

# ECOLOGICAL RISKS INVOLVED IN THE CONSTRUCTION OF THE BORDER FENCE

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During the last decade, conservation efforts have led us to identify those regions of great biological wealth that due to human activities are at high risk of losing species. Those regions, known as “Hotspots”, are found throughout various ecosystems around the globe (Myers *et al.* 2000). Of the 34 currently identified, three are found within Mexico (Conservation International 2007): the Mesoamerica, the California Floristic Province, and the Madrean Pine-Oak Woodlands. The latter two extend beyond our country’s northern border. The California Floristic Province (CFP) runs along more than 113,437 mi<sup>2</sup> from the southern part of the state of Oregon, extending across most of the state of California and the northwestern part of the state of Baja California. This floristic province is characterized by the diversity of its communities, among which are coniferous forests, grasslands, wetlands, coastal scrub and chaparrals, only to mention the most conspicuous. The vegetation wealth is estimated at approximately 3,488 species, out of which 61% is only found in this part of the planet. Some of these endemic species are found in more than one community and are widely distributed within the floristic province. Nevertheless, a significant percentage has a distribution area restricted to hundreds or even tens of square miles, which puts them at risk of disappearing as a result of changes in land use. The region that extends from Southwest California through Northwest Baja California has types of vegetation such as coastal dunes, coastal scrub and chaparral. Some of the species

found in these communities on both sides of the international border, such as the cactacea *Bergerocactus emoryi* and the compositae *Hazardia orcuttii*, *Adenothamnus validus*, have been proposed as candidates to the list of species under special protection, which according to the Official Mexican Norm (known as NOM in Spanish) are endangered species due to the rapid loss of its presence in natural communities.

The Madrean region extends mainly along the Sierra Madre Oriental and Sierra Madre Occidental mountain ranges, and the Trans-Mexican Volcanic Belt, from the state of Chiapas in the southeastern part of Mexico up to Arizona, New Mexico and Texas, where it covers over 40 mountaintops or “Sky Islands”, a significant percentage of which are part of the network of protected areas in the southern United States. In the Baja California peninsula it covers the highest points in the sierras that extend across this physiographical unit (Figure 1). With an area that exceeds 178,070 mi<sup>2</sup>, it contains a fourth of all Mexican flora. This region represents a natural corridor for migratory species that come from the northern United States or Canada (birds, bats or butterflies) that breed in Mexico. The Madrean region contains 40% of the species of pine and 30% of the species of oak in the world, as well as an estimated 525 species of bird.

Even though the ecosystems that are richer in number of species are those located in the Southeast, the temperate or dry forests are the ones that display the greatest percentage of endemic species. The Tamaulipan, Sonoran and Chihuahuan scrubs and the coniferous and oak forests are part of a compound of floristic regions that extend into the states of California, New Mexico and Texas in what has been called, from the floristic point of view, Mega-Mexico (Rzedowski 1991).

The enormous Mexican biological capital, which is reflected in the number of species as well as in the diversity of its biological communities, and which places this nation among the mega diverse, is one of the motivations that drive the National Commission for the Knowledge and Use of Biodiversity (CONABIO) to define priority conservation regions. In this sense, terrestrial, marine and hydrological regions have been established for the conservation of bird species. To date, based on their biological capital, the environmental services they provide or their importance as biological corridors as well as their low degree of deterioration, there are 152 Terrestrial Priority Regions (TPR) defined for conservation. Out of the 1,952 miles that span the length of the international border, 27% are adjacent to 11 of these regions (Figure 1, Table 1).

