



PARKS WATCH

Strengthening Parks to Safeguard Biodiversity

Park Profile – Mexico El Vizcaíno Biosphere Reserve



Date of field visit: December 2003

Date published: October 2004

Location: Peninsula of Baja California encompassing parts of the Pacific Ocean and the Sea of Cortés

Year created: 1988

Area: 2,546,790 hectares

Ecoregion: Xeric scrublands of Baja California – Mexico and Xeric scrublands of Sonora, Mexico and US.

Habitat: Xeric microphyll scrublands, pine forests, halophytic vegetation of coastal dunes, mangroves, and coastal lagoons.



Summary

Description

El Vizcaíno Biosphere Reserve is Mexico's largest protected area. Ecosystems found within the reserve include arid zones, dunes and a 5 km-wide littoral zone along its 450 km of coast. The reserve also includes three gray whale sanctuaries that were created in 1972: Ojo de Liebre, Guerreño Negro and San Ignacio Bays. In 1993, UNESCO listed "Pinturas Rupestres de la Sierra de San Francisco" and Vizcaíno's Whale Refuge Bays as part of the Man and the Biosphere Program (MAB-UNESCO) because of their exceptional natural and cultural value. In 2004, San Ignacio and Ojo de Liebre Bays were also listed in RAMSAR as Wetlands of International Importance.

Biodiversity

Vizcaíno's region is biologically rich; its marine resources are especially important. There are 308 terrestrial and marine vertebrates inhabiting the reserve, not including fish. There are 469 flora species, most of which are shrubs and small trees. There are 39 regionally endemic floral species. In addition to its biological diversity, the reserve includes more than 200 caves with rupestrian paintings and petroglyphs.

Threats

El Vizcaíno Reserve is **threatened** and there is a great risk that in the near future it will fail to protect and maintain its biodiversity. The main threats include agriculture, overuse of groundwater reserves, extensive grazing, illegal fishing, and legal and illegal hunting. Future, potential threats include a mega-tourism/infrastructure project called "Escalera Náutica" or Nautical Ladder, and mining activities.

Description*Physical description*

This reserve is located between 26° 29' 20" and 28° N and 112° 15' 45" and 115° 15' W in the Peninsula of Baja California. The protected area is in the municipality of Mulege, which is part of the state of Baja California Sur (Southern Baja). Its boundaries include a 5 km-wide strip running along the beach into the Pacific Ocean and the Gulf of California (also known as the Sea of Cortés). Vizcaíno's total area is 2,546,790 hectares. The low elevations of the central and western parts of the reserve receive constant coastal winds and intense solar radiation. Altitudes range from 0 at the coast to 1985 meters above sea level at the highest peaks in the mountains. Median annual daily temperatures range from 18° to 22 °C, and during the night temperatures plunge. Average yearly precipitation is usually below 80 mm; although precipitation can drop to 0 mm per year for up to four years at a time, or jump to a few hundred mm in a single year (INE 2000; Arriaga *et al.* 2000).

These extreme climatic conditions result in high evaporation rates; river and stream waters do not reach the ocean. Constant transversal winds continually form dunes. The reserve's mountainous sector is found in the east, where elevations reach over 1600 m, temperatures are cooler, and peaks are occasionally covered with snow during the winter. These mountains are made up of sedimentary and extrusive volcanic rocks. Las Vírgenes, Partido and Azufre volcanoes are located in the San Francisco Range (Sierra de San Francisco). Azufre Volcano is active and possesses important geothermic energy sources. There are 16 islands and islets included in the reserve--the largest are Isla Natividad, Isla Asunción and Isla San Roque.

According to Dinerstein *et al.* (1995), the reserve belongs to the following terrestrial ecoregions: Xeric scrublands of Baja California and Mexico and Xeric scrublands of Sonora, Mexico and the US.

The most representative habitats include xeric microphyll scrublands and xeric shrubs and cacti. There are also marine portions included in the reserve, because they are conservation priorities

(Sealey and Bustamante 1999; Arriaga *et al.* 2000) within the following ecoregions: the Mexican Temperate Pacific and Gulf of Cortés.

Physical characteristics of the marine environments on both coasts are distinct and determine the specific biological diversity and richness present in each. The eastern coast, Gulf Coast, is a transitional area of temperate and tropical species. This partially closed bay contributed to speciation, influenced the formation of endemic species and helped create very diverse biota (Brusca 1980).

The western Pacific Coast is less diverse; but, because the environment is more temperate with permanent emergences, valuable species with high economic potential abound.

Archeology

There are many archeological remains in the region, including cave paintings, petroglyphs and shellfish fossils . The most important cave art in North America is found in the eastern San Francisco Range. There are more than 200 caves with paintings of huge men, pronghorns (*Antilocapra americana peninsularis*), sheep, pumas, birds, whales, turtles, snakes and what appears to be stars, in addition to other images (Hambletón 1979). The ancient Californians' paintings are approximately 10,000 years old.



*Many of the caves within and around the reserve contain cave paintings showing men and wildlife.
This painting depicts a pregnant woman*

In addition to these archeological remains, the colonial legacy continues in surviving architecture. For example, one important colonial architectural structure is the mission of San Ignacio de Loyola, founded in 1728. The most exquisite adornments in the entire peninsula are found within the mission and include a carved, gold-plated wood altar, and oil paintings, among others (CIBNOR 1995).

Historical monuments include the city of Santa Rosalía, because it is the only town in the region with French-colonial influenced architecture. The National Institute of Anthropology and History

(INAH) has cataloged 20 monuments such as the Central Hotel, the Boleo Store, the French Hotel, the Nuestra Señora del Carmen Church, and two works by Gustave Eiffel, among others.



Geographic location of El Vizcaino Biosphere Reserve in the state of Southern Baja California.

Biodiversity

Flora

Flora of the Vizcaíno Desert Region includes many species that live in harmony with the arid landscape. Thus far, 469 species have been identified, a third of which have shrub-like forms. A majority of the others are annual and perennial herbaceous plants. There are 39 endemic floral species in the protected area (León de la Luz *et al.* 1995; INE 2000; WWF and IUCN. 1994-1997). Threatened species include fan palms (*Erythea armata*, *Washingtonia filifera*, *W. robusta*) and tree yucca (*Yucca valida*) (INE 2000). The following vegetation types are found in the area:

- Sarcocaul (Mattoral sarcocaul) shrubland: Thick-stemmed trees and shrubs are characteristic of this vegetative type. Its plants grow in rocky soils from 500 m in the plains to 1200 m in the mountains. Representative species include: *Bursera microphyla*, *B. cerasifolia*, *Agave sebastiana*, *Opuntia invicta*, *Yucca valida*, and *Ephedra aspera*.



