1. CHIHUAHUAN DESERT OVERVIEW

Description of the Ecoregion

The Chihuahuan Desert is the most biologically diverse desert in the Western Hemisphere and one of the most diverse arid regions in the world. This large upland desert on the Mexican Plateau is isolated from surrounding arid regions by the high mountains of the Sierra Madre Oriental, the Sierra Madre Occidental, and the Arizona-New Mexico Mountains. This isolation has produced an area rich in endemic species, especially among plants and reptiles.

Many different definitions and boundaries have been described for the Chihuahuan Desert. Schmidt (1979) discussed various boundaries based upon climate and vegetation factors. Johnston’s (1977) boundary based upon vegetation closely resembles Schmidt’s preferred climatic boundary based upon the Martonne Index of rainfall and temperature. The boundary we use here is modified after the work of CONABIO (1999) and Dinerstein et al. (1995), and incorporating Bailey’s (1990) boundary within the United States. The Mexican portion of the ecoregion combines the Chihuahuan Desert proper, including the Bolson of Mapimi, with the Meseta Central Ecoregion. Additional boundary adjustments were made in the Sierra Madre Occidental and Sierra Madre Oriental in Mexico and along the boundary with the Edward’s Plateau and Tamaulipan Thornscrub ecoregions in Texas. With these adjustments the ecoregion embodies consistent physical and biological features but acknowledges the different concepts of biogeographers and our partners. The resulting final Chihuahuan Desert Ecoregion planning unit (Figure 1) covers 61,157,386 hectares. Adding a 25 km data buffer the area studied expands the ecoregion to some 74 million hectares (183 million acres or 285,838 mi²). The ecoregion extends nearly 1,500 km from just south of Albuquerque, New Mexico to the Trans-Mexican Volcanic Belt just 250 km north of Mexico City, including much of the states of the Chihuahua, Coahuila, Durango, Zacatecas and San Luis Potosi, as well as large parts of New Mexico and the Trans-Pecos region of Texas.

Most of the ecoregion lies between 900 and 1500 m (about 3,000 to 5,000 feet), although foothill areas and some isolated mountain ranges in Meseta Central may rise to more than 3000 m (about 10,000 feet). Schmidt (1979) notes the relative uniformity of climate within the ecoregion; hot summers and cool to cold, dry winters. This uniformity is due to the more-or-less equal distance of most areas of the desert from moisture sources (Gulf of Mexico and the Sea of Cortez), the uniformity of elevation of surrounding mountain masses, and the position of the desert on the continent which results in little frontal precipitation (Figure 2). As a result the Chihuahuan Desert has a high percentage of its precipitation falling in the form of monsoonal rains during the summer months. This desert has more rainfall than other warm desert ecoregions, with precipitation typically ranging from 150 to 500 mm (6 to 20 inches) annually, and the average for this being about 235 mm (10 inches) (Schmidt 1979).
Figure 1: Map of the Chihuahuan Desert Ecoregion
Figure 2: Topographic Relief of the Chihuahuan Desert
Ecoregional Subdivisions

The Chihuahuan Desert Ecoregion is divided into three major *Sections* based upon patterns of geology, soils, and vegetation (Figure 3). The **Northern Chihuahuan** section includes the area of grasslands and desert scrub straddling the Rio Bravo/Rio Grande Valley, as well as a number of isolated, north-south tending mountain ranges which are notable for the “Sky Island” nature of their biotas. Johnston (1977) notes that the western margin of the northern Chihuahuan is grama grassland gradually giving way to shrub desert eastward. Grasslands generally occur on flat areas of deep alluvium while the shrublands dominate on more dissected terrain. The Northern Chihuahuan is further subdivided into three *Subsections*.

The **Rio Grande Basin** (Cuenca del Rio Grande) lies north of the Rio Grande and includes the valley of the Pecos River, the closed Tularosa Basin which is formed from the grabben block valley formation east of the Rio Grande Rift, the basins and ranges of West Texas including the substantial grasslands of the Marfa and Marathon Basins, and the mountain massif of the Davis Mountains and the Big Bend area.

