Tehuacán-Cuicatlán Biosphere Reserve had its origin in the declarations of two national protected areas established for ecological conservation. The first declaration was affirmed by the state of Oaxaca, in the region known as the Cuicatlán Valley, on August 13, 1996. The second declaration was made by the state of Puebla, in the region known as Tehuacán-Zapotitlán, on May 28, 1997. On September 18, 1998, a decree was signed to unite the two areas and create what is now known as the Tehuacán-Cuicatlán Biosphere Reserve. The new reserve corresponds to the vegetation province of Tehuacán-Cuicatlán.

The reserve does not have a management plan. In recent years, the Universidad Autónoma Metropolitana (UAM) did a study to diagnose the need; however, the Technical and Scientific Committee (CTC) of the reserve did not endorse the management plan (SEMARNAT-UAM 1997). The CTC is comprised of researchers from academic institutions, NGO's, civil associations, reserve directors, and municipal and federal authorities. At present, the CTC is working on a management plan and hopes to have it published later this year.

Park personnel includes a director, a sub-director, a department chief, a technical operator, an administrator, and a secretary. The reserve's board of directors receives a federal budget of \$120,000.00. Beginning in 2002, the directors will receive an additional \$120,000.00 from the World Environmental Fund (WEF). The WEF's objective in offering economic resources is to ensure coverage of the protected area's operating expenses. Current field equipment includes 3 small trucks, 1 car, 1 camera, 1 GPS unit, radios, binoculars, and computers. The reserve's administrative and field offices are located in the city of Tehuacán and the community of Cuicatlán, Oaxaca state, respectively.



*Construction of guard stations*

Ecological workshops instruct reserve personal in construction practices that will not disrupt the region's landscape. As a result, new buildings are made of local resources including adobe and compressed earth, and contain composting toilets. Temporary employment programs exist when there is a need for the construction of guard stations at strategic points in the communities of Quiotepec and Santiago Domingullo, Oaxaca state. Temporary employment programs also employ trash collectors. PRODERS provides funding for the implementation of these programs.

Community committees facilitate vigilance programs within the reserve. These committees monitor the protected area's natural resources and enforce park regulation. Offenders include poachers, traffickers of wild species, and loggers. Community committees are in constant communication with the directors of the reserve, as well as judicial authorities and the Federal Procurement of Environmental Protection (PROFEPA).

Short-term development programs have included reforestation and fire prevention. The previous administration

## *Mexico: Tehuacán-Cuicatlán Biosphere Reserve*

also initiated the program, "Management and Sustainable Development of Wildlife" (UMAS). However, the training and financial resources the communities needed to complete the projects were limited, and unfortunately, the UMAS program was not able to achieve its intended results.

An example of this program's failure is a project to increase iguana populations within the reserve (*Ctenosaura pectinata*). Plans to establish a nursery were never completed. Furthermore, the people in the community responsible for carrying out the UMAS iguana plan did not receive training or education pertaining to the management of the species. Currently, the management of the reserve is thinking of re-implementing similar UMAS programs in two communities to protect species such as the white-tailed deer.



*Management and Sustainable Development of Wildlife (UMA) of the iguana. This project and similar ones should be implemented in the region*

### *Human influence*

As previously mentioned, the Tehuacán-Cuicatlán Valley has been populated for thousands of years. Anthropological investigations found human vestiges dating from 7,000 A. D. (MacNeish 1972). These findings have contributed enormously to the understanding of the origin and expansion of the domestication of corn (*Zea mays*) and of the cultivation of plants. These developments facilitated settlement, development of culture, and the establishment of civilizations. Botanical archeological research has been able to reconstruct 11,500 years of prehistoric chronology for these inhabitants. Information concerning recognition of patterns of subsistence and development of agriculture has been documented (Byers 1967, MacNeish et al 1972). Ethnicities currently represented in the valley are Mazatecos, Chinantecos, Nahuas, Chocholtecos, Popolocas, Cuicatléos, and Ixtecos.

The valley has been irrigated for approximately 2,000 years. Through an extensive system of crop irrigation, local communities have been able to cultivate a great extent of the valley. The technology used in irrigation includes, not only a large network of canals for surface water retention, but also large aquifers accessed from a system of tunnels and caves (Enge & Whiteford 1989).