Fruit of the catci known as pithaya (*Stenocereus thurberi*) is protected from predators because it is covered by spines

- Sarcocrasicaul (Matorral sarco-crasicaule) Scrublands: Species in this classification are mostly cacti, many of which have candelabra forms and tall stalks, such as *Pachycerus pringlei*, *Stenocereus gummosus*, *Ferocactus chrysacantus*, and *F. peninsulae*; these last two species are threatened (D.O.F. 2002).
- Halophytic Vegetation: Species in this vegetative group are tolerant of high salinity and alkalinity soils. Representative species include *Ambrosia magdalenae*, *Agave vizcainoensis*, *Euphorbia misera*, *Frankenia grandifolia*, and *Opuntia cholla*.
- Dune Scrublands: Vegetation grows on coastal dunes and helps stabilize the dunes. Representative species include *Abronia carterae*, *Asclepios subulata*, *Chaenactis lacera*, and *Proboscidea altheaefolia*.
- Spineless Scrublands: This vegetation is found between the Halophytic and Dune Scrublands and it is more densely vegetated. Characteristic species include *Asclepias subulata*, *Encelia californica*, *Jatropha cinerea*, *Larrea tridentate*, and *Rhus microphylla*.
- Microphyllous (Matorral desertico microfilo) Scrublands: This group is made up of Dune and Halophytic vegetation and has sandy and rocky soils. Herbaceous and semi-shrub species are most common. The shrub species has non-spiny, deciduous plants. Representative species include *Acacia farnesiana*, *Ambrosia dumosa*, *Prosopis glandulosa*, *Euphorbia misera*, and *Stegnosperma halimifolium*.
- Coastal Dune Vegetation: This vegetation is next to Halophytic Vegetation and grows along the littoral zone. Characteristic species include *Abronia gracilis*, *Atriplex canescens*, *Dalea maritima*, *Plantado insulares*, and *Mesembryanthemum cristallinum*.
- Eriales: These are located close to bays, such as Ojo de Liebre and San Ignacio. Species' abundance is low and there are few individuals. Species growing here are tolerant of the

saline and alkaline soils, constant winds, and elevated solar radiation. Genera include *Atriplex*, *Salicornia*, *Allenrolfea*, *Suaeda*, and *Limonium*.

- **Aquatic vegetation:** This category consists of mangrove species that have small trunks immersed in the water. Species include *Rhizophora mangle*, with special protection status, and *Laguncularia racemosa* (Delgadillo *et al.* 1992). Submerged species include *Zostera marina*, *Phyllospadix scouleri*, and *Ruppia maritima*.

Marine vegetation in the Sea of Cortes is of tropical origin and is less abundant than the vegetation off the western coast. There are 85 species of macro-algae reported for Ojo de Liebre Bay, including *Sargassum spp*, *Neogardhiella sp*, *Laurencia irieii*, *L. pacifica*, *Zostera marina*, *Chondria californica*, *Colpomenia sp.*, *Gigartina tedii*, *Asparagopsis taxiformis*, and *Euchema uncinatum*. It has been found that *Euchema uncinatum* has biotechnological applications.

Terrestrial fauna

Not including fish, there are 308 species of terrestrial and marine vertebrates present in the reserve. There are 4 amphibian, 43 reptile, 192 bird, and 69 mammal species (Alvarez-Castañeda and Patton. 2000; CIBNOR 1991a; INE 2000). According to Official Mexican Ecological Norm 059 published in the Federation's Official Registry (NOM-059-ECOL-2001), within the reserve there are 17 threatened species, including four endangered, six under special protection and one rare species (DOF 2002). There are only two endemic species within the protected area: Baja California rock squirrel (*Spermophilus atricapillus*) and the agile kangaroo rat (*Dipodomys peninsulares*).

Within the herpetofauna, the reptiles and lizards are best represented. Notable species include one terrestrial turtle (*Chrysemys scripta*), the Baja worm lizard (*Bipes biporus*) and five marine turtles in danger of extinction: *Dermochelys coriacea*, *Caretta caretta*, *Chelonia mydas*, *Eretmochelys imbricata*, *Lepidochelys olivacea* (IUCN 2003). Seven of Baja California's endemics are found within the reserve: *Bipes biporus*, the lizards *Petrosaurus thalassinus*, *Cnemidophorus labialis*, *Elgaria paucicarinata*; and the snakes *Eridiphas slevini*, *Crotalus enyo*, *Crotalus exsul* (Flores-Villela 1993).

Of a total 120 bird species, the majority are aquatic, some terrestrial. Best-represented families include Anatidae with 23 species, and Scolopacidae and Laridae with 22 species each.

The habitat diversity found in the reserve's bays and along its coast is an important resource for thousands of migratory birds that arrive every year. The bays of Guarrero Negro, Ojo de Liebre, and San Ignacio are the most important wintering grounds for the Pacific black brant (*Branta bernicla nigricans*), whose flocks number in the thousands. Other important migrant species arriving in lesser numbers include lesser scaup (*Aythya affinis*), red-breasted merganser (*Mergus serrator*), and northern pintail (*Anas acuta*). The reserve's wetlands are considered extremely important wintering grounds for coastal birds. There are estimates that more than 500,000 individuals winter along the Peninsula's western Pacific coast (Carmona and Danemann 1998).

Some species that nest in the reserve include the osprey (*Pandion haliaetus*), which has a large population, the brown pelican (*Pelecanus occidentalis*), the reddish egret (*Egretta rufescens*), terns (*Sterna maximus*, *S. antillarum*, *S. caspia*), and snowy plover (*Charadrius alexandrinus*), among others (Salinas-Zavala *et al* 1991).

Several terrestrial birds are listed as threatened to some degree in NOM-059-ECOL-2001. Golden eagles (*Aquila chrysaetos*), the peregrine falcon (*Falco peregrinus*), and the prairie falcon (*Falco mexicanus*) are listed as threatened; the bald eagle (*Haliaeetus leucocephalus*) is listed as endangered (D.O.F. 2002; IUCN 2003).

There are 44 terrestrial mammals under special protection (D.O.F. 2002), including the peninsular pronghorn (*Antilocapra americana peninsularis*) (which is considered endangered [Castellanos and Holland 2001; Conde 2003; CIBNOR 2004]), mule deer (*Odocoileus hemionus*), and bighorn sheep (*Ovis canadensis*). Among the large predators, the reserve has pumas (*Puma concolor*), bobcat (*Lynx rufus*), and coyotes, which are the most abundant and widely distributed in the zone. The kit fox (*Vulpes macrotis*) needs open soils in order to excavate its dens, and is therefore an example of a threatened species whose distribution is limited (CIBNOR 1991).



The peninsular pronghorn (Antilocapra americana peninsularis) is an endangered species protected in the reserve (NOM-059.ECOL-2001)

Marine fauna

The magnitude of marine biodiversity in the reserve is not entirely known, however the principal invertebrate groups include: sponges, cnidarians (stinging cells like jellyfish, anemones, and corals), platyhelminthes (flatworms), pelecypod (bivalves), opisthobranchia (sea slugs), chitons, cephalopods (nautilus, squid, cuttlefish, and octopus), barnacles, gastropods, shrimp, crabs, and echinoderms (starfish, sea urchins, sea cucumbers). Notable species include the California spiny lobster (*Panulirus interruptus*) because of its high economic value, and the kelp (*Macrocystis*

pyrifera) community because it is the main prey for other species like abalone (*Haliotis spp.*) and lobsters (*Panulirus spp.*).

There is approximately 113 species of ichthyofauna, but most likely this is an understatement--more research is needed to identify these species more thoroughly. Species off the western coast include spotted sandbass (*Paralabrax maculatofasciatus*), and fringed flounder (*Etropus crossotus*) (Miller and Lea 1972; Leija Tristán *et al.* 1991; Acevedo 1997). Important pelagic species supporting the fishing industry include: Pacific sardine (*Sardinops sagax*), Pacific anchoveta (*Cetengraulis mysticetus*) and California anchovy (*Engraulis mordax*), milkfish (*Chanos chanos*), Panama hake (*Merluccius angustimanus*), yellowtail jack (*Seriola dorsalis*), common dolphinfish (*Coryphaena hippurus*) and Spanish mackerel (*Scomber japonicus*). Other species include *Hippocampus ingens*, *Signathus auliscus*, *Fistularia commersonii*, *Paralabrax clathrathus*, *Calamos brachisomus* and *Diodon holocanthus* (De La Cruz-Aguero *et al.* 1996; Leija Tristán *et al.* 1991).