Table 1. Priority Conservation Areas on the U.S.-Mexico Border 1

Region <sup>2</sup>	State(s)	Surface Area in mi <sup>2</sup>	Length along the Border in Miles	Natural Communities	Function as a Biological Corridor	Species that are Threatened, Endangered or Under Special Protection
Sierra de Juarez Mountain Range <sup>3</sup> (1)	Baja California	1,764	9.57	Chaparral, desert scrub, pine forest	A corridor between the sierras in the Baja California peninsula and the mountains in California	Bighorn sheep, cougar
Altar-El Pinacate Great Desert <sup>3,4</sup> (2)	Sonora	2,759	86.41	Dune vegetation and coastal desert scrub	A corridor within the Sonoran Desert, Arizona-Sonora-Baja California	Cactus, reptiles, birds
Cananea-San Pedro <sup>3</sup> (3)	Sonora	1,284	41.58	Natural grasslands, oak forest	A biological corridor within the Chihuahuan, Sonoran deserts, the Arizona mountain ranges.	American black bear, lynx, cougar, golden eagle
Sierra de San Luis-Janos Mountain Range <sup>3</sup> (4)	Chihuahua-Sonora	3,992	58.79	Grasslands, oak forest, pine forest, desert scrub	Between the southern mountains in the U.S. and the Sierra Madre Occidental	Bison, mule deer, ferret, prairie dog
Samalayuca Sand Dunes (5)	Chihuahua	1,223	35.99	Dune and halophilous vegetation	Heritage region	Annual plants and yucca and subterranean forms

Table 1. Priority Conservation Areas on the U.S.-Mexico Border 1 (continued)

Region <sup>2</sup>	State(s)	Surface Length along the Border Area in mi <sup>2</sup> in Miles	Natural Communities	Function as a Biological Corridor	Species that are Threatened, Endangered or Under Special Protection
Santa Elena Canyon <sup>4</sup> (6)	Chihuahua-Coahuila	1,326 72.85	Microphyll desert scrub, rosette-like desert scrub, natural grasslands	Biological corridor to the Big Bend region	Beavers, cactus and riparian birds
Sierra Maderas del Carmen Mountain Range <sup>3,4</sup> (7)	Coahuila	804 18.90	Chaparral, grasslands, rosette-like desert scrub, pine forest	Biological corridor to the Big Bend region	Timber-yielding species, birds
Sierra El Burro Mountain Range-San Rodrigo River <sup>3</sup> (8)	Coahuila	3,440 14.83	Chaparral, submontane scrub, Tamaulipan thorn scrub, rosette-like desert scrub, oak forest, grasslands	Connects the Terrestrial Priority Regions of Cinco manantiales and Tamaulipan scrub in the lower Rio Grande	American black bear, beaver, fish, 24 species of birds
Cinco Manantiales (9)	Coahuila	1,220 17.26	Tamaulipan thorn scrub, submontane scrub, oak forest, grasslands	Connects the Tamaulipan scrub in the lower Rio Grande TPR with the El Burro Mountain Range - San Rodrigo River	Various species of oak and hickory

Table 1. Priority Conservation Areas on the U.S.-Mexico Border 1 (continued)

Region <sup>2</sup>	State(s)	Surface Area in mi <sup>2</sup>	Length along the Border in Miles	Natural Communities	Function as a Biological Corridor	Species that are Threatened, Endangered or Under Special Protection
Lower Rio Grande Tamaulipan Scrub (10)	Coahuila, Nuevo León, Tamaulipas	4,025	164.56	Tamaulipan thorn scrub, mezquital, rosette-like desert scrub	A corridor for both sides of the border	157 endangered species in the U.S. border region
Laguna Madre 3,4 (11)	Tamaulipas	3,303	18.08	Halophilous vegetation, dune scrub, low thorn forests	Transition zone to Neartic fauna	Birds
Total		25,140	538.81			