Two systems of agriculture are practiced in the valley. The first system is practiced in the pine-oak forests of the mountainsides, at altitudes greater than 1,800 m. The second system, practiced in the alluvial areas of the canyons and rivers, is one of intensive agriculture. Harvested crops include corn, haba, squash, tomatoes, beans, pepper, sugar cane, alfalfa, pineapple, lemons, melons, garlic, and sorghum.

## *Mexico: Tehuacán-Cuicatlán Biosphere Reserve*



*Cultivated area in the valley*

According to estimates by the reserve's administration, the total population of the municipalities located within the reserve is 230,000 people. Twenty municipalities in southeastern Puebla (containing 85% of the total population), and 31 municipalities in northeastern Oaxaca (containing the remaining 15% of the population) are located within the reserve. The inhabitants of the region generally associate in local communities where they speak local dialects and/or Spanish.

Tourism, owing to the beautiful landscape and great biological richness of the valley, developed in the area many years ago. Both national and foreign visitors enter the reserve from Oaxaca and the Federal District. Currently, non-governmental institutions are working on the development of the region, intending to identify places where touristic interest and development would have minimal impact to the environment of the surrounding area.

The tourism plan, developed by the reserve administration and various NGO's (such as Geoconservation), includes strict provisions for working with local communities on the promotion, administration, management, and dissemination of projects. Both the Helia Bravo Hollis Botanic Garden and the area of fossils near the community of San Juan Raya, located in the municipality of Zapotitlan de las Salinas, Puebla, are administered by local communities, which control the promotion and improvement of their tourism facilities. The Mesophile Group and Geoconservation consolidate and support the efforts of the communities of Santa Maria Ixcatlan, San Juan Bautista Cuicatlan, and Santa Maria Tecomavaca, Oaxaca in territorial development projects and the promotion of tourism in the reserve. Furthermore, although the communities manage tourism in their local area, the Secretary of Tourism supports their endeavors by marketing and decimating information on sites of interest.

Long before the creation of the Tehuacán-Cuicatlán Biosphere Reserve, tourism was a threat to the valley. A lack of monitoring or signs to indicate regulations within the protected area led to small-scale, but destructive, extraction of resources, primarily of cacti.

### *Conservation and Research*

Investigations in the disciplines of botany, zoology, hydrology, geology, and anthropology, among others, have been carried out in the valley (Ezcurra & Medina 1997, Rojas & Valiente 1996, Salas et al. 1995, Valiente et al 1997, Villasenor et al. 1990, Zavala 1982). Some of the first botanical research in the area was conducted in the 1930s by Dr. Helia Bravo Hollis (Bravo-Hollis 1978), of the National Autonomous University of Mexico (UNAM). Institutions such as UNAM, the Autonomous Metropolitan University (UAM), the National Institute of Anthropology and History (INAH), the National Indigenous Institute (INI), foreign universities, and NGOs have used the valley to conduct a large number of research projects.

## ***Mexico: Tehuacán-Cuicatlán Biosphere Reserve***

Recently, organizations such as the Society for the Study of Biological Resources of Oaxaca, and the State Institute of Ecology of Oaxaca (IEEO), have been researching basic information on the vegetation and soils in the natural areas of the state. Other research groups, including the Mesophile Group, participate in ecological development projects that determine alternative means of development for the region's communities. Through activities such as ecotourism and land reform, Geoconservation also focuses on community development. Focusing on hydrology management, the organization Alternatives for Sustainable Development (PRODERS) implements programs of crop rotation and terrace construction in order to conserve soil fertility and halt erosion.

The administration of the reserve has completed conservation projects including the construction of two guard posts in Oaxaca, where illegal hunting is a problem. In Zapotitlan and Puebla, funds are being solicited for the construction of cabins to be used by tourists and researchers working in the region.

The UNAM and other research institutions continue to enrich basic studies of biology, ecology, and other branches of science. Currently, the greatest effort of all these organizations and institutions is to participate in the Technical Scientific Committee. Supporting the reserve, this committee coordinates the work of obtaining a future management program for the Tehuacán-Cuicatlán Biosphere Reserve.

### **Threats**

Tehuacán-Cuicatlán was established as a Biosphere Reserve in 1998. It is estimated that present levels of primary vegetation remain at only 50-60% of the original cover (Palma personal communication). Over the last 25 years, the reserve's administration and scientific researchers have identified several threats gravely affecting conservation of the area. Among the most significant are:

- Cutting and extraction of cactus
- Illegal hunting
- Extensive goat grazing
- Community relations
- Pollution
- Lack of monitoring
- Lack of information
- Roads and power lines

#### *Cutting and extraction of cactus*

Selected extraction of cacti is permitted within the pine-oak forest of the reserve's mountainous areas. These resources have always been, and continue to be extracted by local communities for personal consumption. Historically, very little of the resource was taken for commercial purposes. Due to poor yields and soils, this area is not used for agriculture.

