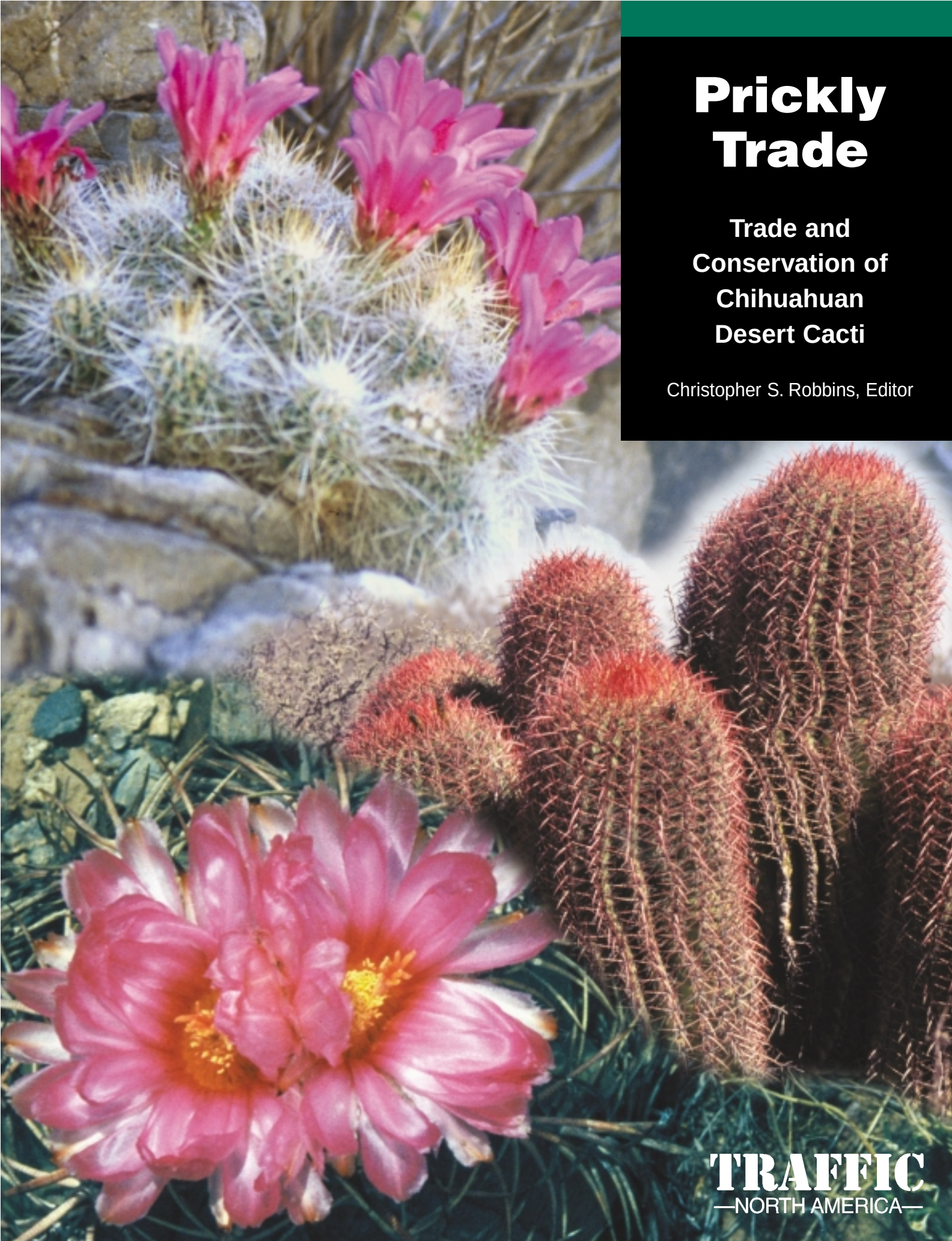

Prickly Trade

Trade and Conservation of Chihuahuan Desert Cacti

Christopher S. Robbins, Editor

TRAFFIC
—NORTH AMERICA—

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Part I:
Chihuahuan Desert Cacti in the United States:
An Assessment of Trade, Management, and Conservation Priorities

by Christopher S. Robbins

Part II:
Chihuahuan Desert Cacti in Mexico:
An Assessment of Trade, Management, and Conservation Priorities

by Rolando Tenoch Bárcenas Luna

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Cover photos of (top to bottom) *Echinocereus stramineus, Ferocactus pilosus*, and *Echinocactus horizonthalonius*, by J. Atchley

Preface

World Wildlife Fund (WWF) considers the Chihuahuan Desert Ecoregion (CDE) of Mexico and the United States an important ecoregion for conservation because of its outstanding biological diversity, ecological fragility, and environmental concerns. The ecoregion, rich in natural resources, faces a range of visible threats stemming from human activities such as mining, fossil fuel exploration, livestock grazing, industrial agriculture, and development. A less publicized, but significant, threat in the U.S. portion of the ecoregion is the commercial extraction of wild native succulents, including cacti, for landscaping in private gardens hundreds of miles away. In the Mexican Chihuahuan Desert, some of the world's rarest cacti are harvested and exported, often illegally, by opportunistic foreign collectors, or sold to unaware tourists by impoverished villagers supplementing paltry incomes.

WWF approached TRAFFIC North America, the wildlife trade monitoring unit of WWF and the World Conservation Union (IUCN), to investigate the implications of harvest and trade on the conservation of affected cactus taxa and localities in the Chihuahuan Desert. TRAFFIC divided this study into two parts to reflect the political boundaries of the CDE in the United States (Part I) and Mexico (Part II). TRAFFIC recognizes, however, that the geographic delineation of the CDE is defined by ecological and biological characteristics shared by both countries, and so it should be treated as one biogeographic region. TRAFFIC's decision to assess the trade and management of CDE cacti in Mexico separately from the trade and management of CDE cacti in the United States was determined by practicality and methodology. The disparate issues associated with cactus trade, taxonomy, and management in Mexico and in the United States required two different investigators with knowledge specific to each country. Each investigator contributed a report to this publication and, to the extent possible, the reports have been harmonized to minimize stylistic differences.

Commercial trade drives the harvesting of CDE cactus species in Mexico and the United States, but the nature and scale of this trade differ in both countries. Mexico harbors the greatest diversity of endemic, endangered, and newly discovered cactus species. Those species are highly sought after by foreign collectors and continue to appear in the international marketplace in spite of Mexico's laws prohibiting illegal collection. The number of specimens entering trade illegally is believed to be small but may be significant enough to destabilize wild populations of some species. This practice also undermines the competitive advantage of Mexican growers to propagate and sell endemic cacti in the marketplace. In the United States, the cactus trade involves fewer cactus species but considerably more plant material. The primary markets are southwestern U.S. cities with an arid climate where consumers are trying to conserve water by resorting to desert landscaping with plants like cacti instead of water-intensive gardens. Contrary to their best intentions, gardeners and homeowners are addressing one conservation issue at the expense of another.

TRAFFIC North America hopes the findings and conservation priorities detailed in this report will help WWF, in collaboration with local stakeholders, to improve the sustainability of harvest and trade in cacti and other succulents from the CDE.