Off of the eastern coast, the most representative species include groupers *Mycteroperca rosacea*, *M. jordani* and *Epinephelus labriformis*—which are very valuable. The mesopelagics, that is, mid-depth dwelling fish, are also common off of the eastern coast. The most important species include 18 shark species, and 14 manta ray species that are also important to the fishing industry.

Charismatic marine mammals such as the gray whale (*Eschrichtius robustus*) are under special protection (IPN. 1986; Taylor 1990; Álvarez and Granados 1992; D.O.F. 2002). This large mammal is found off of both coasts and uses the Ojo de Liebre and San Ignacio Bays to reproduce. Another captivating mammal is the California sea lion (*Zalophus californianus*), also found on both coasts. Its largest congregations are on large islands like Natividad, Asunción, and San Roque. The common seal (*Phoca vitulina*) also inhabits deserted beaches and islands like San Roque (INE 2000).



The gray whale (*Eschrichtius robustus*) is protected in Vizcaíno Bays where it arrives every year to reproduce



In the reserve, Isla Asunción protects large colonies of California sea lions (Zalophus californianus); some groups have more than 200 individuals

Management

Vizcaíno Biosphere Reserve was created through a decree published November 30, 1988 in the Federation's Official Registry (D.O.F 1988). In 2000, the National Ecology Institute (INE) presented and published the reserve's management program. The program is extensive and considers the main factors influencing the protected area (Ortega and Castellanos 1995; INE

2000; INE-SEMARNAP-FMCN 2000). The National Commission of Natural Protected Areas (CONANP) is responsible for administering and managing the reserve.

This reserve has been zoned. There are several core zones in which permitted activities are restricted to environmental education, scientific research, recreation, and tourism. There are 16 core zones covering 362,438 hectares including:

1. Desierto del Vizcaíno
2. Guerrero Negro
3. Laguna Ojo de Liebre I
4. Laguna Ojo de Liebre II
5. Laguna Ojo de Liebre III
6. Laguna Ojo de Liebre IV
7. Laguna Ojo de Liebre V
8. Vertiente de California (Tinajas de Murillo)
9. Isla Delgadito
10. Islas pelicano
11. Islotes Delgadito
12. Isla Malcomb
13. Isla San Ignacio
14. Isla San Roque
15. Isla la Asunción
16. Isla Natividad

The rest of the reserve is part of the buffer zone. The buffer zone's objective is to maintain and improve ecosystem conditions and ensure continuity of ecological processes. This zone is further subdivided into other areas and covers a total of 2,184,351 hectares:

- a. Sustainable Natural Resource Use Zone: Sustainable use activities are permitted, including activities that modify the ecosystems when that is the best option from a technological and legal point of view.
- b. Restricted Use Zone: Sustainable natural resource development activities are permitted as long as they maintain the ecosystems' conservation, improving the state of conservation in certain situations.
- c. Human Settlement Zones: Settlement is allowed in these population centers, including legal, rural farms and territory reserves.

The World Heritage Sites declared by [UNESCO](#) in 1993 located within the reserve include:

1. Gray Whale Refuges in Vizcaíno's Bays: Lagunas Ojo de Liebre, Guerrero Negro, and San Ignacio.
2. The Sierra de San Francisco Cave Paintings.



Laguna San Ignacio is a recently declared RAMSAR site (2004). Here, thousands of aquatic birds congregate

Mining exploration and exploitation is prohibited within San Ignacio Bay (INE 2000). There is no such prohibition mentioned for Ojo de Liebre Bay, and in Sierra de San Francisco mining activities are conditional, based on rules 76, 77, and that declare any mining projects in the area must follow the established guidelines set in the General Law of Ecological Equilibrium and Environmental Protection (LGEEPA), in the reserve's management program, and finally in the regulations stated in the Mexican Official Norms published in the Federation's Official Registry.

Vizcaíno Biosphere Reserve has 22 employees, five of whom are core staff (a director, a vice-director, an administrator, and two project coordinators). The other 17 are field support staff and patrol officers. There are three field stations, also used as offices and control posts. One station is the reserve's central office and it is located in Guerrero Negro. The second station is Berrendo, located in the Desierto del Vizcaíno, and the third station is Borrego, located near the Tres Vírgenes Volcano.



El Vizcaíno Biosphere Reserve's offices are located in the city of Guerrero Negro; they are better known as the house of wildlife

The total budget for 2003 was approximately \$US 270,000. The principal sources of funding were the Federal Government (via CONANP), which provided \$US 87,000; the Global Environment Fund (GEF), which provided \$US 100,000 for reserve operations; and private institutions like the FORD Foundation and FMCN (CONANP 2004; B. Bermúdez Personal Communication).

It is important to mention that in 2003 a bilateral cooperation agreement was signed between Spain and Mexico via the Secretary of the Environment and Natural Resources (SEMARNAT) and the Spanish Aid Agency in order to conserve El Vizcaíno Reserve's natural resources. Currently, CONANP is also formalizing cooperation agreements with countries like Brazil, Costa Rica, Belize, and Australia (CONANP 2003).

Human influence

The Peninsula of Baja California is one of the least populated regions in the country: there is less than one inhabitant per km² (INEGI 2003; CIBNOR1995). This is also true of El Vizcaíno Biosphere Reserve. As of the 2000 census, the reserve's population was estimated at 38,000 inhabitants. The largest communities, where 44% of all the inhabitants live, are Guerrero Negro, El Vizcaíno, and Santa Rosalía. Other important communities include San Ignacio, Bahía Asunción, La Bocana, Bahía Tortugas, Punta Abreojos, and the ejido Díaz Ordaz Grupo 2. There are some illegal settlements found in San Ignacio and in the estuaries (El Cardonal and El Dátil), and to this date no exact data exist regarding the number of illegal inhabitants.

Reserve inhabitants are dedicated to intensive agricultural. Farming is extremely important as both a source of food and as a source of employment in the region of the Desierto del Vizcaíno. Extensive grazing is also a common activity, although it is not financially profitable aside from

some intensive milk producing activities. Fishing is another important activity in the region because of the great species richness and biological diversity (G. Carreón Personal Observation. INE 2000). Mining also plays an important role in Guerrero Negro, where Exportadora de Sal S.A de C.V operates a salt mine; it is the largest salt mine in the world, extracting approximately 7 million tons per year.



Agricultural fields in Vizcaíno Valley produce large quantities of vegetables, which are primarily exported to the United States of America

In addition to salt, the mining industry also exports gypsum, copper, cobalt, manganese, silica, and phosphorous. In the past, Santa Rosalía was an important mining town, however today it is less important and large mining companies have left (INE 2000). Small communities and private properties around the protected area do not seem to be using Vizcaíno's natural resources; rather, they extract resources from their own properties.

The Transpeninsular Highway No. 1 is the most important access road to the reserve. No. 1 goes from Loreto in Baja California Sur, to Tijuana in Baja California (Gómez-Pompa and R. Dirzo 1995; INE 2000). The reserve can be accessed via air as well, arriving in Loreto in the south or Tijuana in the north. There is an airport in Guerrero Negro, but the flights are irregular and expensive. There are also landing strips in San Ignacio that used during the whale season. There are many bays along the western Pacific coast and the Sea de Cortes that can be entered by boat. Infrastructure is concentrated in the principal cities of Guerrero Negro, El Vizcaíno, Santa Rosalía, and San Ignacio. There are public buildings, museums, and abandoned and active mining installations, among other large buildings. These cities also enjoy services such as telephone, email, hotels, restaurants, hospitals, electricity, and potable water.

