ABSTRACT: The state of Baja California Sur has the largest protected surface area in Mexico, amounting to approximately 2,813,914 ha (38.3% of the state area). Included are two biosphere reserves, a submarine refuge of flora and fauna, and several islands in the Gulf of California. These reserves and refuges provide legal protection for most of the ecosystems of the region. The state's protected areas are distinguished by the occurrence of a great number of marine mammals, several nesting and wintering sites for migratory and resident aquatic birds, several endemic and threatened species, and numerous archaeological sites. This paper describes the status of these reserves and refuges in terms of category of protection, legal status, biodiversity, and species statuses. In addition, we appraise the management of these protected areas and the importance of management to the conservation of the natural resources of the state, region, and country.

INTRODUCTION

The biodiversity of Mexico is one of the highest in the world (Toledo 1988, Flores-Villela and Gerez 1989). Within an area of 2,000,000 km², Mexico holds 9% of the phanerogamic plant species on the earth (Rzedowski 1991a), 10% of the mammal species (Ceballos and Navarro 1991), and 11% of the reptile and bird species (Flores-Villela and Gerez 1989). Mexico also has a high concentration of endemic species. An estimated 9300 plant species (Rzedowski 1991b) and 760 vertebrate species (Flores-Villela and Gerez 1989) are endemic to the country.

The National System of Protected Areas (NSPA) was created to preserve this valuable heritage. Currently, there are 86 protected natural areas under federal administration (Secretaría de Desarrollo Social 1993, Diario Oficial 1993, Diario Oficial 1994a, Diario Oficial 1994c). The total area covered by the NSPA is 10,292,520 ha, which is 5% of the national territory. Almost all major ecosystems of the country are represented in the NSPA. Most of the reserves and national parks are distributed in tropical and temperate regions. Although there are only a few reserves, refuges, and national parks in arid and semiarid zones of Mexico, these nevertheless constitute about 45% of the surface area under the protection of the NSPA.

The state of Baja California Sur, located within the arid and semiarid regions of northwestern Mexico, has more surface area under protection than any other state of Mexico. Here, reserves and refuges provide legal protection for most of the terrestrial, marine, and insular ecosystems of the state and the region. We analyzed these areas for their purpose, natural and historical characteristics, management status, and potential role in the conservation of biodiversity in Baja California Sur and Mexico.

GENERAL CHARACTERISTICS OF THE ZONE

Baja California Sur is located in northwest Mexico at the southern extreme of the Baja California Peninsula, extending from 22°52' to 28° N latitude and from 109°25' to 115°05' W longitude (Figure 1). Along this narrow strip of land is a series of mountain ranges of volcanic origin. The physiography of these sierras includes a mixture of coastal plains, plateaus, and hills, which at different latitudes may be continuous or intersected by treeless plains, valleys, and streams from coast to coast. An important physiographic feature in the northern part of the state is a large plateau with cemented and saline soils, known as the Vizcalo Desert (Wiggins 1980).

The general climate of the region is hot and dry, but there are three geographically distinct precipitation patterns. On the Pacific Coast from the U.S. border to parallel 25°30', rains occur primarily during the winter. On the northeastern slope and the central portion of Baja California Sur, rain falls during both the summer and the winter. The southern portion of the state is characterized by a summer precipitation pattern. In the southern extreme of the
Figure 1. Location of the four protected natural areas of Baja California Sur.
peninsula there are several types of climates owing to the altitudinal gradient imposed by the Sierra de la Laguna. In the lowlands, the climate is dry and hot, while the highest elevations receive significant rainfall and experience temperatures lower than those of other regions in the zone (García and Mosiño 1968).

There are two phytogeographic zones in the state. Most of the surface is included in the Sonoran Desert, the desert with the highest biodiversity in North America (Shreve and Wiggins 1964). The other phytogeographic zone is the Cape Region in the southern tip of the state; it is characterized by sub tropical and tropical vegetation (León de la Luz and Coria 1992).