—Christopher S. Robbins, Editor

Part I

Chihuahuan Desert Cacti in the United States:
An Assessment of Trade, Management, and Conservation Priorities

by
Christopher S. Robbins

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ACKNOWLEDGMENTS

This report benefited enormously from the input of many individuals who generously offered their insight and patiently responded to the author's repeated inquiries for information. I would like to thank the following people for their time and tolerance during the preparation of this report: Jennifer Atchley (World Wildlife Fund); Edward "Ted" Anderson (Desert Botanical Garden); Rolando T. Bárcenas (Centre for Plant Diversity and Systematics, United Kingdom); Dennis Day (California Department of Agriculture); Kenneth Dulik (U.S. Fish and Wildlife Service); Mike Ebers (California Department of Agriculture); David Ferguson (Rio Grande Botanic Garden, New Mexico); Julie Gray (TRAFFIC International); Simon Habel (TRAFFIC North America); Héctor M. Hernández (Instituto de Biología de la Universidad Nacional Autónoma de México—IBUNAM); Mike Howard (Bureau of Land Management, Las Cruces, New Mexico); Jim McGinnis (Arizona Department of Agriculture); Teresa Mulliken (TRAFFIC International); Bud Petitdemange (U.S. Department of Agriculture); Jackie Poole (Texas Parks and Wildlife); Mike Powell (Sul Ross State University, Alpine, Texas); Dana Price (Texas Parks and Wildlife); Adrian Reuter (TRAFFIC North America); John Sherman (Bureau of Land Management, Carlsbad, New Mexico); Robert Sivinski (New Mexico Forestry Division); Sherry Sanderson (New Mexico Department of Agriculture); and Alice Taylor (World Wildlife Fund).

TRAFFIC North America is grateful to WWF-Netherlands and the WWF-US Endangered Spaces program for providing much of the funding for the Chihuahuan Desert Cactus Study.

Executive Summary

Cacti belong to a family of plants that evolved exclusively in the Americas, occupying arid, semi-arid, and moderately humid environments from Canada to Patagonia. The evolutionary precursors to cacti were probably tropical plants whose climate turned increasingly arid, resulting in the selection and ultimate survival of those species capable of conserving water. The physical and physiological traits that give cacti and related plants, called *succulents*, the ability to tolerate desert environments are the same features that make them so irresistible to collectors and attractive to municipalities and homeowners trying to save water (and money) by landscaping with desert flora, a practice known as xeriscaping.

The popularity of cacti, especially the rare, geographically restricted or threatened species, as collectibles, garden plants, food, or medicine may be contributing to the overharvesting of some cactus species and their natural populations, especially those growing wild in the Chihuahuan Desert of the United States and Mexico. The Chihuahuan Desert Ecoregion is home to almost 25 percent of the 1,500 cactus species known to science. The outstanding diversity of plants, animals, and habitats of the Chihuahuan Desert speaks of the biological value and ecological significance of an ecoregion whose conservation is a high priority to World Wildlife Fund–US (WWF–US).

TRAFFIC North America, on behalf of WWF–US, studied the trade and management of Chihuahuan Desert cacti to determine which species harvested commercially from the wild may be managed and monitored better. TRAFFIC documented a thriving landscaping and nursery market in the southwestern United States for wild cacti and other succulent species originating from the Chihuahuan Desert of Arizona, New Mexico, and Texas.

Cities in the desert southwest of the United States are advocating the use of desert plants in landscaping to conserve water. However, those well-intended campaigns may be mitigating one environmental problem while exacerbating another. Unless propagation, sustainable harvest, and protection for some species is increased, a continuing demand for hardy cacti and other succulents in landscaping projects may eventually exceed the availability of some species in the wild. In particular, West Texas, comprising the largest swath of Chihuahuan Desert in the United States, is the dominant producer of showy cacti (such as barrel and hedgehog cacti) and other succulents (for example, ocotillo, yucca, and agave) for urban markets in Arizona, Nevada, and southern California. Between 1998 and June 2001, nearly 100,000 succulents, with an estimated value of US$3 million, were harvested from mostly wild populations in Texas or were illegally imported into Texas from Mexico and destined for consumers in cities such as Phoenix and Tucson, Arizona.

Although none of the species identified in U.S. trade by TRAFFIC faces imminent extinction, with the possible exception of one species in Texas, the enormity of a trade that shows no signs of abating prompts questions about the long-term transparency, legality, sustainability, and impact of large-scale harvest. Faced with the added pressures of habitat loss and the vagaries of an unforgiving and possibly changing climate, many of the taxa exploited for trade may become threatened and even disappear locally if conservation measures are not implemented.

TRAFFIC concludes that succulents of the Chihuahuan Desert can be managed and traded in a sustainable manner as long as the various stakeholders, ranging from resource managers and landowners to harvesters and consumers, take the necessary steps to ensure the conservation of a resource that is valued as much economically as it is ecologically. TRAFFIC recommends that WWF, with the participation of local governments, landowners, garden clubs, and cactus traders, implement several actions to protect a resource of ecological and economic value in the Chihuahuan Desert. Among such practices is establishing commercial propagation and starting a sustainable certification program for popular and high priority species in the Chihuahuan Desert, as well as encouraging federal, state, and local governments to advise consumers in the market for desert plants to purchase plants only from propagated or verifiable sustainable sources.

Introduction and Background

World Wildlife Fund (WWF) has identified the Chihuahuan Desert as an ecoregion of outstanding biological diversity and value, and the organization is striving to conserve the desert's natural beauty and bounty. The Cactaceae, a family of succulent (water-storing) plants native to the Americas, is symbolic of the botanical diversity of the Chihuahuan Desert. Approximately 80 percent of the Chihuahuan Desert lies within Mexico, while the other 20 percent stretches into West Texas, southern New Mexico, and southeastern Arizona.

As desert dwellers, cacti have evolved special adaptations to surviving in arid and semiarid environments. Among those biological advantages is the ability of cacti to absorb and retain water in their fleshy stems for extended periods of drought. Cacti minimize water loss by growing protective protrusions that appear in the form of spines or fine hairs to deter herbivores and to block damaging sunlight. Ironically, the very features that afford cacti longevity and protection in their natural habitat also make them vulnerable to humans, who use them for food, medicine, candy, and ornamentation.

TRAFFIC North America, with funding from WWF, undertook an assessment of collection, commerce, conservation, and management of cacti that occur within the Chihuahuan Desert Ecoregion (CDE) of the United States. Cactus exploitation in the CDE of Mexico was reviewed in a parallel study, the results of which are presented in Part II of this report. The findings summarized here identify key issues for the conservation of CDE cactus species and localities affected by exploitation within the United States. TRAFFIC's recommendations for cactus conservation work in the region take into account *in situ* and *ex situ* management priorities, gaps in monitoring and regulation, and barriers to and opportunities for working with stakeholders.

On one level, this report clarifies questions about cactus exploitation and management in the CDE of the United States, while on another it raises some new questions. To a large extent, cactus taxa and populations affected by commercial exploitation are better known, but the intensity, level, and biological impacts of harvest are less understood. Some species documented in trade are relatively widespread yet are collected in large enough quantities to raise legitimate concerns about the status of wild populations. Although falling outside the original scope of this review, a few species of succulents other than cacti have emerged as a potential conservation priority because of strong commercial demand, heavy interstate trade, or illegal trade across the U.S.-Mexico border.