The **Northern Plains** (Llanuras del Norte) is an area of low basins with numerous small desert mountain ranges lying between the Sierra Madre Oriental and the Sierra Madre Occidental. Dominated by grasslands and desert scrub, this subsection of the Northern Chihuahuan is the most arid and biologically isolated unit of the Chihuahuan Desert.

The **Sierra Madre Occidentale Foothills** (Pie de Monte de la Sierra Madre Occidental) contains the headwaters of many of the basin rivers of the Northern Chihuahuan including the Casas Grandes, Santa Maria, del Carmen, and Conchas. The Foothills subsection includes some lower elevation montane habitats including grasslands and meadows, pine-oak forests and chaparral.

The **Mapimi Basin Section** (Bolson de Mapimi) consists of a series of basins and ranges with a central highland between the Sierra Madre Oriental and Rio Grande, and lying north of the Sierra Madre Oriental and the Mexican Plateau, extending across most of Coahuila into Durango. Much of this section consists of desert scrub. The most significant feature of the Mapimi is the large bolson, a closed basin in the center of the section. The Mapimi Basin Section is further subdivided into two *Subsections*.

The **Durango Basins and Plains** (Bolsones y Llanuras Duranguenses) contains the foothills of the Sierra Madre Occidental, with moderately high mountain ridges interspersed with deep valleys and closed basins. Most of this subsection lies between 1200 and 3000 m elevation. Many of the most important free waters of the Chihuahuan Desert drain from these foothills. Some of these are tributary to the Rio Conchos, but most drain into the closed basin of the Mapimi.
Figure 3: Section and Subsection Stratification of the Chihuahuan Desert

Legend
- City/Town
- Roads
- Section Boundary
- Subsection Boundary
- State Boundary

SCALE 1:5,500,000
UTM Projection
Map created May 2003
The **Coahuila High Plains and Ranges** (Sierras y Llanos Altos Coahuilenses) consists of a series of isolated mountain ranges and internal basins lying south and west of the lower Rio Grande. This section is characterized by isolated closed basins including the Bolson de Mapimi and the Bolson de Cuatro Cienegas which have been important centers for evolutionary radiation.

The **Meseta Central Section** is considered by many to be a separate ecoregion from the Chihuahuan Desert. This region is surrounded by the Sierra Madre Occidental on the west, the Sierra Madre Oriental in the east, and by the Transverse Volcanic Ridge to the south. The Meseta Central is dominated by desert plains and mountains that rise up to 2400 m above sea level. The climate is dry and hot, with precipitation levels below 500 mm/year. Vegetation is typically matorral dominated by lechuguilla, acacia and agave. This section contains portions of the states of Durango, Zacatecas, San Luis Potosi, Tamaulipas, Nuevo Leon, and Coahuila. The Meseta Central Section is further subdivided into two Subsections.

**Zacatecas - Potosino Tablelands** (Meseta Zacatecano – Potosina), on the west, consist of high mesas between 1500 and 2500 m. Much of the substrate of this subsection is composed on sedimentary rocks. In this western portion of the Meseta Central the dominant vegetation is yucca and acacia matorral.

**Potosino - Nuevo Leon Mountains** (Sierras Potosino – Neoleonenses), to the east, lies on the western flank of the high Sierra Madre Oriental. Much of the substrate is of volcanic origin. This varied subsection includes the long rift from Torreon to San Luis Potosi, marking the western edge of the Sierra Madre Oriental uplift. As a result, this subsection includes elevations ranging from 1100 to almost 3000 m.

**Biodiversity Status**

The Chihuahuan Desert is a rather recent phenomenon – as recently as 9,000 years ago this area was much more mesic and dominated by coniferous woodland, typically of piñon pine (*Pinus* spp.) and juniper (*Juniperus* spp.) (Wells, 1974; Allen et al., 1998, Van Devender, 1990). Miller (1977) suggests that the region served as a post-Pleistocene dispersal route for many organisms, and that as aridity increased the result was isolation, differentiation, and extinction that led to the unique Chihuahuan biota of today.