Over time, the continual cutting of the cactus plants has resulted in negative impacts on the ecosystem. The degraded landscape prevents water from filtering into the aquifers, leading to water shortages and severe soil erosion. Due to the increased difficulty of water extraction by pumping, wells must now be 100 to 200 m deep, increasing both work and costs. In the rainy season, communities have experienced torrents of water running down the eroded mountain slopes, which affects urban areas and fields under cultivation alike.



## *Mexico: Tehuacán-Cuicatlán Biosphere Reserve*



*Conversion of forests to croplands*

The lack of vigilance within the reserve has allowed the region to become rife with extractors and traffickers of species, including the endemic cacti. It is well known that there is a large market for these species at the national and international levels. Extractors from other countries have taken advantage of the conditions of poverty and marginalization of the communities living in the region. For a few pesos, local people are contracted to gather species having commercial (for collections and ornamentation), as well as research (for potential medicines) value. Of those extractions that have been detected, specimens of cactus and cactus seed are the most common. In cities such as Tehuacan, Puebla, one can find several nurseries commercially producing both ornamental and common species of cactus. However, when clients show interest or request varieties of cactuses not on display, store managers offer to obtain the desired species from the forest.

### *Illegal hunting*

Illegal hunting is not new to the region; in reality, it is a practice that has been carried out for centuries. Local communities do hunt legally, but poachers also come from towns and cities close to the reserve. Likewise, the presence of foreigners, and with them more sophisticated hunting equipment, has elevated the volume of illegal hunting in the valley. Poachers hire local residents as guides for 300 pesos a day. Their prey is usually white-tailed deer, peccary, ferrets, hare, and puma.

Presently, communities have formed "watch committees" that work in coordination with the administration of the reserve, the communal authorities, and PROFEPA. During our field investigation, ParksWatch documented a successful arrangement by guards working through one of these committees to catch poachers. The administration had suspected illegal activity in the area and was successful in identifying a group of Spaniards who has shot two deer and a puma. The leaders reported the poachers to the proper authorities.

### *Extensive grazing*

Extensive grazing in the region began with Spanish conquest, around the year 1530. At this time, much agricultural land was appropriated from the indigenous communities that depended on it, and many of these communities were relegated to the highlands. With the passing of time and through concessions from the Spanish, the indigenous populations established livestock pastures in the highlands, and in this manner were able to preserve their culture (Barabas 1991, Flannery 1983).

Due to their adaptations to environmental and climatic conditions of the valley, agricultural activity in the region involves primarily goat herding. A result of over 500 years of extensive pasteurizing, the landscape has been modified with disastrous consequences to the soil and vegetation. Goats feed on generally any type of vegetation in the valley, and their indiscriminate feeding preferences create one of the more severe pressures on

## *Mexico: Tehuacán-Cuicatlán Biosphere Reserve*

the flora of the reserve. Currently, UNAM conducts research projects on the effects of grazing on the native vegetation of the region.

### *Community relations*

The large number of people with different cultures and idiosyncrasies living in the area creates a situation where working relationships between the administration of the protected area, the NGOs, and private landholders are difficult to achieve.

Because they lack community support, and/or because many government level programs contradict one another, some communities, such as Poblana, are in disagreement about whether to even continue participating in long-running programs. Currently, various communities are disgusted with the policies of the administration of the reserve. The reserve restricts activities and natural resources extraction practices that the valley's inhabitants have traditionally practiced. Extractions before the creation of the reserve included logging, collection of firewood for sale, and subsistence hunting. Because the support of some communities is lacking, and in several cases participation has been nonexistent, community disagreements provoke difficulties in implementing reserve development programs.

When the biosphere reserve was decreed, several communities in the Oaxacan portion of the valley requested protection under the law, stating that they were not informed about their legal status as landowners within the reserve. At the time of our investigation, this sort of information was disseminated through workshops, and the people had a different attitude about the reserve and its administrators. This situation proved the importance of local participation in sustainable development programs and temporary work projects.