TRAFFIC's research shows that a three-pronged approach is needed to conserve cactus populations of the U.S. Chihuahuan Desert from unsustainable and illegal trade: (1) improving monitoring of species harvest and trade, (2) strengthening protection for species under the most pressure from exploitation and habitat loss, and (3) developing a community-based program for the sustainable harvest of common species and commercial cultivation of the rarest or slowest-growing species. Additional regulation should be pursued if collection is found to be detrimental to wild populations and other conservation measures are not sufficient or successful. Toward this end, field research is needed in areas where collection occurs so that the effects of harvest on natural populations can be studied and evaluated. The conservation of native CDE cactus species of the United States will hinge on the collaborative efforts of multiple stakeholders, not the least of which are public land management agencies in Arizona and New Mexico, and private landowners in West Texas.

The success of any sustainable management program for wild cactus populations on private lands in Texas will hinge on demonstrating the economic benefits to landowners, many of whom have an unfavorable opinion of cacti as a nuisance or hazard to livestock. Whatever actions are taken to advance Cactaceae conservation in the Chihuahuan Desert of the United States, it is clear that a multifaceted strategy is needed to protect cactus species and populations from unsustainable harvest levels and methods that may undermine their ecological role, evolutionary potential, and contribution to local economies.

Methods and Sources of Information

Some of the findings of this report are based on firsthand observations and anecdotal information that may not reflect a complete set of facts about the issues covered. The informal and fluid nature of the cactus trade from the Chihuahuan Desert hinders research efforts and has implications for the reliability of information gathered. A draft of this report was circulated to the following panel of experts in an effort to detect factual inaccuracies or inconsistencies and to determine the feasibility of recommendations for enhancing cactus and succulent trade monitoring and management in the ecoregion: Jennifer Atchley (World Wildlife Fund); Edward "Ted" Anderson (Desert Botanical Garden); Rolando T. Bárcenas (Centre for Plant Diversity and Systematics, United Kingdom); David Ferguson (Rio Grande Botanic Garden, New Mexico); Julie Gray (TRAFFIC International); Mike Howard (Bureau of Land Management, Las Cruces, New Mexico); Jim McGinnis (Arizona Department of Agriculture); Teresa Mulliken (TRAFFIC International); Dana Price (Texas Parks and Wildlife); Jackie Poole (Texas Parks and Wildlife); Mike Powell (Sul Ross State University, Alpine, Texas); and Adrian Reuter (TRAFFIC North America).

TRAFFIC used several sources of quantitative and qualitative information in assessing trade in cacti from the Chihuahuan Desert of the United States. U.S. cactus exports were tallied from Convention on International Trade in Endangered Species (CITES) trade data provided by the World Conservation Monitoring Centre (WCMC), a repository of trade and biological information based in Cambridge, United Kingdom, under the United Nations Environment Program. Although CITES regulates international trade in fauna and flora and requires member countries to report such trade to its secretariat, CITES does not have jurisdiction over domestic commerce. Thus, CITES's data are not available for trade within the United States.

Catalogues of U.S. nurseries, supplemented by observations from nursery visits in Arizona, New Mexico, and Texas, provided most of the information for the analysis of the U.S. market. Phytosanitary (plant health) certificates and movement permits issued by the Texas Department of Agriculture and Arizona Department of Agriculture, respectively, were used to quantify trade between Texas and Arizona, both of which are significant producers of and markets for cacti. Two plant inspection stations (Winterhaven and Blythe), administered by California's Department of Food and Agriculture, along the California-Arizona border provided copies of quarantine forms issued for plants imported into California from New Mexico and Texas since 1999. These documents proved to be a useful source of statistics on plant species traded from Texas to Arizona or California, although identifying plants to the species level was problematic as scientific names were not included on forms. Experts familiar with the common names of plants disclosed on trade permits and advertised on Web sites offering plants documented in trade were consulted to clarify species nomenclature. The Arizona Department of Agriculture also released to TRAFFIC photocopies of native plant salvaging permits for cacti harvested from wild populations in southeastern Arizona, the only part of the state within the Chihuahuan Desert.

The following U.S. federal agencies were contacted for information on legal and illegal harvest and trade: the Fish and Wildlife Service (FWS), the Bureau of Land Management (BLM), and Big Bend National Park under the U.S. Department of the Interior; the U.S. Forest Service (USFS) and the Animal and Plant Health Inspection Service (APHIS) under the U.S. Department of Agriculture (USDA); and the Drug Enforcement Agency under the U.S. Department of Justice. APHIS made available to TRAFFIC information on reported cacti seizures along the U.S.-Mexican border. Those data indicate the species intercepted by U.S. authorities upon entry into the country and which ports experience the most cacti seizures. Several state parks in Texas and the Big Bend National Park were contacted for additional information on illegal cacti collection.

State laws of Arizona, New Mexico, and Texas were summarized from Web sites. State officials in the following agencies provided additional information and clarification of those laws: Arizona Department of Agriculture, New Mexico Department of Agriculture, and Texas Parks and Wildlife Department. TRAFFIC sought input and assistance from several institutions on the geographical distribution and biology of CDE cactus species in the United States: Texas Parks and Wildlife Department (Austin, Texas); Desert Botanical Garden (Phoenix, Arizona); Sul Ross State University (Alpine, Texas); Arizona Cactus and Succulent Research (Bisbee, Arizona); and Albuquerque Botanical Garden (Albuquerque, New Mexico). The Association for Biological Diversity (Arlington, Virginia) was consulted for information on the state status of succulents documented in trade between Texas and Arizona. The overall conservation status of rare cactus species of the CDE identified in this review was obtained from the World Conservation Union (IUCN) Red List of Threatened Plants.

Results and Discussion

Legal Commercial Cacti Trade

The United States ranks among the world's largest cactus producers and markets, with the highest concentration of growers and harvesters located in the southwestern states. There are three primary markets or outlets for ornamental cacti produced in the United States: nurseries, supermarkets, and private collectors. Nurseries supply cacti used in residential gardens, commercial establishments (e.g., golf courses), or public areas such as parks or median strips in urban and suburban areas where the climate is suitably arid. Xeriscaping, or landscaping with plants adapted to arid climates, is gaining popularity in desert cities where water shortages are a growing concern. Barrel cactus (*Ferocactus* spp.), prickly pear cactus (*Opuntia* spp.), and saguaro cactus (*Carnegiea gigantea*) are the species most frequently used in landscaping projects because of their large, showy appearance. Another significant outlet for U.S.-grown cacti is the supermarket. Large volumes and varieties of miniature cacti grown artificially from seeds in states such as California and Arizona are shipped to supermarkets in the United States and abroad to be purchased as indoor ornamental plants. Private collectors represent a smaller, diffuse segment of the cactus market who are driven by a desire for the rarer and newly discovered species in the Cactaceae family.

In the United States, cacti are also used for traditional medicine, food, candy, commercial beverages, and cosmetics, furniture, and materials for fence construction. For instance, furniture manufacturers and commercial landscapers obtain dead cactus wood of wild saguaro and cholla (*Opuntia fulgida*), usually from the Sonoran Desert in Arizona and Mexico, to decorate gardens and homes (Floyd 1998). A relatively new line of products containing prickly pear cactus, ranging from bottled beverages to skin-care lotions to herbal remedies to insect repellants, is available in retail stores throughout the United States (Worth 2000).