Johnston (1977) indicates that the Sierra Madre Oriental, which forms the eastern boundary of the Chihuahuan Desert, is one of the oldest and richest centers of plant evolution on the North American continent. Johnston maintains that the northern Chihuahuan Desert, which lies on the Mexican Plateau, is essentially a broad physiographic expansion of the Sierra Madre Oriental, and that the flora of this region has its strongest affinities with this high mountain block. Johnston further indicates that there are at least 1,000 endemic plant taxa in the Chihuahuan Desert, an astonishing richness of biodiversity. This high desert area is a center for endemism of yuccas and cacti (Hernandez and Barcenas 1995). The dominant plant species throughout the
Chihuahuan Desert is creosote bush (*Larrea tridentata*), but large areas of the region are grama grasslands, with black grama (*Bouteloua eriopoda*) characteristic, and mesic swales of tobosa (*Hilaria mutica*) and giant sacaton (*Sporobolus wrightii*).

The Chihuahuan Desert also supports more than 120 species of mammals, 300 species of birds, 110 species of fish, and more than 170 species of amphibians and reptiles. The mammal and bird faunas of this area are largely comprised of widespread and common species, and there are few endemics (Findley and Caire, 1974; Phillips, 1974). Nevertheless, the Chihuahuan Desert grasslands serve as wintering grounds for a large proportion of North American Great Plains birds including a number of significantly declining species such as mountain plover (*Charadrius montanus*), ferruginous hawk (*Buteo regalis*) and Baird’s sparrow (*Ammodramus bairdii*). Also of significance is that the largest remaining black-tailed prairie dog (*Cynomys ludovicianus*) towns on the continent and the only populations of the endemic Mexican prairie dog (*Cynomys mexicanus*) occur in the Chihuahuan Desert.

Morafka (1974) indicates that at least 18 species of reptiles and amphibians are endemic to the Chihuahuan Desert, including the bolson tortoise (*Gopherus flavomarginatus*), black softshell turtle (*Trionyx ater*), and the Chihuahuan fringe-toed lizard (*Uma exsul*).

A striking number of endemic fish occur in the Chihuahuan Desert – nearly half of the species in the ecoregion are either endemic or of limited distribution. Most of these are relict pupfish (*Cyprinodontidae*), shiners (*Cyprinidae*), livebearers (*Poeciliidae*), and Mexican livebearers (*Goodeidae*) found in isolated springs in the closed basins of the region. The best known of these aquatic basins is Cuatro Ciénegas in central Coahuila, but other significant areas of endemism include the Rio Nazas, Media Luna, the Guzman Basin (Miller 1974; Minkley 1974; Minkley et al., 1991), and the Pecos Plain. At least one undescribed species of trout (*Oncorhynchus* sp.) occurs in the Chihuahuan Desert ecoregion as an evolutionary isolate in headwater streams in the Sierra Madre Occidental (Hendrickson et al., 1999).
2. ECOREGIONAL ASSESSMENT PROCESS

The Chihuahuan Desert Portfolio was developed through a joint effort of Pronatura Noreste, World Wildlife Fund and The Nature Conservancy (See the List of Team Participants, page i). The portfolio complements the recent World Wildlife Fund Chihuahuan Desert Biological Assessment (Dinerstein et al. 2000). Other organizations and individuals contributed substantial information and expertise. The tasks of compiling and processing data, generating a portfolio and assessing results were accomplished across agency, state and international boundaries. The portfolio is comprehensive in scope as it combines ample quantitative data, a powerful computer model, the knowledge and guidance of experts, and results of previous conservation efforts to produce a vision for Chihuahuan Desert conservation. It is our belief that involvement of a spectrum of participants and tools increases the relevance and usefulness of the portfolio.

The goal of the portfolio is to identify those areas that, if managed appropriately, will conserve viable examples of the biodiversity of the entire ecoregion (The Nature Conservancy 2000). A companion goal is that the portfolio should be efficient in size, in recognition of practical limits on our ability to implement conservation on an ecoregional scale. Conservation areas must also be sufficiently intact and functional to sustain the ecoregion’s ecosystems and biota. Finally, the portfolio should compensate, where possible, for biodiversity losses that have resulted from accelerated human impacts, particularly over the past 100-200 years (Pimm et al. 1995).