COMPILATIONS AND DEFINITIONS

Our list of protected areas (size and number) in the NSPA was obtained from the master list of the Ministry of Ecology and Development (Secretaría de Desarrollo Social 1993) and completed with recent information published in the Federal Official Newspaper. The species list and data on endemics were compiled from different scientific sources. The species and subspecies statuses were defined according to the Official Mexican Norm (NOM) (Diario Oficial 1994b). Categories of the NOM are equivalent to those published by the IUCN (International Union for Conservation of Nature and Natural Resources 1988), with the exception of one additional category— "species under special protection."

Management of the protected areas was evaluated using parameters established by the corresponding administrative agency, combined with field visits. We assigned a qualitative level to these parameters based on how they met the management needs of the natural resources.

PROTECTED NATURAL AREAS IN BAJA CALIFORNIA SUR

In Baja California Sur, four areas are protected by presidential decree (Figure 1). Table 1 lists the name, category of protection, establishment date, size, environments, and plant communities of each protected area. The total surface area under protection is approximately 2,813,914 ha, which is 27% of all the national territory under the National System of Protected Areas.

El Vizcaíno Biosphere Reserve is located in the northern part of the state. This reserve includes the lagoon complex of Ojo de Liebre-Guerrero Negro and the San Ignacio Lagoon, as well as the Vizcaíno Desert and some mountain ranges. The Sierra de la Laguna Biosphere Reserve is located in the southern end of the peninsula in the Cape Region. The submarine refuge is located in Cabo San Lucas at the end of the peninsula. This refuge was created to protect the sand cascades that are formed by marine currents and the deep canyon topography of the area. All the islands in the Gulf of California were established as reserves and refuges to protect both migratory and resident seabirds and other wild fauna and flora.

**Purposes**

The reserves and refuges in the state were created to accommodate (1) international and national interest in preserving water fowl, migratory seabirds, and gray whales (*Eschrichtius robustus*); (2) national interest in protecting unique ecosystems, wildlife, endemic species, endangered species, and archaeological remains; and (3) government interest in developing scientific research and sustainable development in natural areas.

<table>
<thead>
<tr>
<th>Name</th>
<th>Category</th>
<th>Date*</th>
<th>Area (ha)</th>
<th>Environments</th>
<th>Plant Communities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cabo San Lucas</td>
<td>submarine refuge of flora and fauna</td>
<td>1973</td>
<td>4,687</td>
<td>marine</td>
<td>aquatic vegetation</td>
</tr>
<tr>
<td>Gulf of California Islands</td>
<td>refuge and refuge of migratory birds and wild fauna</td>
<td>1978</td>
<td>150,000</td>
<td>marine, coastal &amp; terrestrial</td>
<td>aquatic vegetation, coastal strand &amp; dryland-scrubland</td>
</tr>
<tr>
<td>El Vizcaíno</td>
<td>biosphere reserve</td>
<td>1988</td>
<td>2,546,790</td>
<td>marine, coastal &amp; terrestrial</td>
<td>aquatic vegetation, saline marsh, coastal strand &amp; dryland-scrubland</td>
</tr>
<tr>
<td>Sierra de la Laguna</td>
<td>biosphere reserve</td>
<td>1994</td>
<td>112,437</td>
<td>terrestrial</td>
<td>dryland scrub, tropical dry forest, oak forest &amp; oak-pine forest</td>
</tr>
</tbody>
</table>

*Date established as a protected area.
Ecological and Historical Features

Phytogeographic zones and plant communities

The two phytogeographic zones of Baja California Sur, the Sonoran Desert and the Cape Region (Bryant 1891, Shreve and Wiggins 1964), are represented in the protected areas. El Vizcaino Biosphere Reserve is an important example of the Sonoran Desert; it includes the Vizcaino Desert and part of the San Francisco Sierra. It is also an important example of the arid and semiarid zones of Mexico, which cover 53% of the national territory (Schmidt 1989).