### *Pollution*

Along the federal roads that surround and cross the borders of the reserves it is easy to observe the accumulation of trash. Open dumps are evident near the more populated areas. Pollution is undoubtedly due to both the high concentration of inhabitants and the significant number of industries surrounding the city of Tehuacan. Another source of the high volumes of litter along the roads near and within reserve, are religious pilgrimages. Pilgrims cross the states of Oaxaca and Puebla on foot to venerate their saints.



*Garbage disposal on side roads*

### *Lack of monitoring*

The reserve's basic staff, 6 employees, does not include park guards. Employees are only in charge of projects, technical operations, and inspections of specific regions of the reserve or communities. Although small, this

## *Mexico: Tehuacán-Cuicatlán Biosphere Reserve*

workforce does have an active presence in the reserve. However, it there is a need for a greater numbers of personal dedicated exclusively to park monitoring. Additionally, to permit park staff to monitor as large an area as possible, their numbers must increase.

### *Lack of information*

There is a lack of information being disseminated within the reserve and its surrounding areas. Examples include a lack of local education on the regulations affecting communities living within the reserve, and a lack of signs posted within the interior and along the borders of the reserve. A great number of municipalities exist within the reserve's boundaries, and many claim that they are not aware of the functions of the reserve or the locations of its borders. This situation leads to disputes over land ownership. In several cases, dishonest people have sold land included as part of the protected area. The lack of adequate signs creates a situation where poachers and traffickers of wild animals can easily enter the reserve's most remote and best preserved areas.



*There are few signs providing information about the reserve's regulations*

### *Highways and power lines*

The Tehuacán-Cuicatlán Biosphere Reserve exemplifies the great risks to conservation in areas that do not have proper protection. The construction of the highway crossing the best-preserved region of the valley accelerated the process of its establishment as a biosphere reserve. Problems arose when environmental authorities at SEMARNAP permitted the construction of the highway without completing an Environmental Impact Statement (EIS). The EIS was completed after construction, by which time the study was futile.

Currently, the Federal Commission on Electricity (CFE) is installing power lines and towers. The introduction of the first power lines had grave impacts, including the destruction of plant communities under the towers. As this construction project continues, native vegetation will continue to be significantly impacted.

## *Mexico: Tehuacán-Cuicatlán Biosphere Reserve*



*Electric tower on the back. Electrical energy projects produce severe vegetation damage*

### **Recommended solutions**

#### *Cutting and extraction of cacti and illegal hunting*

The extraction of cacti and poaching have been practiced by indigenous and mestizos groups in the region for at least 100 years. These practices have considerably diminished the area's resource base. The numbers of cactus traffickers and poachers arriving from other parts of Mexico and other countries have increased within the last 20 years. The rise in illegal activity is partly because the scarce presence of guards and PROFEPA personal, the two agencies responsible for the monitoring of the reserve.

Fortunately, communities are now organizing monitoring committees to construct guard stations in strategic points along some highways. We believe that these actions to protect and monitor the area should be supported by additional economic resources. These resources would ensure continuance of the project, and facilitate the hiring of personnel dedicated exclusively to the task. To diminish these threats, action should also be taken to increase both regulatory signage and methods for disseminating information on the reserve.

#### *Extensive grazing*

Because goats deplete new shoots of vegetation, grazing practices in the valley place a large stress on the vegetation and reforested areas of the reserve. Despite the impact this practice is having on the conservation of biological diversity of the valley, there is little knowledge of the impact of grazing, as studies have been few. Thus, it is important to promote new studies working to clarify the effects that the goats have on the vegetation and its regeneration. We also recommend the reforestation of agricultural areas and pastures that have been abandoned due to their low productivity.

#### *Community relations*

Due to the regulations imposed on local communities by management, and the lack of continuity in economic and development projects, several communities in the region have recently demonstrated discontent with both reserve administration and government institutions. Additionally, the cultural traditions of the communities have not been integrated into the development plans.

Community relations with the park and government institutions could be improved by inviting the communities to participate and propose their own projects. This process would prevent the feeling of paternalism. Locals should have a means of voicing their opinions on sustainable development projects and their needs. To ensure

## *Mexico: Tehuacán-Cuicatlán Biosphere Reserve*

the success and continuity of these projects, planning should be undertaken on short, medium, and long-term scales. These actions should be endorsed by presence of reserve and government personal, as well as through local education and community participation programs.