The international trade in ornamental cacti grown in the United States is flourishing. During the past 20 years, the U.S. cactus trade has experienced some positive changes, including a progressive shift from solely relying on wild specimens of rare species to artificially propagating those species. The trend is made apparent when one is examining trade data, particularly data on U.S. exports and imports of cacti. More than 40 countries, led by Canada, which accounted for 83 percent of all U.S. cactus exports in 1998, import artificially propagated cacti from U.S. growers. U.S. exports of artificially propagated cactus plants and seeds totaled 2.6 million and dwarfed exports or reexports of field-collected plants, of which there were 5,700 in 1998, the most recent year for available data (table 1). Most of these exports were live plants comprising 55 genera and 251 taxa; 105 (42 percent) taxa are native to the Chihuahuan Desert. About 71 percent of U.S. exports of artificially propagated cactus specimens consisted of species that occur naturally in the Chihuahuan Desert. The large quantity of Chihuahuan Desert cacti documented in U.S. exports suggests that international demand for artificially propagated cacti native to this ecoregion is strong.

Fewer than 500 wild-harvested cactus specimens representing seven genera were exported from the United States to eight countries, primarily to Japan and the Netherlands, in 1998. Most U.S. exports of wild cacti in recent years have been reexports of musical instruments (rainsticks) made from species of *Eulychnia* and *Echinopsis*, two genera native to South America, that originated from shipments or tourists in Chile. Of the 22 species reported in U.S. exports of wild-collected cactus specimens, 10 species totaling 98 live plants involved cacti whose geographical range includes the Chihuahuan Desert in the United States (table 1). For additional information on U.S. exports and imports of cacti refer to Appendices 1-5.

U.S. imports and reexports of field-collected cacti, especially live plants, from Mexico have declined to a fraction of the levels recorded in the early 1980s. In 1982, 73,000 live cacti of known or likely wild origin were

Table 1. Exports or Reexports of Wild Cacti by Species (1998)

Taxon	Specimens Exported	Quantity	Chihuahuan Taxon
Cactaceae	Stems, timber pieces	11	
Carnegiea gigantea	Live plants, stems, timber pieces	55	
Echinocactus horizonthalonius	Live plants	64	✔
Echinocactus polycephalus	Live plants	9	
Echinocereus dasyacanthus	Live plants	20	✔
Echinocereus engelmannii	Live plants	9	
Echinocereus nicholii	Live plants	10	✔
Echinocereus stramineus	Live plants	3	✔
Echinocereus triglochidiatus	Live plants	12	✔
Echinocereus viridiflorus ssp. *chloranthus*	Live plants	6	✔
Echinopsis chiloensis	Carvings	13	
Eriosyce subgibbosa ssp. *clavata*	Live plants	24	
Escobaria tuberculosa	Live plants	2	✔
Eulychina acida	Carvings, live plants	5,194	
Ferocactus cylindraceus	Live plants	136	
Ferocactus emoryi	Live plants	31	
Opuntia spp.	Timber pieces	9	
Opuntia basilaris	Live plant	1	
Opuntia bigelovii	Live plant	1	
Opuntia echinocarpa	Live plant	1	✔
Opuntia erinacea	Live plant	1	✔
Opuntia ramosissima	Live plant	1	✔
Sclerocactus uncinatus	Live plants	5	✔
Sclerocactus uncinatus ssp. *wrightii*	Live plants	30	✔
Total		**5,648**	

Source: World Conservation Monitoring Center.

legally imported into the United States from Mexico (Fuller 1985). Today, legal U.S. imports of cacti from Mexico number fewer than 500 and consist entirely of artificially propagated plants or wild-harvested timber pieces of various cactus species. The only significant legal U.S. imports of field-collected cacti from Mexico in 1998 were timber pieces of saguaro (*Carnegiea gigantea*), a species native to the Sonoran Desert, and 8,000 timber pieces of cholla (*Opuntia fulgida*), a Chihuahuan Desert species. Mexico's accession to CITES in 1992 and stricter enforcement of the country's laws prohibiting exports of wild plants, combined with the abundance of artificially propagated plants in the United States, are largely responsible for lower U.S. imports of field-collected cacti from that country.

By comparison, U.S. domestic consumption of cacti harvested from the CDE is markedly higher than exports to foreign markets. Southwestern U.S. cities with arid climates absorb most of the live cactus plants harvested from the wild for xeriscaping. The main U.S. markets for wild-harvested CDE cactus plants include medium-to-large cities in Arizona, California, Nevada, New Mexico, and Texas. Less important regional markets for CDE cacti include Colorado and Oklahoma. Phoenix and Tucson, Arizona, and Las Vegas, Nevada, are among the fastest-growing markets in the country. Residential development in those urban areas is associated with higher demand for mature desert plants, which can be easily transplanted from the wild to suburban gardens with a similar environment. Heightened sensitivity to water shortages contributes to

demand for desert plants in major cities of the U.S. Southwest. As a conservation measure, people are replacing water-intense plants with hardier, native vegetation such as cacti and other desert plants that require less water than most other popular garden plants.

A survey of nurseries, catalogues, and Web sites, as well as analyses of state-issued quarantine and agricultural permits, confirms that CDE cacti harvested from the wild in the United States are destined for markets in Arizona, California, Nevada, New Mexico, and Texas. According to individuals familiar with the trade, plant material from the Mojave and Sonoran Deserts may dampen commercial demand for CDE cacti west and north of Arizona (Ferguson 2000). For instance, the Mojave Desert is the main source of drought-tolerant native plants used in residential landscaping in Las Vegas, Nevada. The driving distance from the Chihuahuan Desert in West Texas, where the highest level of cactus collecting in the U.S. portion of the ecoregion occurs, to Las Vegas is considerable and may deter Texas cactus traders who can just as easily find buyers in Arizona cities. Despite the distance barrier for Texas traders, some cacti native to the Chihuahuan Desert in Texas are traded to the Las Vegas area, as evidenced by the availability of wild-collected specimens of blue barrel cactus (*Echinocactus horizonthalonius*) and horse crippler (*Echinocactus texensis*), which are native to West Texas in the Chihuahuan Desert. Southern California, particularly Los Angeles, Riverside, and San Bernardino Counties, is also a destination for succulents, including cacti, originating in the Chihuahuan Desert of Texas and New Mexico. From 1999 to 2002, California imported 2,300 live succulents likely of wild origin from Texas or New Mexico; 1,090 live plants were reportedly from Eddy County in New Mexico or from Pecos and Brewster Counties in Texas, all three of which are part of the Chihuahuan Desert (table 2).