We chose a two-tiered multi-scale approach to portfolio assembly. In this approach ecological systems (vegetation types combined with landscape features), vegetation-sites, indicator species and keystone species are considered coarse-filter conservation targets. These targets approximate ecosystems in scale and complexity. Though rare species are the traditional focus of conservation efforts, a consensus has grown in recent years that species persist only in the context of functional ecosystems, and that these systems are at risk and should be conserved (Franklin 1993, Flather et al. 1998). The aim of the coarse filter is to embrace the most central ecological processes and components of the Chihuahuan Desert, and in so doing act as an umbrella to capture the plants and animals that depend on those systems. Fine-filter targets comprise the second tier of our approach. These are rare taxa and those that are characteristic of the Chihuahuan Desert. The fine-filter ensures that all biological components of the desert, including those that might slip by the coarse-filter, are represented.

Biodiversity may be defined as the biological and ecological systems and processes that occur at multiple scales and comprise the planet’s biosphere (Poiani et al. 2000). These systems and processes include such diverse elements as genes, populations, species, evolution, habitats, ecosystems, nutrient cycles, etc. Human-mediated changes are typically not included in this definition. For the purpose of assembling a portfolio, the coarse and fine-filter targets are considered practical surrogates for biodiversity conservation.
The huge area of the Chihuahuan Desert presents a technical problem for creating a single ecoregion-wide portfolio of conservation areas. In particular, the SITES computer model (Davis et al. 2001), which we used to generate the draft terrestrial portfolio, has computational limits that are exceeded by an ecoregion the size of the Chihuahuan. As a solution we developed a separate portfolio for each of the three major sections of the ecoregion. During the portfolio review process we carefully assessed proposed conservation areas associated with section boundaries to ensure that the three portfolios are compatible and make sense as an ecoregion-wide conservation solution.
3. ASSEMBLING THE TERRESTRIAL PORTFOLIO

Overview

Portfolio assembly was actually carried out at the level of the planning units, which are 2000-hectare hexagons that cover the ecoregion. Planning units of uniform size and shape have the advantage of “leveling the playing field” so that conservation areas are identified based on clear parameters, rather than factors that may be difficult to understand or quantify. These parameters include the known distributions of conservation targets, numeric and area goals for capturing targets, the degree of human impacts and the overall size of the portfolio. SITES can select planning units individually or in aggregation, depending on the specific targets and goals. The chief disadvantage of these planning units is that they do not, of themselves, represent conservation areas, even when aggregated. However, they provide a useful way to point us to potential conservation areas, which then will become more real as conservation area planning is applied to each site.

Portfolio assembly entailed several steps. Criteria for identifying conservation targets were established and a conservation target list was developed. Location records for targets were compiled from various sources and standardized. Species locations were processed to approximate populations. Ecological system and vegetation-site locations were honed using a landcover map of the ecoregion. Quantitative goals, intended to support target viability, were set and govern each target’s level of representation in the portfolio. An impacts assessment was developed for the ecoregion that highlights intact areas and those with low human impacts. SITES, which is designed to meet conservation goals while constraining portfolio size, produced a draft portfolio. Results were reviewed by a team of scientists, planners and land managers who adjusted the portfolio as necessary to better meet goals and reflect biological and practical reality. The review team balanced the computer-driven output of SITES with first-hand knowledge of the ecoregion. Both at the SITES phase and during review previous Chihuahuan Desert conservation efforts were acknowledged and, to some extent, integrated into the portfolio. In the final step the portfolio was assessed as to how it compares to the ecoregion in terms of physical and biological composition, human population distribution, and fragmentation.

A large amount of information was collected, analyzed and generated through the portfolio assembly process. Tabular data were managed in a relational database, Microsoft Access 2000, and spatial data were managed using ArcView 3.2 and ArcInfo 8 Geographic Information System (GIS) software (ESRI 2000). Supportive data layers developed for this project include a Digital Elevation Model (DEM), a landcover map, a biophysical model and a fragmentation model.