The Sierra de la Laguna Biosphere Reserve is an example of the Cape Region phytogeographic zone. This biosphere reserve harbors the following plant communities: tropical dry forest, oak forest, and oak-pine forest (Arriga and Ortega 1988). Some of these communities have unique characteristics owing to the isolation and the extreme climate of the zone.

Diversity and endemism

Generally, arid and semiarid zones have lower biodiversity than tropical ecosystems but a greater number of endemic species. In Mexico, 43% and 28% of the vascular plant genera, respectively, are endemic to arid and semiarid zones (Rzedowski 1978). Sixty-eight vertebrate species are endemic to arid and semiarid zones (Flores-Villela and Gerez 1989).

Baja California Sur is distinguished by the high number of endemic species resulting from its geographical isolation. An estimated 80% of the vertebrate species that are endemic to Mesoamerica are found within the limits of the state (Flores-Villela and Gerez 1989). In addition, approximately 23% of the state's flora is native to Baja California Sur (León de la Luz, unpubl. data). Numbers of species, by taxonomic group, found in the protected areas are given in Table 2.

Numbers of endemic species in these reserves are shown in Table 3. The Gulf of California Islands have the greatest number of endemic reptile and mammal species. The Sierra de la Laguna has the highest endemism in plants.

Status of flora and fauna in protected areas

Numbers of endangered, threatened, and rare species, and of those "under special protection" (see Diario Oficial 1994b) are given in Table 4. El Vizcaino Biosphere Reserve has the highest number of endangered and vulnerable species; among these are gray whales, peninsular pronghorn (Antilocapra americana peninsularis), sea turtles (Dermochelys coriacea, Chelonia mydas, Eretmochelys imbricata, Lepidochelys olivacea), and peregrine falcon (Falco peregrinus). The number of species designated "rare" and "under special protection" is also high. The Gulf of California Islands reserve contains many vulnerable, rare, and protected species, mainly small mammals and reptiles. No endangered species are known from the Sierra de la Laguna Biosphere Reserve.

Special biological features

The islands and coastal lagoons along the Pacific Coast within El Vizcaino Reserve constitute one of the most important breeding and wintering areas for many North American birds (Saunders and Saunders 1981, Everett and Anderson 1991, Masey and Palacios 1994). Black brant (Branta

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Table 2. Number of species in the protected areas of Baja California Sur.

<table>
<thead>
<tr>
<th></th>
<th>Mexico</th>
<th>Vizcaino</th>
<th>S. de L.</th>
<th>Islands</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reptiles</td>
<td>717</td>
<td>43</td>
<td>27</td>
<td>81</td>
</tr>
<tr>
<td>Birds</td>
<td>961</td>
<td>192</td>
<td>74</td>
<td>201</td>
</tr>
<tr>
<td>Mammals</td>
<td>439</td>
<td>69</td>
<td>30</td>
<td>45</td>
</tr>
<tr>
<td>Amphibians</td>
<td>284</td>
<td>4</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Plants</td>
<td>22,000</td>
<td>447</td>
<td>694</td>
<td>581</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>24,401</strong></td>
<td><strong>755</strong></td>
<td><strong>827</strong></td>
<td><strong>910</strong></td>
</tr>
</tbody>
</table>


Table 3. Number of species endemic to the protected areas of Baja California Sur.

<table>
<thead>
<tr>
<th></th>
<th>Mexico</th>
<th>Vizcaino</th>
<th>S. de L.</th>
<th>Islands</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reptiles</td>
<td>368</td>
<td>—</td>
<td>8</td>
<td>28</td>
</tr>
<tr>
<td>Birds</td>
<td>78</td>
<td>—</td>
<td>1</td>
<td>—</td>
</tr>
<tr>
<td>Mammals</td>
<td>141</td>
<td>2</td>
<td>2</td>
<td>18</td>
</tr>
<tr>
<td>Amphibians</td>
<td>173</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Plants</td>
<td>9,300</td>
<td>42</td>
<td>81</td>
<td>18</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>10,060</strong></td>
<td><strong>44</strong></td>
<td><strong>92</strong></td>
<td><strong>64</strong></td>
</tr>
</tbody>
</table>

bernicla) (Conant et al. 1992) and osprey (Pandion haliaetus) (Henny and Anderson 1979, Castellanos and Ortega 1995) both occur in their largest known populations here. These lagoons are also one of the breeding and wintering areas of gray whales (Bryant and Lafferty 1980, Swartz 1980).