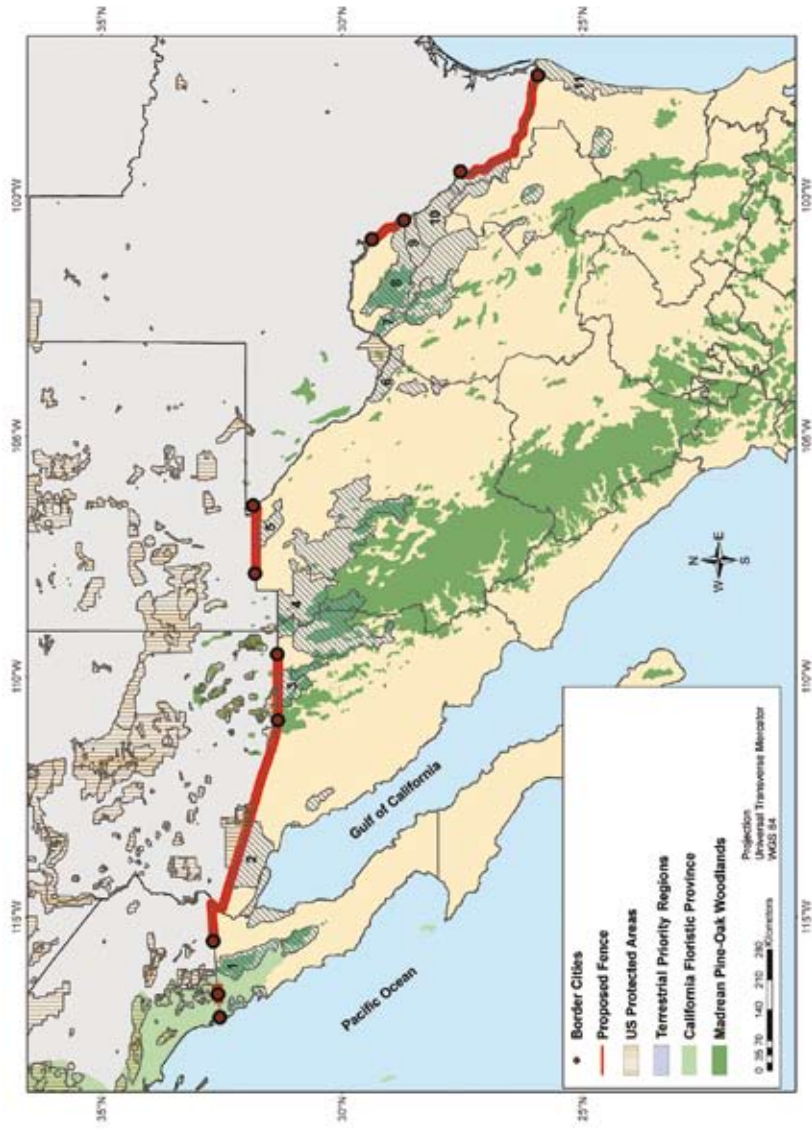
1 Sources: Arriaga, et al. 2000, Benítez, et al. 1999, CONANP, 2007.

2 The numbers in parenthesis correspond to those in Figure 1.

3 Coincides with Important Bird Area (IBA).

4 Totally or partially included within a Natural Protected Area.

Figure 1. U.S. Mexico border, Mexican terrestrial priority regions (TPR), U.S. protected areas, and hotspots. TPR numbers correspond to Table 1



One of the first effects of modifying the natural environment is the fragmentation of the landscape; the consequences are manifested in the biological systems' various levels of complexity (Table 2).

Table 2. The Effects of Landscape Fragmentation on the Various Levels of Ecological Complexity

Level of Complexity	Effects
Organisms	Physiological changes. Behavioral disruptions. Isolation and a reduction in their reproductive capacity
Populations	Reduction in genetic variability. Reduction in the size of populations. Changes in the age structure. Isolation of populations. Changes in migration patterns.
Communities	Changes in species diversity and richness. Changes in trophic networks. Invasion by noxious species. Increase in the risk of animals spreading diseases.
Ecosystems	Reduction in the capacity to offer goods and services. Erosion; pollution of soil, air and water bodies. Changes in waterways, a drop in the phreatic level. Changes in the means of production and an increase in the population's poverty level.