Several Arizona cities, especially Tucson and Phoenix, import live CDE cacti directly from Texas, where diggers harvest them from private property. However, many Tucson nurseries also offer plants that are clearly grown from seeds or artificially propagated through tissue culture. In New Mexico, the cities of Alamogordo, Albuquerque, Deming, Las Cruces, Lordsburg, Santa Fe, Truth or Consequences, and Tulerosa are confirmed or potential commercial markets for CDE cacti exported from Texas (Ferguson 2000). The most frequently documented cactus species in Las Cruces, an important market in New Mexico, were rainbow hedgehog (*Echinocereus dasyacanthus*) and Texas barrel (*Ferocactus* spp.), the specimens of which had

Table 2. Imports of Succulents into California from New Mexico and Texas (1999–2002)

Taxon	County and State of Origin	California Destination	Quantity of Plants	Shipment Date
Agave	Eddy, N.M.	La Quinta	102	8/31/99
Cactaceae	Hidalgo, Tex.	Bermuda Dunes	9	1/17/02
Ocotillo	Pecos, Tex.	Palm Desert	62	7/24/01
Yucca	Hidalgo, Tex.	La Puente	1,200	7/03/01
Ocotillo	Brewster, Tex.	Pasadena	275	6/01/01
Yucca	Brewster, Tex.	Bermuda Dunes	30	4/19/01
Ocotillo	Brewster, Tex.	Indio	100	4/19/01
Cactaceae	Brewster, Tex.	Pasadena	356	3/29/01
Ocotillo	Brewster, Tex.	Indio	95	3/29/01
Ocotillo	Brewster, Tex.	Apple Valley	45	2/28/01
Ocotillo	Brewster, Tex.	Palmdale	25	2/28/01

Source: California Department of Food and Agriculture.

apparently originated in the wild in Texas. A survey of West Texas markets from El Paso to Laredo documented surprisingly few CDE cactus species and plants in local commerce. That finding is in contrast to a 1984 market survey conducted by TRAFFIC USA, in which a number of nurseries between Brownsville and El Paso were identified as offering live cactus (Fuller 1984). When the nursery stocks of vendors in Alpine, Del Rio, Eagle Pass, El Paso, Fort Davis, Sanderson, and Valentine were examined, rainbow hedgehog (*E. dasyacanthus*) was the most widely available CDE cactus species documented.

Arizona and Texas: A Case Study of Harvest and Interstate Trade

Arizona's Department of Agriculture maintains records of protected plant species that have either been salvaged within the state or imported from out of state. TRAFFIC obtained photocopies of permits issued for plant salvage operations in several southeastern counties of Arizona for 1998 and 1999, including Cochise, Graham, Pinal, and Pima Counties, which are partially or entirely within the Chihuahuan Desert. A number of plant species of conservation concern can be salvaged under permit from private property where future land uses, for example, development, were likely to disturb the natural habitat and destroy wild plant populations.

During 1998 and 1999, 3,165 succulents were reportedly salvaged from those four counties in southeastern Arizona. Of those succulents, 96 percent were cacti, including barrel (*Ferocactus* spp.), saguaro (*Carnegiea gigantea*), prickly pear (*Opuntia* spp.), cholla (*Opuntia imbricata)*, and hedgehog (*Echinocereus* spp.) (table 3). According to information from permits, most of the salvaged plants entered local commerce, though personal use was also reported on some permits. A total of nearly US$13,000 was generated through the sale of permits and transportation tags for plants salvaged in southeastern Arizona. An unknown number of cactus salvaging enterprises operate in Arizona largely because state regulations make it legal to salvage native and protected plants for commercial purposes.

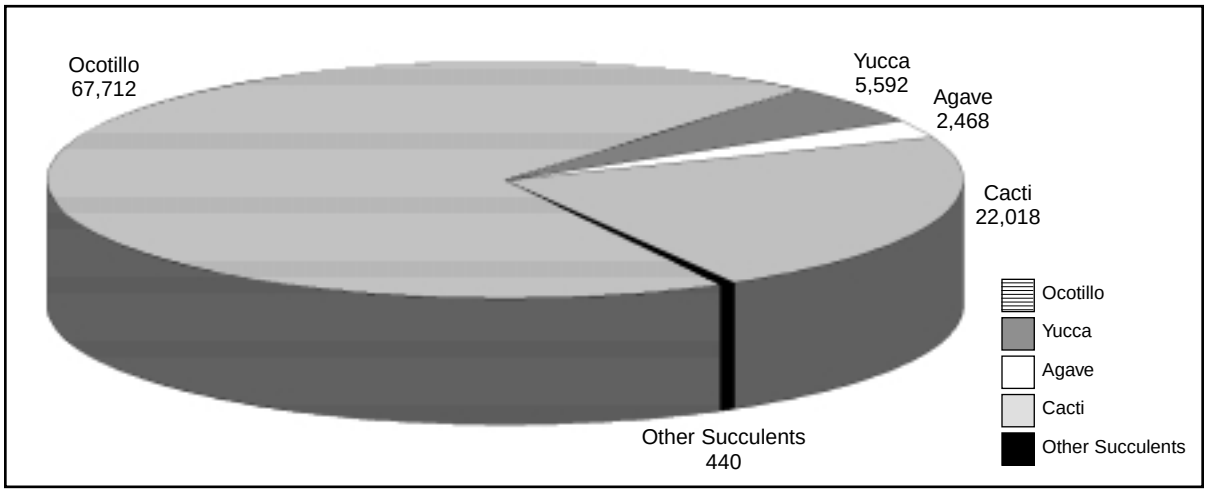
Landscaping businesses and nurseries in Arizona also import live cactus plants into Arizona from nearby states to supply a thriving local market for arid garden plants. The most significant producer of cacti and other succulents for Arizona markets is Texas, from which Arizona nurseries imported nearly 100,000 live plants, with an estimated retail value of more than US$3 million, from 1998 through the first six months of 2001 (figure 1). Most, if not all, of these plants were probably harvested from wild populations on private property, because no known nurseries in West Texas are capable of producing the volume of plants entering trade during this period. According to the U.S. Fish and Wildlife Service, a large but unknown quantity of plants reportedly originating in Texas was illegally exported from Mexico to Texas for

Table 3. Succulents Harvested from Southeastern Arizona, including Cochise and Graham Counties (1998–1999)

Common Name	Scientific Name	Quantity	Revenue From Tags Sold (US$)	Purpose
Barrel cactus	*Ferocactus* spp.	825	2,505	Commercial, personal
Cholla	*Opuntia* spp.	335	1,005	Commercial, personal
Hedgehog	*Echinocereus* spp.	25	75	Unknown
Ocotillo	*Fouquieria* spp.	85	255	Commercial, personal
Prickly pear	*Opuntia* spp.	515	1,500	Commercial, personal
Saguaro	*Carnegiea gigantea*	1,329	1,175	Commercial, personal
Yucca	*Yucca* spp.	51	153	Commercial, personal

Source: Arizona Department of Agriculture.