In San Ignacio Bay, the situation is very different because communities settled around the bay do not have electrical energy unless they produce it using windmills. There are no medical or urban services, and as a result the water bodies are contaminated and old vehicles are dumped.

Tourism

Tourism activity is focused on whale watching during winter when they migrate to Vizcaíno's bays to reproduce and give birth to their young. Whale watching occurs from December to April. To a lesser degree people come to the area to observe resident and migratory birds that arrive in the thousands in the wetlands. The archeological sites also attract tourists, mostly the cave paintings in the Sierra de San Francisco. Another tourist activity is near the Vírgenes Volcano in the Alfredo V. Bonfil ejido where they develop conservation and sustainable use activities with the bighorn sheep.

Recent data indicate that the reserve receives 13,000 visitors per year. As a result, the Federal Government has received \$US 19, 200 from use fees—the total economic impact is of course higher since these data do not include concessionary or tourist agencies earnings.



Tourism has created expectations among local inhabitants, who try to sell crafts to people visiting the reserve

Infrastructure for tourism is still deficient and low capacity. Nice hotels can only be found in the towns of Santa Rosalía, Guerrero Negro and San Ignacio. In places like San Ignacio Bay, new camping grounds have been established but they only operate during whale watching season. In Ojo de Liebre Bay, in coordination with Benito Juárez ejido, a visitors' center has been built that offers food, a souvenir store, bathrooms, and has an environmental education hall where videos can be shown, talks given, or temporary expositions shown.



The environmental education program implemented by the reserve's direction tries to create environmental awareness among the school children and tries to involve them actively in conservation projects

There are approximately 22 tourism companies operating in San Ignacio and Ojo de Liebre Bays and in the Sierra de San Francisco. Most people working with these companies are fishermen during the rest of the year when tourism is slow.

An important consideration is transportation. It is not hard to get to the main cities because the public bus system is good, but for tourists to reach the bays, mountains, or wetlands, they must rely on their own transportation. Some tourist companies do offer full packages that include hotel, food, and transportation to sites of interest.

In general, CONANP and the Secretary of Tourism do a good job publicizing the areas' tourist attractions. They have printed information and signs along the main highways that cross through

the protected areas, and even along some secondary roads. Tourism services offered by locals are good, and in many cases the local fishermen stop fishing during the tourism season and work as guides. Some successful tourism initiatives have been implemented by the [RARE CENTER](#), an organization that works with local young people to manage tourism businesses and develop skills by offering English courses, enabling the guides to provide better services to foreign visitors.

Reserve staff also develop a series of activities to ensure compliance with whale watching norms and regulations during the season. They follow the guidelines and specifications provided in the Official Mexican Norms NOM-131-ECOL-1998 regarding whale watching activities and its relation to their protection and habitat conservation.

Other tourism projects in which the [Reserve Administrators](#) participate or coordinate include 1) the Berrendo (Peninsular Pronghorn) Project in the Desierto del Vizcaíno that has an information center and includes school visits to the station to see the peninsular pronghorn reproduce and raise young in captivity; and 2) the conservation and sustainable use of bighorn sheep in the southern part of the reserve. Tourists can visit this project and stay overnight in accommodations run by the Alfredo V. Bonfil cooperative.

Conservation and Research

One of the Biological Research Centers (Unidades del Centro de Investigaciones Biológicas, [CIBNOR](#)) is located in Guerrero Negro. This institution carries out projects focused on developing technologies for sustainable farming in arid zones. Dr. David Raúl López Aguilar and Andrés Orduño Cruz, MS, are the experts and principal project researchers. Their projects attempt to increase biological and technological knowledge of life cycles of crops adapted to desert and hypersaline environments. Within CIBNOR La PAZ Unit, located in Baja California Sur, Jorge Cancino coordinates work related to the Peninsular Pronghorn Recovery Plan.



The Northeast Biological Research Center (Guerrero Negro Center, CIBNOR), maintains presence in the reserve. They carry out many research projects relating to agricultural production in desert areas

[PROESTEROS](#) is an institution with a wealth of bibliographic information on Vizcaíno's wetlands. It has research on the reserve's major bays (Ojo de Liebre, San Ignacio, and Guerrero Negro) in addition to information on other sites throughout the peninsula. The sites' descriptive

profiles are complete and include information on the physical and biological characteristics and flora and fauna lists of each place.

The Interdisciplinary Center for Marine Sciences (Centro Interdisciplinario de Ciencias Marinas, CICIMAR) within the National Polytechnic Institute develops comprehensive research on commercial fishing to increase productivity knowledge and improve techniques. Their oceanographic studies analyze physical-environmental conditions of the seas and oceans and their biological richness.

Financing from the Spanish Aid Agency (Agencia Española de Cooperación Internacional, AECI), via the Araucaria and Iberoamericana Marine Reserves Program, has supported sustainable development projects and increased productivity in arid zones within the protected area. To reach their objectives, AECI has coordinated with CIBNOR to support projects.

Different institutions within Mexico's National Autonomous University (Universidad Nacional Autónoma de México, UNAM), have focused on different subjects such as flora and wildlife within the reserve. Researchers with the Biological Institute have participated in activities such as creating floral inventories (León de la Luz *et al.* 1995), and in some wildlife conservation projects.

The University of Baja California (Universidad de Baja California), who has its biology faculty in Ensenada, conducts studies on marine resources and on arid zone ecosystems.

[WildCoast](#) is a conservation organization working throughout the peninsula of Baja California. They have environmental education projects in rural communities, schools, and fishing camps. Their work is focused on protected species like marine turtles and they have developed didactic, promotional materials such as [Sea Turtles, Learn About them and Protect Them!](#) in collaboration with PROESTEROS and [Chelonia, the Return of the Sea Turtle](#). According to WildCoast, between 8,000 and 9,000 turtles are killed in the region between Lent and Saint's Week.

RARE Center worked in the reserve, training naturalist guides and offering a course to train locals in ecotourism in order to create and strengthen the bases for community development in tourism. They carried out campaigns to highlight social values and consciousness regarding the threats to the region's natural resources. Part of their training focused on young people interested in local ecotourism and biodiversity. They offer intensive English classes to this focus group, which are very well received.

The salt mining company, Exportadora de Sal S.A de C.V., has contributed to the area's conservation and research. Its recent policies focus on environmental care and they have achieved certification from the Federal Prosecutor's Environmental Protection Office (Procuraduría Federal de Protección al Ambiente, PROFEPA) as a "clean business." Among its conservation activities are water quality monitoring in Vizcaíno bays, and wildlife species monitoring (focusing on gray whales, sea turtles, marine mammals, and migratory birds arriving in the area for the winter).

The non-governmental organization Natural Spaces and Sustainable Development A.C. (Espacios Naturales y Desarrollo Sustentable A.C., [ENDESU](#)) administers and implements the GEF project and money for the protected area. It has also solicited funds from private foundations for projects like “Save the Peninsular Pronghorn” that will last for 10 years (1997-2007) and hopes to conserve 1000 antelopes in semi-captive conditions by the end of the project.