New roads and highways, agricultural, forestry, livestock or mining activities and human settlements disrupt biological communities, which under natural conditions would present a continuous distribution across natural gradients, leading then to fragment and present a partial or total degree of isolation, forming patches that have lost many of their distinctive characteristics and are no longer representative of their original communities..

The cumulus of knowledge that the science of ecology comprises, from the theoretical as well as the practical perspective, allows us to generate scenarios of the possible consequences that changes to the border environment may bring about and their long term repercussions.

The number of species contained in a community is the result not only of the conjunction of historical and environmental factors; it is also related to the surface area that the community covers. The models created by Olof Ar-

rhenius (1921), later reconstructed by the American ecologist Frank W. Preston (1948, 1962), are part of the theoretical support that has enabled us to explain this relationship between area and wealth of species. With the fragmentation of the natural landscape, the biological communities it contains suffer a loss of unity, forming a mosaic of patches of various sizes and a partial or total degree of isolation from each other, and which will depend on their species' capacity for dispersion or displacement. As the fragmentation increases and the patches are smaller, the number of species decreases, not only within each vegetation patch, but also the species richness of all the patches will be less than that of the original community. The first populations to disappear will be those whose individuals: a) require vast territories for feeding and maintaining a reproductive population, as is the case of felines and bears, and b) those species categorized as "rare" because of the small size of their populations. The disappearance of predators promotes the proliferation of rodent populations that impact not only the plant community, but also affect the regional agricultural economy and promote an increase in species considered noxious or hazardous, such as coyotes and rattlesnakes, their natural predators. The increase of rodent species could become a risk to public health, as is the case with Lyme disease, caused by the spirochete *Borrelia burgdorferi* which is transmitted by ticks of the genus *Ixodes*, which parasitize birds and mammals (Allan *et al.* 2003).

The fragmentation of populations into isolated nuclei has repercussions on their genetic characteristics. The isolation of small reproductive groups raises the reproduction rate between related individuals, allowing the appearance of undesirable traits, which is especially worrisome in species that have biological and economic importance.

The reduction in the size of animal populations or their isolation caused by fragmentation of the landscape reduces the frequency of encounters between reproductive individuals. As a result, populations lower their reproduction rate to a level from which they cannot recuperate. Young pre-reproductive and reproductive individuals dwindle in numbers, populations become senile and even though they may still persist in the remaining patches of natural habitat, their low or nonexistent reproductive capacity condemns them to disappear, since there are no young individuals to balance the population pyramid.

With the fragmentation of the landscape, edge conditions that were previously nonexistent, start to appear. The natural environment suffers drastic modifications along its boundaries, the removal of the original vegetation, soil compaction and pollution which leads to the introduction of species that

are non representative of the original biota. The bordering area generates an interconnected network of altered conditions that favor the dispersion of harmful and aggressive species that are difficult to eradicate, which change the natural conditions and impact the regional economy. The alteration of the natural environment along the edges forms a gradient from the edge toward the interior. As the landscape is fragmented into smaller patches, the edge effect reaches the nucleus zones, permanently modifying the original community.

The transformation of the landscape resulting from works of engineering alters the natural drainage patterns, changing the course of seasonal streams and waterways. It also promotes erosion which leads to the loss of soil that accumulates in low lying areas silting up ponds and bodies of water which harbor seasonal vegetation communities that represent points of refuge, nesting and night shelter for migratory birds.

The effects of landscape fragmentation may not be immediately perceptible; nevertheless, they are almost always irreversible and give rise to a chain of causal factors that unfold over time and lead to the loss of biological capital and a reduction in the ecosystems' capacity to provide goods and services.

Even if in the future, a process develops to eliminate the border fence, its effects would remain for a long time, and many of them, in fact, would be permanent and would remain as one more scar inflicted on our planet by political decisions.

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For more information, see the website from Conservation International, 2007, *Biodiversity Hotspots*. <http://www.biodiversityhotspots.org/xp/Hotspots>.