Figure 1. Gross Imports of Live Plants into Arizona Originating from the Chihuahuan Desert in Texas (1998–June 2001)



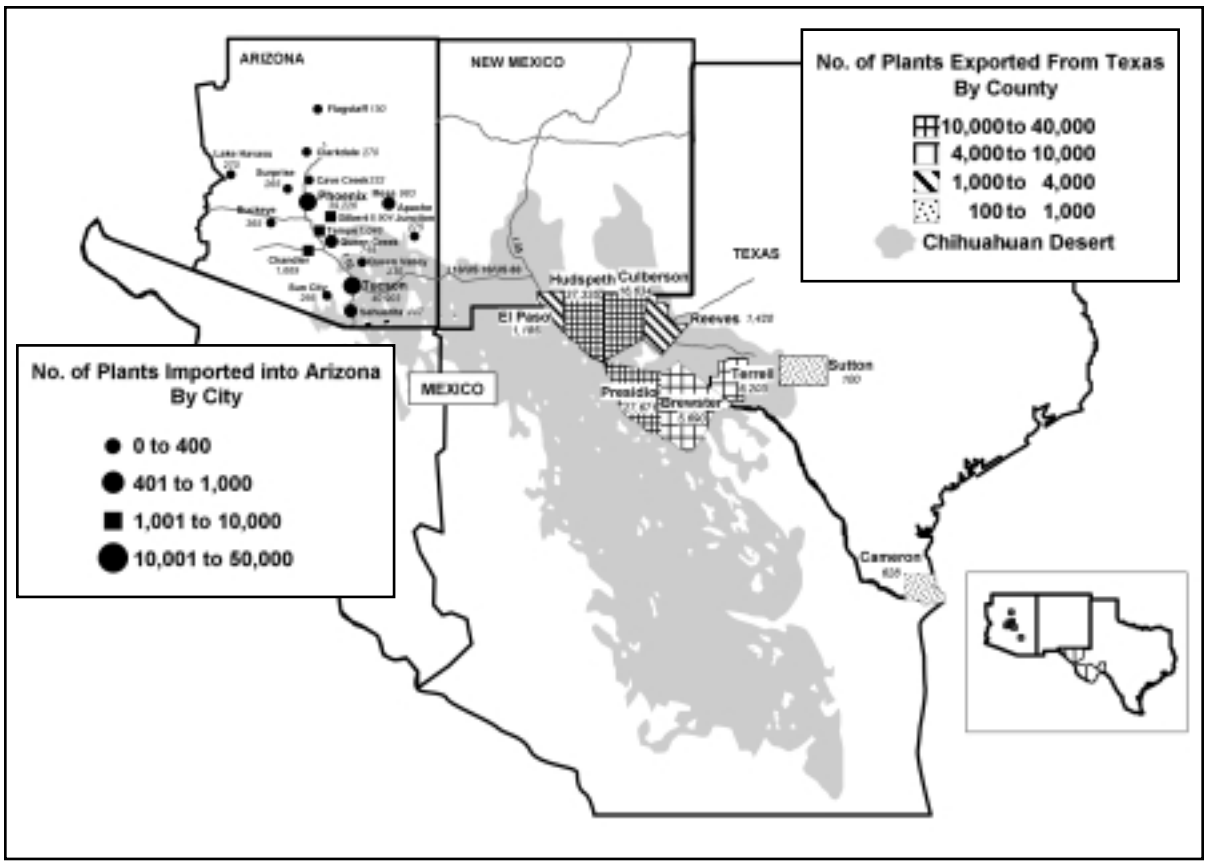
Source: Arizona Department of Agriculture.

redistribution in other states. Moreover, Texas does not allow the commercial collection of cacti from state lands. According to a phytosanitary certificate issued by the Texas Department of Agriculture, 100 ocotillo (*Fouquieria splendens*) and 100 unidentified cacti destined for Phoenix were propagated in Hudspeth County, Texas. The veracity of the claim of artificial propagation is questionable, because at the time no known commercial operations existed in Hudspeth that were capable of producing so many plants through propagation.

Texas has historically been a significant supplier of field-collected succulents. Almost all harvesting occurs on private property, for which there are few state regulations. In addition, wild-dug succulents from Texas cost less than those salvaged from wild populations in Arizona because plant harvest permits and tags are generally not needed in Texas but are mandatory for many species in Arizona. Scientific take permits are needed to harvest from state-owned land species that are protected by Texas endangered species laws; commercial permits are required for such species taken from private lands. The difference in cost enables Texas cactus dealers to undercut the price for plants salvaged and marketed in Arizona (McGinnis 2000). Private ranchers in Texas make their land available for plant collecting, leasing diggers the right to harvest cacti from areas to which public access is usually restricted. A Texas agricultural agent contacted by TRAFFIC indicates that contractors clear private land of cacti with verbal permission from landowners (Clay 2000). The cactus salvaging industry in West Texas is generally cyclical, with high turnover among businesses engaged in cactus collection (Clay 2000). Cactus diggers and dealers transport field-dug plants to cities such as Phoenix and Tucson, where markets for mature desert plants for xeriscaping continue to expand along with residential development.

Nearly 100,000 plants, belonging to 20 genera and eight families, were documented in trade between Texas and Arizona from 1998 to 2001, with a conservative estimated market value of US$3.2 million (tables 4 and 7). The estimated monetary value of plants documented in trade between Texas and Arizona (table 7) is based on the retail prices of species offered on the Web site of Arizona-based vendors. Approximately 28 individuals or enterprises from at least nine West Texas counties exported cactus or succulent species to Arizona during the period beginning in 1998 and ending in June 2001 (figure 2). Two businesses accounted for 66 percent of plants exported to Arizona during this period, obtaining plants for this trade reportedly from six different counties in West Texas. Hudspeth and Presidio Counties, located in the Trans-Pecos region of West

Figure 2. Source and Destination of Cacti and Succulent Plants Traded between Texas and Arizona



Texas, together supplied 67 percent (65,006) of plants exported from Texas to Arizona during the same period (table 5).

The Trans-Pecos and the South Texas Plains near Laredo in Zapata County, which falls outside the Chihuahuan Desert boundary, have the highest diversity and greatest concentration of cacti in Texas (Westlund 1991). The absence of large-scale nurseries in the Texas counties where cacti reportedly originated strongly suggests that most live cacti were harvested from wild populations. Today, a small but growing proportion of cactus plants produced in Hudspeth County may actually be artificially propagated in a Fort Hancock nursery (Clay 2000). It is also possible that some cacti were collected in counties not reported on Texas agricultural forms. As discussed in the section on illegal trade, many succulents, especially ocotillo (*Fouquieria* spp.), imported into Arizona from Texas (Presidio County) in 1999 and 2000 were probably smuggled into the United States from Mexico via the Rio Grande River in Presidio County, Texas. A company based in Texas, recently implicated in smuggling live plants across the U.S.-Mexico border, was among those exporting cacti and ocotillo from Texas to Arizona.

The volume of plants leaving Texas for Arizona in 1998, 1999, 2000, and part of 2001 is low compared to figures generated in a similar analysis commissioned by the Texas Parks and Wildlife Department in 1991 (Westlund 1991). During the period between December 1989 and November 1991, Arizona agricultural inspectors reported the entry of more than 470,000 cacti and cactus-like plants into the state from Texas. The same study highlighted some concerns, including the role of nonlicensed dealers in removing wild-harvested cacti from Texas. The report also cited the following problems as requiring attention: (1) too few well-trained agricultural inspectors to identify federal and state listed endangered species and (2) no controls on

Table 4. Number of Succulent Plants by Genus Imported into Arizona from Texas (1998–June 2001)