### *Pollution*

The inability of park administration to adequately monitor the park allows for many illegal activities, including the dumping of trash within the reserve boundaries. Although the park administration has taken action by posting several signs prohibiting the disposal of garbage within the park, efforts have not been entirely effective. Signs have failed to raise local consciousness concerning the detrimental effects this activity has on the environment. We suggest a strong and continued campaign to distribute information on the impacts of trash dumping to local populations living within affected areas. Programs for trash collection, such as locating trash receptacles in heavy impacted areas including religious pilgrimage routes, should also be established. These activities will require the participation of reserve personnel, municipal authorities, and the government as soon as possible.

Local inhabitants, industry workers, as well as the industries themselves, generate large amounts of pollution. ParksWatch proposes that regional business sponsored environmental education workshops for their workers and to conduct waste collection campaigns.

### *Lack of monitoring*

The allowance of repeated illegal activities within the park, including the dumping of trash, poaching, extraction of native fauna, and deforestation, result from the lack of personal and a systematic monitoring system within the reserve. We suggest that the administration of the reserve include park guards as a component of the reserve's operating personnel infrastructure. It is also suggested the management plan provides that park guards are able to patrol as much of the reserve as possible.

### *Lack of Information*

The reserve administration has not sufficiently generated or disseminated information about the protected area. This inaction has caused a general misunderstanding of the reserves rules and regulations. This lack of understanding about the purpose of the reserve affects several sectors of the population, including communities, tourists, industries, and government programs working to promote development activities of the area. ParksWatch proposes, as a component of the management plan, the generation of information about the reserve by the administration. As soon as possible, this information on the reserves different subcomponents must be disseminated and used in environmental education. We also believe that a better system of signs could reduce pressures on the natural resources.

### *Highways and power lines*

The highway located within the reserve is one of the protected areas major problems. The layout of the road destroyed the vegetation of several of the reserve's microhabitats. Because the EIS was not completed by the time of construction, and no contingency plan existed, the species affected by the construction of the highway could not be protected. The impacts that this major construction project will have on local ecosystems are not yet known.

Future threats to the reserve include imminent colonization due to past road construction. ParksWatch believes it would be advantageous to evaluate the human activities originating from the highway's construction. Though these potential studies, changes in population dynamics within the reserve due to the road could be evaluated.

## *Mexico: Tehuacán-Cuicatlán Biosphere Reserve*

Studies on the increase in activities associated with the highway, including impacts on flora and fauna are necessary.



*Sugar cane crops within the reserve*

The CFE and UNAM are currently working with the administration of the reserve to mitigate the effects on the vegetation caused by the construction of power lines and towers. UNAM has offered workshops for CFE personnel to improve their understanding of how the electricity towers and other infrastructure effect the vegetation. Additionally, they have created a nursery for the plants negatively impacted by the construction. In the nursery, they are propagating plants they plan to use in reforestation projects within the affected areas.

### **Conclusion**

The Tehuacán-Cuicatlán Biosphere Reserve is located in a critically important region of Mexico, the confluence of the Neoartic and Neotropical regions. As a result, the reserve is one of the greatest centers of biological diversity and plant and animal endemism in the world. Because previous research within the reserve has focused mainly on its flora, there is a void in information concerning the reserve's fauna and ecological processes. For this reason, new studies should emphasize work in the areas of ecology and zoology.

The reserve administration is currently becoming more centralized. It is critical that this process is completed in a timely manner, for it will open and strengthen avenues for dialogue and coordination between the different institutions, both public and private, working within the reserve. Once the park's management plan is complete and permanent and dependable lines of communication are opened, sustainable development programs can be elaborated and provisions can be made to assure that the governing institutions do not only contradict or overlap one another. Because the organizations involved in protecting the biological diversity of the region have many adversaries, it is essential to promote collaboration between federal authorities and local communities.

Threats vary in their effects on the biological integrity of the reserve's ecosystems, and include poaching, extraction of cacti, pollution, increased human activity within the reserves, deforestation, and lack of information and monitoring. The development of a management plan for the reserve is the first step towards remedying these threats. An official management plan will help obtain much-needed funds to strengthen the reserve's ability to achieve its objectives, such as those granted by the Fund for World Environment (GEF). With this plan, we believe that those involved will have the necessary tools for effective regulation and elimination of noted threats to the conservation of the Tehuacán-Cuicatlán Biosphere Reserve.