Threats

- Grazing
- Agriculture
- Overfishing
- Overhunting
- Mining
- Contamination
- Vehicles and highways
- Lack of PROFEPA presence

Future potential threats

- Mega-tourism project
- UMAS

Grazing

Grazing occurs throughout most of the protected area and its impacts are notorious. It is important to remember that this region is an arid zone with very little annual precipitation, meaning that no natural vegetation is capable of sustaining cattle grazing. Free range grazing of bovines, cattle, goats, and horses creates competition for native wildlife species like the peninsular pronghorn, bighorn sheep and the mule deer. Some species, like burros become feral and gather in wild herds negatively impacting native flora and fauna. Lack of interinstitutional governmental coordination worsens the situation since different social development programs, such as those promoted by the Secretary of Agriculture, Ranching, Rural Development, Fishing, and Alimentation (SAGARPA) that offer credits for grazing activities within Vizcaíno, establish contradictory policies regarding land uses and land limitations due to prolonged droughts in the region.



It is common to see cattle wandering about in the reserve, in addition to their negative environmental impact, they are a hazard to motorists on the highway. In this photo, a wild burro is next to the road

Agriculture

Agricultural activity is located in the buffer zone in the northern sector of the reserve, in the region known as Vizcaíno Valley, and covers approximately 11,000 hectares. The region is known as one of the country's main vegetable producers. However, almost all of the production is for export and it is at a high environmental cost. As was previously mentioned, water is the limiting resource in Baja California Sur, yet vegetable farming requires large quantities of water. Therefore, the agro-businesses extract ground water using wells for irrigation. The ground water and water from aquifers is used to grow tomatoes, chilies, peas, strawberries, alfalfa, and garlic among other crops (that are later canned). Locals comment that although this is an important industry, local benefits are minimal because the workforce comes from other parts of Mexico.

There is communication between the reserve administration and large agricultural businesses. Yet, the producers have not assumed total responsibility and they refuse to invest resources. This results in what is all too common: lands become impoverished and production rates decrease. These large-scale farmers will leave the zone and look for new land in this or other region. This is what happened in states like Sinaloa and Sonora, from where some of Vizcaíno's large farmers originate. Growth in agricultural activities, like grazing, is likely one of the largest landscape modifiers that can convert expanses of native, sustained vegetation into small patches of native vegetation that cannot sustain itself over the long-term.

Subsistence farming in the reserve is minimal since it is very costly due to lack of water.



Large agricultural field that requires large quantities of groundwater

Overfishing

The main problems related to fishing are due to a lack of organization of some isolated fishing sectors within the reserve. In these areas, fishermen engage in illegal fishing and catch out-of-season species, or species under special protection, like mollusks, lobster, and abalones. In some sites, such as El Cardón, Delgadillo, and El Dátil on the Pacific Coast, fishermen still catch sea turtles.

Overharvest of mollusks (*Lyropecten subnudosus*) and abalone (*Haliotis spp*) are two clear cases of illegal fishing, where even the fishermen recognize that the populations are diminishing.

The Pacific is known as one of the country's richest fishing areas, and in fact, it is considered underdeveloped to a certain degree. The largest fishing cooperative is found in the region, known as the Northern Pacific (Pacífico Norte). In these areas, there are sufficient economic resources for the fishermen (businessmen) to conduct studies of the species they harvest. However, in other regions, like in Mar de Cortes, there is less technical capacity, fewer financial resources, and a lack of studies to determine population sizes of harvested marine resources. This situation shows that there are some well-organized groups with access to financial resources and capacity, but others that are not organized, lack resources, and haven't diversified their harvests, thereby only concentrating on a few species.

The fishing methods used also pose a threat to the marine resources. For example, bottom trawling is notorious because of the damage it causes, yet it is commonly practiced. By-catch is extremely high when using bottom trawling, and in many cases, more by-catch is harvested than target species.

Without a doubt, there is a lack of biological fishing studies and little promotion for the need of such studies. However, they are required in order to identify additional potentially commercial species and to develop better sustainable harvest techniques with very clear regulatory measures.



Illegal fishing is common in the reserve's distant and difficult-to-access waters. In addition, PROFEPA does not maintain a constant presence

Overhunting

Hunting in the reserve takes place in two ways: 1) hunting that is regulated via the System of Conservation, Management, and Sustainable Wildlife Use Units (UMAS); and 2) illegal hunting. Hunted species include bighorn sheep, mule deer, peninsular pronghorn, puma, bobcat, and small mammals. There is a large, economically powerful market for Bighorn sheep meat, and the hunting of this species is one of the best-developed programs within UMAS. The biggest prob with this program, unfortunately, is that the allowable harvest rates may be biased because they are based on data generated from the census of bighorn populations as well as on the number of hunting permits solicited. Experts in the region and within the UMAS system comment that because different areas within the program overlap, they may be counting one population of bighorns as two different herds, thus over-counting the number of sheep. As a result, this specially protected species has not demonstrated a true recovery.

Bighorns, deer, and peninsular pronghorns are hunted illegally, as are wild cats such as pumas and bobcats, which ranchers kill when these animals are threats to their cattle.

Mining

Mining peaked during the last century in places like Santa Rosalía, where minerals such as copper, manganese, and gypsum were extracted. This mining activity created soil erosion, contamination, pollution, and litter from abandoned machinery and infrastructure (much of which was dumped into the ocean); in short, damaging the environment. After companies decided to leave the region and the capital that stimulated employment, commerce, and development was gone, prosperous communities like Santa Rosalía entered an economic recess.

Salt mining has been the most profitable in Guerrero Negro, where large salt evaporation processors exist, owned by Exportadora de Sal (SEMARNAT 1997). Considering that the inputs for this industry come from the ocean, it is estimated that its reserves are “almost infinite.” The main threat posed by salt mining is the by-products created by high salt concentrations (brine) that have been associated with the death of threatened species such as sea turtles.



At Guerrero Negro’s Salt Mine, there are large concentration glasses covering much of the land where they produce salt



Another important location within the Salt Mine is “El Chaparrito” where the ships transport salt towards Cedros Island, where large barges later arrive for the produce

Another threat is the growth of the salt industry and the resulting transformation of large extensions of land, which will eventually turn into highly saline areas that would only be able to support hyper-saline tolerant vegetation.

In summary, mining is not regulated in a way that is compatible with the environment and the area's conservation. There are currently new mineral exploration projects being conducted by foreign companies interested in reactivating mining in the region.

Contamination

Contamination threatens the reserve in several different ways. For one, farming activities create soil and water contamination when agrochemicals seep into the ground water. Vizcaíno Valley's intensive agriculture also creates significant amounts of inorganic waste, such as plastics that are used during vegetable production and then deposited in open-air dumps or simply thrown away in non-designated areas, affecting the environment.





The dump at Guerrero Negro is open-air and it receives very little attention from authorities. What we were able to find out, and from our observations, the dump is burned frequently which produces large clouds of smoke that can be seen from far away. Among the waste is fishing waste, scrap metal, industrial garbage, in addition to everything else one can imagine

Depositing organic waste in sanitary landfills is quickly becoming a solution to get rid of waste. However, in each field, several landfills are created and the waste is not managed in a systematic way, so dispersed contamination continues.