Genus	1998	1999	2000	2001	Plant Family
Agave	1,204	126	625	513	Agavaceae
Ariocarpus	100	5	85	101	Cactaceae
Bombax	0	0	10	0	Bombacaceae
Bursera	0	0	0	10	Burseraceae
Cephalocereus	160	72	44	70	Cactaceae
Cylindropuntia	270	40	0	20	Cactaceae
Dasylirion	38	55	40	10	Agavaceae
Dioscorea	26	0	0	0	Dioscoreaceae
Echinocactus	1,263	495	150	182	Cactaceae
Echinocereus	3,906	3,741	1,579	1,270	Cactaceae
Echinomastus	90	0	0	0	Cactaceae
Escobaria	120	0	23	0	Cactaceae
Escobaria (= Coryphantha)	11	1	3	1	Cactaceae
Euphorbia	0	15	0	5	Euphorbiaceae
Ferocactus	1,786	452	981	567	Cactaceae
Fouquieria	14,581	11,410	27,640	13,919	Fouquieriaceae
Ibervillea	137	17	0	1	Cucurbitaceae
Jatropha	0	9	41	1	Euphorbiaceae
Mammillaria	59	4	1	0	Cactaceae
Neolloydia	0	0	8	0	Cactaceae
Nolina	0	0	0	25	Agavaceae
Opuntia	235	206	168	0	Cactaceae
Peniocereus (= Cereus)	42	6	0	0	Cactaceae
Sclerocactus (= Ancistrocactus)	42	76	4	51	Cactaceae
Yucca	1,457	1,079	2,012	1,044	Agavaceae
Unidentified cacti	155	2	16	150	—
Unidentified succulents	391	0	0	0	—
Unidentified plants	150	0	342	30	—
Total	**26,223**	**17,811**	**33,772**	**17,970**	**95,776**

Source: Movement permits issued by Arizona Department of Agriculture.

exports of nonlisted species. The reasons for a significant drop in the number of plants exported from Texas to Arizona are not fully understood. Individuals close to the trade hypothesize that cacti trade between Texas and Arizona declined significantly during the past decade because wild populations of cactus species are smaller today than they were a decade ago. Smaller populations may be the result of overharvesting or grazing or the effect of a prolonged drought on seed germination and survival of plants or of both (Ferguson 2000; Miller 2000). Successful artificial propagation of cacti, especially barrel cactus (*Ferocactus* spp.), may have also reduced commercial demand for specimens harvested from natural populations. Even so, the Texas-Arizona trade in *Ferocactus* spp. was high between 1998 and 2001, involving thousands of specimens that were likely to have been harvested from natural populations (table 4).

Three dozen companies or individuals in Arizona imported cacti or other succulents from Texas counties located within the Chihuahuan Desert from 1998 through the first half of 2001. Seventeen cities or towns in Arizona were identified as having been the destination for those plants, with Tucson and Phoenix accounting for the heaviest volume, or 82 percent of this trade (table 6). In spite of difficulties matching common names of species with their corresponding scientific

Table 5. Summary of Plants Exported from Texas (by County) to Arizona (1998–June 2001)

County	1998	1999	2000	2001	1998–2001
Brewster	472	458	3,096	1,664	5,690
Cameron	0	0	401	227	628
Culberson	4,356	6,283	2,511	3,214	16,364
El Paso	1,185	0	0	0	1,185
Hudspeth	16,595	11,022	4,276	5,442	37,335
Presidio	365	0	19,983	7,323	27,671
Reeves	0	0	1,420	0	1,420
Sutton	0	0	0	100	100
Terrell	3,250	1,048	1,905	0	6,203
Unknown	0	0	240	0	240
Total	**26,223**	**18,811**	**33,832**	**17,970**	**96,836**

Source: Movement permits issued by Arizona Department of Agriculture.

Table 6. Summary of Plants Imported into Arizona (by City) from Texas (1998–June 2001)

City	1998	1999	2000	2001	1998–2001
Apache Junction	0	0	275	0	275
Buckeye	365	0	0	0	365
Cave Creek	230	32	70	0	332
Chandler	1,669	0	0	0	1,669
Clarkdale	0	270	0	0	270
Flagstaff	0	0	150	0	150
Gilbert	0	0	5,199	3,705	8,904
Lake Havasaw	0	0	135	135	270
Mesa	0	0	116	867	983
Palm Springs (Calif.)[1]	0	0	0	350	350
Phoenix	10,719	8,071	13,571	6,865	39,226
Queen Creek	422	0	326	0	748
Queen Valley	0	0	230	0	230
Sun City	0	0	266	0	266
Surprise	265	0	0	0	265
Sahuarita	0	0	447	0	447
Tempe	0	1,048	0	0	1,048
Tucson	12,553	9,390	13,034	5,926	40,903
Total	**26,223**	**18,811**	**33,819**	**17,848**	**96,701**

Source: Movement permits issued by Arizona Department of Agriculture.
[1] Reexported from Arizona.

names, 30 succulent species were identified in trade, with ocotillo (*Fouquieria splendens*) in the Fouquieriaceae family accounting for more than two-thirds of all plant exports from Texas to Arizona and exceeding imports of cacti by a factor of three to one. Unlike many desert plants, ocotillos bloom in dry conditions and, therefore, provide a reliable source of nectar and energy for hummingbirds during the spring migration from Mexico to northern North America (Phillips and Wentworth 1999). The most heavily traded cactus species are the

claretcup hedgehog (*Echinocereus triglochidiatus*), rainbow hedgehog (*Echinocereus dasyacanthus*), eagle claw (*Echinocactus horizonthalonius*), and Texas fishhook barrel (*Ferocactus wislizenii*) comprising more than one-third of Arizona imports (table 7). A variety of other plant species belonging to the following families was also shipped from Texas to Arizona from 1998 to June 2001: Agavaceae, Bombacaceae, Burseraceae, Cucurbitaceae, Dioscoreaceae, and Euphorbiaceae.

Illegal Collection and Trade

The illegal collection and commercialization of plants remain a law enforcement problem and resource management challenge on public and private lands throughout the country. Some cases involve individuals who, unaware of state or federal laws restricting harvest, remove plants from wild populations for personal use and enjoyment. A more serious practice is the targeting by poachers of plant species and products for commercial sale in domestic and foreign markets. Migrant workers, who are increasingly employed to harvest wild plants in the United States, may be more likely to violate harvest regulations because of their ignorance of government restrictions and language barriers.

Cacti are desirable plants whose wild populations in the United States and Mexico have been subject to illegal collection and trade. Some cactus hobbyists, known as cactophiles, are well known for their passion and interest in rare and recently discovered cactus species and have gone to illegal lengths to obtain certain species for their private collections. In recent years, Europe and Japan have been popular destinations for smuggled plants, seeds, and fruits of rare and valuable cacti originating from the United States and Mexico (Reed 1997). Even cactus fruits and parts used in producing traditional foods sold to unsuspecting consumers have been illegally harvested from protected areas in the southwestern United States. For instance, during the 1980s and 1990s, as many as 42,000 wild barrel cactus plants (*Ferocactus cylindraceus*) were illegally collected and commercialized from federal land in California, including Mojave National Preserve, for use in *biznaga*, a popular, traditional candy of Mexico (Inman 2000).