The Vizcaíno Desert defines the limit between the cold deserts of the North and the subtropical deserts of the South. Several species are at their geographical limit in this zone. The most unique vegetation in the peninsula, tropical dry forest, is found in the Sierra de la Laguna Biosphere Reserve; this occurrence represents the extreme northwest distribution of this vegetation type (Arriaga and León de la Luz 1989, Breceda 1994). The biosphere reserve also harbors oak and oak-pine forests that are isolated from similar communities by hundreds of kilometers of deserts or water (Arriaga and Ortega 1988).

The Gulf of California Islands Reserve contains endemic biota and unique gene pools of extreme evolutionary and ecological interest (Anderson 1980). About 120 islands and islets harbor seabirds and wildlife; each is unique in its own way (Anderson et al. 1976).

### Historical and cultural values

The cave paintings and petroglyphs of the Sierra de San Francisco are found in El Vizcaíno Biosphere Reserve. This is one of the richest areas of prehistoric archaeology in North America (Uriarte 1981, Bendímez-Patterson 1987, Laylander 1987). At present these vestiges constitute a Human Heritage Site, according to UNESCO.

### Management Status

The management status of the four protected natural areas is deficient (Table 5). Presently, only one reserve has a manage-
ment plan, and it has been poorly implemented. On a national scale, the factors that have limited the development and implementation of management plans for reserves and refuges are (1) the low priority of conservation on the political agenda, (2) the high instability of the government agencies responsible for nature conservation (Ramos 1988), and (3) a communication gap between researchers and decision makers. At the local level these factors are (1) poor planning and incomplete legal definitions, (2) insufficient economic support, (3) lack of technical staff, (4) lack of equipment, and (5) lack of infrastructure and poor general services within the protected areas.

CONCLUSIONS

The reserves and refuges of Baja California Sur provide legal protection to several marine, insular, and terrestrial ecosystems with high species diversity, high numbers of endemic species, endangered species of flora and fauna, and valuable archaeological zone. These areas could play an important role in the preservation of the biodiversity of northwest Mexico. Their biological and archaeological characteristics justify inclusion in the National System of Protected Areas.

Unfortunately, serious limitations obstruct the effective preservation of the state's natural resources. The objectives and protection categories of these areas (reserve, refuge, and biosphere reserve) still focus on wildlife protection, giving less attention to other aspects of natural area conservation such as sustainable use of resources, recreation, environmental education, landscape care, and conservation of historical and cultural values. The poor management of these protected areas thwarts effective programs in recreation, education, and conservation of natural resources. The services and economic benefits derived from the management of these areas remain insignificant in terms of the state's economy.

Nowhere is the planning and development of protected areas easy, and Mexico is no exception. We believe that effective management of these protected areas requires a deep and critical review of their present condition. Decentralization of administrative and financial resources is paramount to success at the local level. It is also important to diversify the financial resources to include international, federal, state, and county agencies. We believe that commercial activities inside the reserves would help to promote the economic autonomy of each reserve and refuge. The legal protection status of each area needs to be completed with additional official regulations.

Better management strategies for protected natural areas require capable technical staff. Such personnel could be obtained through both in situ and ex situ training programs and by encouraging students in nature management disciplines at universities.

In our opinion, the creation of a regional subsystem within the NSPA to include all of the Baja California Sur reserves could be a mechanism to improve the management and protection of the wild lands in the state. This subsystem must have a general management plan with provisions for combining nature conservation with development projects. Such a plan should be firmly implemented and adequately funded and should include all federal, state, and county protected areas.

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LITERATURE CITED


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