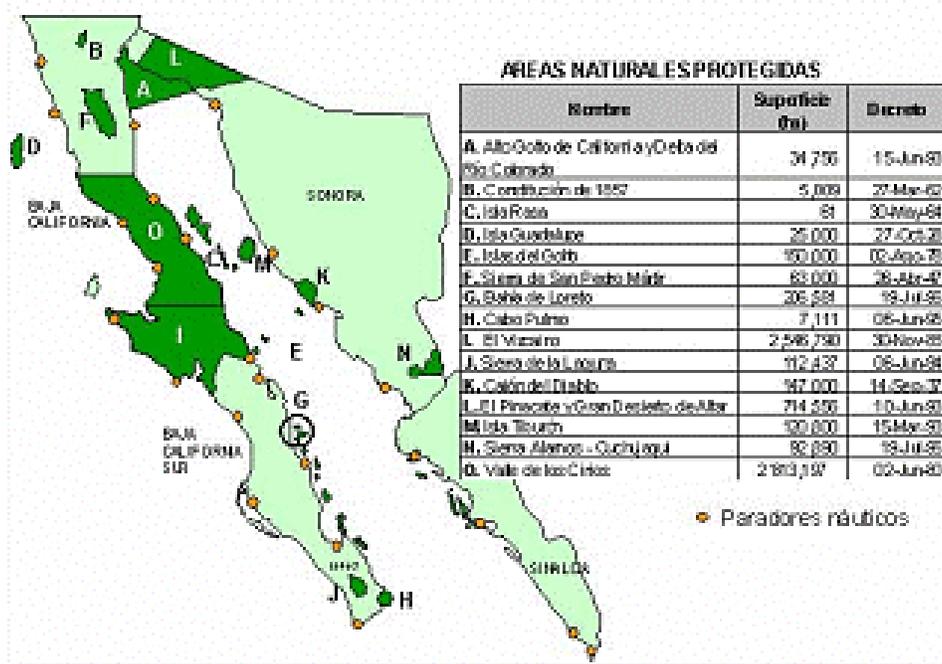
Because there is insufficient infrastructure and technology for final deposition, other activities, such as fishing, mining, dumping domestic garbage, and scrapping vehicles, create pollution as well.

Vehicles and highways

Although the main highway in the peninsula is the Transpeninsular No. 1, secondary roads connecting major communities are still important. From these roads many tourists (mostly Americans) in all-terrain vehicles enter the protected areas without any authorization or advice and end up driving through remote, well-conserved areas, destroying vegetation.

The extensive network of secondary roads, some of which are now asphalted, is a threat for species like the peninsular pronghorns that inhabit Vizcaíno's desert plains because these highways fragment and isolate their habitat and populations, making the species more susceptible to threats and predators.

Projects like the "Escalera Náutica" represent a threat because they create incentives for more road and highway construction to allow easy access to the most important tourist sites (more information on this particular project follows).



The magnitude of Escalera Náutica is seen in these maps. It represents a potential threat that could affect all of the Peninsula's and Gulf of California's protected areas and biodiversity.

Mega-tourism project

The project “Escalera Náutica” (Nautical Ladder) represents a major tourism investment during this governmental term. In short, it is a multimillion-dollar investment to build new infrastructure to optimize the nautical, terrestrial, and aerial capacities along the entire Baja California Peninsula.

They are considering creating 24 ports, 11 nautical centers, and a land bridge that connects the Pacific Coast with the Sea of Cortés. Also contemplated are four entrance routes from the United States, 20 airports and airfields, and a system of fuel distribution at every port. Eight of the potential ports would be located in protected areas including El Vizcaíno Biosphere Reserve, which would have ports at Bahía Tortugas, Punta Abreojos, and Santa Rosalía and two airfields. Another protected area, the Cirios Wildlife Protection Area, would have four sites (Cabo Colonet, Punta San Carlos, Santa Rosalillita, and Bahía de los Ángeles).

UMAS

As was mentioned previously, extensive UMAS could be playing a double role when it proposes sustainable use with special protection of wildlife species that are threatened. This warning sign stems from the General Wildlife Office’s lack of solid administrative and field structure, prohibiting it from clear and systematic field monitoring of species included in the UMAS. In addition, population studies are needed for some endangered species and for some protected species before allowing them to be hunted or harvested. However, as is the case with the sea cucumber (*Isostichopus fuscus*), the UMAS is about to permit harvest in the region Santa Rosalía without such population status studies.

Lack of PROFEPA presence

It is a well-known fact that the environmental authority (PROFEPA) is incapable of covering all the needs of a reserve like El Vizcaíno. The reserve is the country’s largest protected area, yet only one PROFEPA officer is assigned to it. In addition to lack of staff, the PROFEPA officer that is assigned to Vizcaíno does not have sufficient equipment or infrastructure to guarantee natural resource protection.

Recommended Solutions

Grazing

Grazing activities need to be converted from extensive to intensive, with a better investment to make the activity financially feasible and one that can truly create benefits for the people. There are a few successful cases in the milk industry (Santa Clara) that show that private and federal investments via SAGARPA could help develop or apply intensive cattle-raising management technologies in coordination with CIBNOR, who conducts research on foraging and other agricultural projects in arid zones.

There is a need to study the impacts of feral populations of burros and goats that roam the habitat of peninsular pronghorns, bighorn sheep, and mule deer. Using information generated, SAGARPA along with other agencies like CONANP, local authorities, and communal cooperative representatives should propose measures to control animals that compete with wildlife and destroy ecosystems. Another reason animal grazing activities should be regulated is that some animals, like wild burros and cattle, cause fatal highway accidents.

Agriculture

In order to resolve the problems related to agricultural activities, such as indiscriminate agrochemical usage and other contaminating materials, there is a need for increased monitoring and vigilance and follow-up regarding compliance with environmental laws and regulations. This industry, as well as other companies related to other productive activities, should be subjected to environmental inspections and be required to adapt mitigation measures when they impact the environment.

We know that the local governing body of Guerrero Negro works together with agricultural businesses, agencies like CONANP, and other municipal authorities to establish management and control of sanitary landfills created in agricultural fields.

In a region like Vizcaíno that lacks vital resources such as surface waters, businesses and agricultural landowners should agree to a more rational use of water. Local water demand is very high for the agricultural lands, while the benefits to local inhabitants are few. Water concessions granted by the National Water Commission ([CONAGUA](#)) to the agricultural producers in Vizcaíno are practically free and may explain why water is extracted in such huge quantities. An analysis is needed regarding use of this common resource for commercial purposes that benefits only a few instead of a whole society. Authorities like CONAGUA in the state of Baja California Sur need to establish better regulation methods for industrial water use.

Farming causes the greatest ecosystem modifications in the region, and relatively fast soil impoverishment spreads into protected, conserved areas and native vegetation is removed for cultivation.

Overfishing

One of the most important, if not *the* most important, economic activities for reserve inhabitants is subsistence and commercial fishing. Data indicate that marine resources found in the Northern Pacific and the Sea of Cortés are some of the richest in Mexico and North America, making the region one of the best fishing areas. The zone has one of the richest banks of abalones and lobsters and is abundant in additional commercial species such as shark, and a great variety of mollusks, crabs, and shrimp.

In order to maintain the fishing industry at its current large extraction scale, research is needed to diversify commercially harvested species. Regulation of fishing methods is also needed and recent research should be incorporated into management. Institutions like CICIMAR and CRIP are constantly generating useful information for management and regulations.

Although it is mentioned that there are rich banks of abalones, it should be noted that some of these species (*Haliotis cracherodii*, *H. rufescens*, *H. sorenseni*) have been overharvested in the past. It's also hypothesized that their biomass has been affected by climate change—an argument that can be supported by past experiences. For example, in 1998 the El Niño effect increased the ocean's temperature and caused certain species of mollusks to practically disappear from the region.