### **Bibliography**

## ***Mexico: Tehuacán-Cuicatlán Biosphere Reserve***

- A.A. Arias Toledo., M. T. Valverde Valdés & J. Reyes Santiago. 2001. Las Plantas de la región de Zapotitlán Salinas, Puebla. UNAM
- Arriaga, L., J.M. Espinoza, C. Aguilar, E. Martínez, L. Gómez & E. Loa (coordinadores). 2000. Regiones terrestres prioritarias de México. CONABIO
- Barabas, A.M. 1991. Historia Chocholteca. Serie de Historias Etnicas 4. Centro de Investigaciones y Estudios Superiores en Antropología Social. 35 pp.
- Byers, D.S. 1967. The prehistory of the Tehuacán Valley, Vol. 1: Environment and subsistence. University of Texas Press, Austin. 331 pp.
- Bravo Hollis, H. 1978. Las cactáceas de México. Vol. I. UNAM. México
- CONANP. 2000. Areas Naturales Protegidas de México. México, D.F. 107 pp.
- CONANP. 2001. Programa de Trabajo 2001-2006. México, D.F. 64 pp.
- Dávila-Aranda, P.D. 1983. Flora genérica del Valle de Tehuacán-Cuicatlán. M.S. thesis. Universidad Nacional Autónoma de México, México, D.F. 694 pp.
- Dávila, A. P & Herrera-MacBryde. 1994-1997. in WWF and IUCN. Centres of plant diversity. A guide and strategy for their conservation. 3 volumes. IUCN Publications Unit. Cambridge, U.K.
- Enge, K.I. & Whiteford, S. 1989. The keepers of water and earth: Mexican rural social organization and irrigation. University of Texas Press, Austin. 222 pp.
- Ezcurra, E. & Medina I.R. 1997. Flora del Valle de Tehuacán-Cuicatlán. Fascículo 18. Instituto de Biología, UNAM, 13 pp.
- Flannery, K.V. 1983. Pre-Columbian farming in the valleys of Oaxaca, Nochixtlán, Tehuacán, and Cuicatlán: a comparative study. In Flannery, K.V. and Marcus, J. The cloud people: divergent evolution of the Zapotec and Mixtec civilizations. Academic Press, New York.
- INEGI. 1981. Carta Topográfica, 1:250,000. Oaxaca, E 14-9. Instituto Nacional de Estadística, Geografía e Informática (INEGI). México
- López-Ramos. E. 1981. Geología de México, Tomo III. Publ. Particular autorizada, México, D.F. 446 pp.
- MacNeish, R.S. 1972. Summary of the cultural sequence and its implications in the Tehuacán Valley, In MacNeish, R.S. et al., the prehistory of the Tehuacán Valley. Vol 5: Excavations and reconnaissance. University of Texas Press, Austin. Pp. 496-504
- MacNeish, R.S., Peterson, F.A. & Neely, J.A. 1972. The archaeological reconnaissance: Introduction. In: MacNeish, et al., The prehistory of the Tehuacan valley, vol, 5: Excavations and reconnaissance. University of Texas Press, Austin. Pp 341-360.
- Rojas, M. A. & Valiente, A.B. 1996. Análisis comparativo de la quiropterofauna del Valle de Tehuacán-Cuicatlán. Acta Zoológica Mexicana: 67.1-23
- Salas S., L. Schibli, E. Torres, G. Ramírez & A. González. 1995. Análisis de la vegetación y uso actual del suelo en el estado de Oaxaca III. (Cañada y Mixteca). Informe técnico final SERBO A.C. The John D. And Catherine T. MacArthur Foundation y WWF. México 202 pp.
- SEMARNAT-UAM. 1997. Estudios climaticos y de la vegetación de la Reserva de la Biosfera Tehuacán-Cuicatlán. Informe Técnico. 192 pp.
- Smith, C.E. 1965. Flora, Tehuacán Valley. Fieldiana, Bot. 31:101-143
- Valiente-Baunet, A., A. Rojas-Martínez, M.C. Arizmendi & P. Dávila. 1997. Pollination biology of two columnar cacti (*Neobuxbaumia mezcalaensis* and *Neobuxbaumia macrocephala*) in the Tehuacan Valley Central Mexico. American Journal of Botany 84 (4): 452-455
- Villaseñor, J. L., Dávila, P & Chiang, F. 1990. Fitogeografía del Valle de Tehuacán-Cuicatlán. Bol. Soc. Bot. 50: 135-149
- Zavala, H.J.A. 1982. Estudios ecológicos en el Valle semiárido de Zapotitlán, Puebla. Clasificación numérica de la vegetación basada en atributos binarios de presencia o ausencia de las especies. Biótica 7:99-1202