Mining

The idea to develop a strategy and regulate mining activities as outlined in the management program is a principal step to confronting new mining projects in El Vizcaíno Biosphere Reserve. It is a reality that foreign businesses are already conducting exploration activities in the region in search of minerals (Margain Minerals Inc., International Curator Resources Lt., Viceroy Resources Corp., Vista Gold Corp., among others).

The mining management program should be changed, because it only sees activities in the past as a problem and considers current mining activities advantageous. The management program is a legal instrument that should establish a regulation and norms framework that guarantees conservation of the ecosystems as well as outlines regulations for any needed mitigation measures.

A relevant element within the mining activity regulation strategy is the establishment of an advisory board that will follow up with the environmental impact studies and environmental risk assessments. This group could also provide a rapid response in case of any ecological disasters caused by the activity.

Contamination

Contamination is a general consequence of all reserve activities, from agriculture to fishing to mining to domestic garbage production. Coordinated actions are needed between the local government--in this case the municipal government of Mulegé--and institutions such as CONANP, which already includes contamination management within its program.

Industrial activities like fishing and farming need a coordinated strategy to develop communal sanitary landfills in order to concentrate waste in one controlled place to avoid proliferation of contamination and infection from dispersed sites.

The fishing industry generates large quantities of shells from mollusks harvest. These materials could be used in crafts or in other processes instead of thrown away as waste. Today, they form large mounds of waste that attract wildlife and pests, such as rats.

Since tourism will be better promoted in the region, an improved garbage management system is needed. Tourism companies, the reserve's management, and municipal authorities ought to be involved. Within the management program, reuse, recycle, and recuperation of useful materials should be promoted through an environmental education program.

Vehicles and highways

In addition to taking actions such as increasing the number of signs and restricting the number of vehicles in the core zone, specifications should be established regarding who can enter which ecosystems (dunes, desert areas, and mountains). There should be inspection posts and monitoring to verify compliance.

Highway projects should concentrate on existing secondary roads and aim to minimize their impacts on ecosystems. The projects should also pay heed to information generated by research institutions and follow recommendations to minimize impacts when it is shown that a potential project will effect a threatened species or ecosystem.

Lack of PROFEPA presence

We recommend expanding the formation of vigilance committees throughout the reserve. This has already begun in certain regions of the reserve; community members join the vigilance committee (or they contract people to participate). In certain sectors, where fishing activities (in the Northern Pacific area) and areas under UMAS are monitored, such committees have been functioning well, mostly because these industries generate large income and the sectors are (for the most part) well-organized. The appropriate functioning of the community committees in these areas seems to have eliminated the need for a permanent PROFEPA inspector.

Nonetheless, in sectors generating fewer economic profits, including the Vizcaíno bays, the desert, and the mountains, more personnel are needed to patrol and monitor resource use. In these areas, illegal hunting and fishing, and cacti poaching are prevalent, in addition to other activities that negatively impact biodiversity.

Currently, there are coordinated patrol and inspection operations aimed at fishing. The community patrol committees, fishing cooperatives, federal inspectors with CONAPESCA (the federal agency responsible for sanctioning and enforcing the fishing laws), and reserve staff participate. The cooperatives demonstrate excellent self-regulation and their cooperation with the different governmental agencies and community groups is exemplar. We recommend extending these initiatives to all bays and principal fishing ports. The on-the-ground operations and results should be announced by radio or in the newspapers to further strengthen this association's identity and to promote information exchange and share experiences between sites.

Mega-tourism project

The Escalera Náutica Project will develop infrastructure within the reserve's borders. Both marine constructions and airfields will affect the reserve's ecosystems and could affect protected species such as migratory birds and whales. These threats are not considered within the management program and therefore there is no work plan to direct needed actions. Hence, the reserve administration needs to develop a strategy that regulates infrastructure development and transportation centers where the flow of human traffic will be highest.

Parallel to this tourism development project, certain academic institutions and civil society organizations from the United States and Mexico are promoting an initiative called Escalera Ecológica, or Ecological Ladder. This project serves a watch-dog function, following the developments of the Escalera Náutica Project, and it works to analyze and propose less environmentally damaging alternatives. They also propose consolidating a biological corridor in the Gulf of California that would connect the zone's protected areas.

Wildcoast began a campaign to inform and publicize the extent of the Escalera Náutica Project. Using funds from the David and Lucile Packard Foundation, they contracted the San Francisco research firm, EDAW Inc., to conduct a market feasibility study. This study concluded that the Mexican Government overestimated the tourist demand for the area by 600%. As a result, much of the planned infrastructure is unnecessary and the project should focus on improving existing infrastructure instead.

As a result of organizations' and research institutions' fight using solid and well-founded arguments, the National Tourism Promotion Fund (Fondo Nacional de Fomento al Turismo, FONATUR) has announced that the project does have serious limitations and that the anticipated investment is not just a tourism investment, but a national investment. The project has changed focus, and even its name has changed to Proyecto Mar de Cortés, or Sea of Cortés Project. Priority destinations for financial investment will be in Guaymas Sonora and Mazatlán in Sinaloa.

Continued monitoring of the Escalera Náutica Project is needed to prevent any attempts to reactivate it.

UMAS

Because within the UMAS there is a certain level of controversy when the General Wildlife Office assigns the permitted number of individuals (per species) for commercial hunting (like the bighorn sheep and mule deer), an independent, third-party study is needed to determine the actual state of the species and population sizes for those species subjected to hunting under the UMAS system. This would help determine which individuals correspond to which population, and to determine whether or not a temporary hunting ban is required to help these populations grow.

This is one way to help guarantee that wildlife populations are not overhunted because of potential over estimations of numbers of individuals. One important element to remember is that these animals have large ranges and move around, and it is difficult to determine if a population belongs to one specific place or another.

In Baja California, hunting of bighorn sheep and mule deer means big money for local landowners. However, the panorama for hunted species is not as clear. While environmental education and vigilance by landowners has had some impact, wildlife populations have not rebounded; officially they are maintained, but the populations have probably reduced in number, considering official counts may be biased towards hunting.

As with the land mammals, population estimates are needed for the sea cucumbers prior to harvest. Necessary regulations should be established and harvest rates determined in order to guarantee that the species' population will not be detrimentally affected.

Conclusions

Vizcaíno Biosphere Reserve is an important mosaic of ecosystems, many of which are still in pristine conditions. It is both nationally and internationally recognized and not just because it is Mexico's largest protected area; it is especially important for gray whale migration and reproduction, for thousands of migratory birds who visit its wetlands every winter, and for its wealth of an ancient culture in its cave paintings. Together these important characteristics have helped earn Vizcaíno recognition as a UNESCO World Heritage Site.

The reserve is considered **threatened** because of the pressures it faces from resource uses such as fishing, agriculture, hunting, mining, and mega-tourism projects that affect its ecosystems and species. The region previously faced serious threats such as salt mining in San Ignacio Bay (CIBNOR 1994), but luckily in this particular case, non-governmental organizations and academic and research institutions successfully stopped the project and the then-president supported conservation of the region. Today, the rationale is sufficiently large to continue to conserve protected areas and enforce their decrees.

Priority actions for the reserve include reinforcing the law and increasing the number of inspectors from PROFEPA and CONAPESCA. With this first step, there will be enough human resources to influence the other threats, such as agrochemical contamination, vegetation clearing for expanded grazing activities, and other related contamination. More attention is needed for illegal hunting and fishing, and more monitoring is needed for mining, tourism, and infrastructure development.

The reserve's management should develop and seek funding for a project to control and eradicate feral and exotic species from the reserve in order to stop habitat destruction, competition with native species, and highway accidents caused by feral animals. The management should do this in collaboration with SAGARPA and rural communities and cooperatives.

The reserve's management, with the help from non-governmental organizations, needs to establish regulations and/or norms regarding mining exploration and extraction, and infrastructure development in projects like Escalera Náutica, so that the construction and operation of mining, maritime, terrestrial, and aerial infrastructure is low-impact. In addition, the management program needs to monitor marine, land, and air travel in and around the reserve. All of these actions will help to better conserve Vizcaíno Biosphere Reserve.

Bibliography

- **Acevedo C., A.** 1997. Caracterización ecológica de la comunidad icticia de la laguna Ojo de Liebre, B.C.S., México. Tesis de Maestría. CICIMAR-IPN. La Paz, B.C.S. 108 pp.
- **Alvarez-Castañeda, S.** y J. L. Patton. 2000. Mamíferos del noroeste de México II. S. CIBNOR, BCS. México. .
- **Alvarez B.** y A. Granados. 1992. Variación espacio-temporal de temperatura en un hábitat de invierno de la ballena gris: Laguna Ojo de Liebre. Ciencias Marinas 18(1):151-165.
- **Arriaga, L., J.M. Espinoza, C. Aguilar., E. Martínez, L. Gómez y E. Loa.** 2000. Regiones terrestres prioritarias de México. CONABIO.
- **Carmona, R.,** y G. D. Danemann. 1998. Distribución espaciotemporal de aves en la salina de Guerrero Negro, Baja California Sur, México. Ciencias Marinas 24(4):389-408.
- **Castellanos, R. y J. Holland.** 2001. Península Pronghorn (*Antilocapra a. peninsularis*). Regional Studbook.
- **CIBNOR.** 1991. Asociaciones fisionómico-florísticas y flora, en la Reserva de la Biosfera El Vizcaíno en la Península de Baja California.
- **CIBNOR.** 1991a. Aspectos generales sobre la fauna de vertebrados en la Reserva de la Biosfera El Vizcaíno en la Península de Baja California.
- **CIBNOR.** 1994. Centro de Investigaciones Biológicas de Baja California Sur. A.C. 1994. Manifestación de Impacto Ambiental Modalidad Intermedia: Proyecto "Salitrales de San Ignacio". Primera parte: 228pp. + anexos.
- **CIBNOR.** 1995. Estrategia para el manejo de la Reserva de la Biosfera El Vizcaíno, B.C.S., México. CIBNOR, S.C. 12:130 p.
- **CIBNOR.** 2004. Taller de evaluación del plan de recuperación del Berrendo Peninsular. CIBNor, INE, IUCN, RBVI.
- **Conde, O. D.** 2003. Tesis sobre la Filogenia y estructura genética del berrendo (*Antilocapra americana*) e implicaciones para su conservación. UNAM.
- **CONANP.** 2003. Áreas naturales protegidas de México. Proyección internacional. Ed. REDACTA. 31 p.
- **CONANP.** 2004. Dirección ejecutiva de administración y efectividad institucional relación de ANP's y montos asignados. 1 p.

- **De La Cruz-Aguero, J., M. Arellano-Martínez y V.M. Cota-Gómez.** 1996. Lista sistemática de los peces marinos de las lagunas Ojo de Liebre y Guerrero Negro, B.C.S y B.C., México. *Ciencias Marinas* 22(1):111-120.
- **Delgadillo, J., M. Peinado, M. De la Cruz, J.M. Martínez-Parras, F. Alcaraz y A. de la Torre.** 1992. Análisis fitosociológico de los saladares y manglares de Baja California, México. *Acta Botánica Mexicana*. 19: 1:35.
- **D.O. F. 1988.** Decreto de la Reserva de la Biosfera El Vizcaíno, ubicada en el Municipio de Mulegé, BCS. Noviembre 30 de 1988. México, D.F. Tomo CDXXII No. 22.
- **D.O.F. 2002.** Norma Oficial Mexicana NOM 059-ECOL-2001. Protección ambiental especies nativas de México de flora y fauna silvestres. Segunda sección.
- **Flores-Villela, O.** 1993. Herpetofauna Mexicana. Carnegie Museum of Natural History. Special Publication No. 17. 73p.
- **Gómez-Pompa y R. Dirzo.** 1995. Reservas de la biosfera y otras áreas naturales protegidas de México. INE – CONABIO. 159 pp.
- **Hambleton, E.** 1979. La pintura rupestre de Baja California. Fomento Cultural Banamex, 156 p.
- **INE. 2000.** Programa de Manejo Reserva de la Biosfera El Vizcaíno. INE. 235 pp.
- **INE-SEMARNAP, FMCN. 2000.** Sistema de monitoreo y evaluación del Fondo para Áreas Naturales Protegidas.
- **INEGI, 2003.** Censo General de Población y Vivienda. Página Web.
- **IPN. 1986.** Evaluación de los parámetros ambientales y su relación con la distribución y movimientos de la Ballena Gris *Eschrichtius robustus* Lacepede 1804 en la Laguna Ojo de Liebre, B.C.S., México. *Ciencia Pesquera- IPN* (5):33-49.
- **IUCN. 2003.** 2003 IUCN Red list of threatened species. Download on 06 february 2004.
- **Leija-Tristán, A. + 11 autores.** 1991. Estudio biológico-pesquero del camarón de la costa occidental de Baja California Sur (zona protegida: complejo lagunar Magdalena-Almejas) Informe Técnico final. CIBNOR, CRIP, CICIMAR, CONACYT.
- **León de la Luz, J.L., Coria, B, R. y J. Cancino.** 1995. Listados Florísticos de México. XI. Reserva de la Biosfera El Vizcaíno Baja California Sur. Instituto de Biología, UNAM. 29 p.

- **Miller, J. D. Y R. N. Lea.** 1972. Guide to the coastal marine fishes of California. California Department of Fish Game, Fish Bulletin 157. 1-249 p.
- **Nom-131-ECOL-1998.** que establece los lineamientos y especificaciones para el desarrollo de actividades de observación de ballenas, relativas a su protección y la conservación de su hábitat.
- **Ortega, A. y Castellanos, A.** 1995. Estrategia para el manejo de la Reserva de la Biosfera El Vizcaíno, B.C.S. México. Public. 12 CIBNOR, México, 130 p.
- **Salinas-Zavala, C. J. G. Llinas y R. Rodriguez-Estrella.** 1991. Aspectos biológicos del Águila pescadora (*Pandion haliaetus carolinensis*). En Ortega, A. y L. Arriaga (Eds.). La Reserva de la Biosfera del Vizcaíno en la Península de Baja California. Centro de Investigaciones Biológicas del Noroeste de Baja California Sur A.C., México 265-293.
- **Sealey, S. K. Y G. Bustamante.** 1999. Setting Geographic Priorities for Marine Conservation in Latin America and the Caribbean. BSP. TNC y USAID. 225 p.
- **SEMARNAT. 1997.** Salitrales de San Ignacio, sal y ballenas en Baja California. México. 25p.
- **Taylor, T. A.** 1990. Que desea saber de las ballenas de Baja California. México.
- **WWF and IUCN.** 1994-1997. Centres of plant diversity. A guide and strategy for their conservation. 3 volumes. IUCN Publications Unit. Cambridge, U.K.

Written by: Gerardo Carreón, ParksWatch – Mexico

Translated by: Amanda Vanega

Date published: October 2004

Photo credits © Gerardo Carreón