Evaluation of the level and impact of illegal cactus collection in the Chihuahuan Desert was limited to a review of information on documented violations, seizures, and criminal incident reports. However, anecdotal information from U.S. government officials

Table 7. Estimated Market (Retail) Value of Plant Taxa Imported into Arizona from Texas (1998–June 2001)

Taxon	Common Name(s)	# of Plants Imported	Plant Retail Price (US$)	Plant Size	Estimate Market Value (US$)
Agave spp.	Agave	2,463	15	1 gallon pot	36,945
Agave parryi	Perry eye century plant	5	15	1 gallon pot	75
Ariocarpus fissuratus	Living rock cactus	291	15	4” pot	4,365
Bombax ellipticum	Shaving brush tree	10	45	8–10” diameter	450
Bursera spp.	Bursera	10	50	8–12” diameter	500
Cephalocereus	Don King, old man cactus	346	10	4” pot	346
Coryphantha ramillosa[1]	Bunched cory cactus	16	3	?–1” diameter	48
Dasylirion leiophyllum	Sotol	95	35	5 gallon pot	3,325
D. wheeleri	Desert spoon	48	15	1 gallon pot	720
Dioscorea villosa	Wild yam	26	6	1 plant	156
Echinocactus horizonthalonius	Blue barrel, eagle claw	1,472	25	1 gallon pot	36,800

Table 7. Estimated Market (Retail) Value of Plant Taxa Imported into Arizona from Texas (1998–June 2001) *(continued)*

Taxon	Common Name(s)	# of Plants Imported	Plant Retail Price (US$)	Plant Size	Estimate Market Value (US$)
Echinocactus texensis	Horse crippler, cow crippler	618	25	1 gallon pot	15,350
Echinocereus	Hedgehog	4,762	15	1 gallon pot	71,430
E. dasyacanthus	Rainbow hedgehog	2,258	20	1 gallon pot	45,160
E. reichenbachii	Lace hedgehog	219	20	1 gallon pot	4,380
E. russanthus	Varied hedgehog	17	20	1 gallon pot	340
E. stramineus	Strawberry hedgehog	309	20	1 gallon pot	6,180
E. triglochidiatus (coccineus)	Claretcup hedgehog	2,813	20	1 gallon pot	56,260
E. viridiflorus	Green hedgehog	88	15	1 gallon pot	1,320
Escobaria vivipara	Pincushion cactus, spinystar	143	20	1 gallon pot	2,860
Escobaria minima[1]	Nellie cory cactus	16	5	2.5” pot	80
Euphorbia antisyphilitica	Candelilla	20	15	1 gallon pot	300
Ferocactus hamatacanthus	Texas barrel, Turk’s head	1,878	25	5–6” diameter	46,950
F. wislizenii	Fishhook Texas barrel	2,928	50	5 gallon pot	146,400
Fouquieria splendens	Ocotillo	67,712	35	5 gallon pot	2,369,920
Ibervillia tenuisecta	Slimlobe globeberry	155	35	3–4” diameter	5,425
Jatropha	Jatropha	50	25	Caudex 2–3”	1,250
J. dioica	Leatherstem, rubber plant	1	25	Caudex 2–3”	25
Mammillaria	Mammillaria	39	10	4” pot	390
Nolina	Beargrass	25	45	5 gallon pot	1,125
Opuntia	Prickly pear, cholla	841	15	1 gallon pot	12,615
O. macrocentra	Purple prickly pear	78	15	1 gallon pot	1,170
Peniocereus greggii	Queen of the night	48	8	—	384
Sclerocactus (= Ancistrocactus)	Sclerocactus	173	20	1 gallon pot	3,460
S. intertextus (= Echinomastus intertextus)	Chichuahua pjne-apple cactus, white fishhook cactus	90	10	1 gallon pot	900
Yucca spp.	Yucca	4,402	75	1–2 feet	330,150
Y. brevifolia	Joshua tree	3	75	1–2 feet	225
Y. faxiona	Giant white dagger, palm yucca	12	75	1–2 feet	900
Y. filifera	Yucca tree	3	75	1–2 feet	225
Y. rigida	Mexican blue yucca	15	75	1–2 feet	1,125
Y. rostrata	Texas, beaked yucca	253	75	1–2 feet	18,975
Y. thompsoniana	Thompson yucca	822	75	1–2 feet	61,650
Y. torreyi	Spanish dagger, Torrey’s yucca	82	75	1–2 feet	6,150
Unidentified	Pine cone cactus	20	—	—	—
Unidentified	Visnagita	68	—	—	—
Unidentified	Turtle toe	25	—	—	—
Total					**3,296,804**

Source: Arizona Department of Agriculture; retail prices posted on the Web sites of vendors in Arizona.
[1] Species of cory cactus undetermined but likely to be either *Coryphantha ramillosa* (bunched cory cactus) or *Escobaria minima* (Nellie cory cactus).

suggests that the number of reported incidents of illegal or unauthorized cactus harvesting and trading is probably very low compared to the actual level of this activity.

One indicator of illegal trade is the frequency and size of cactus seizures reported by officials at U.S. ports along or near the U.S.-Mexican border. APHIS of the U.S. Department of Agriculture enforces controls on the importation of plants, including cacti, whose trade into the United States is regulated under CITES. According to data compiled by APHIS, nearly 800 cactus specimens were seized from travelers entering or passing through the United States from Mexico in 1998. Of those seized, about 130 (19 percent) were specimens of cactus taxa that originated or could have originated from the Chihuahuan Desert. In 1999, 480 cactus specimens, of which 191 (40 percent) were confirmed or likely to be taxa of the Chihuahuan Desert, were reportedly seized from travelers' baggage at ports along or near the U.S.-Mexican border (table 8). In 1998 and 1999, the majority of cacti seizures were reported at the border ports of Nogales, Arizona, and El Paso, Texas, followed by Houston and Brownsville, Texas, and San Diego, California.

Rural West Texas has recently served as a conduit for plants smuggled into the United States from Mexico (Dulik 2001). A significant share of succulents imported into Arizona and Nevada from Texas in 1999 under presumably valid agricultural permits may have actually been harvested from wild populations in Mexico for subsequent illegal export to the United States. According to the U.S. Fish and Wildlife Service, more than 30,000 plants, including more than 24,000 ocotillo (*Fouquieria* spp.) and in excess of 8,000 cacti consisting of 16 different species, with an estimated market value of US$1 million, were illegally imported into Texas in Presidio County via the Rio Grande River (Dulik 2001a). Individuals prosecuted by the U.S. government under the Lacey Act had falsified documents, claiming on plant health certificates issued by the Texas Department of Agriculture that all plants were harvested from the wild in Presidio County, Texas. Most of these plants were ultimately sold to unsuspecting nurseries in Arizona, southern California, and Nevada where desert plants are popular in landscaping (Dulik 2001). The harvesting and exporting of wild plants, including ocotillo, from federal and communal (*ejidios*) lands in Mexico is restricted and requires a permit from the government. Under U.S. law, ocotillo imported into the United States cannot exceed 18 inches in height and must be issued a valid plant health certificate prior to entry.

Evaluating the number and impact of incidences of illegal cactus harvest on state or federally managed public lands in the Chihuahuan Desert depends largely on the observations, anecdotal information, and reports of government agencies in the region. Very little quantitative and qualitative information is available on the intensity, location, and frequency of cactus poaching in the Chihuahuan Desert of Texas.

Texas state parks are prone to unauthorized cactus collection. Previous incidents involving illegal cactus removal from the Franklin Mountains State Park near El Paso have been documented. According to the park's manager, the urban public's proximity and easy access to the Franklin Mountains increase the park's susceptibility to cactus collecting (Cierra 2000).

Big Bend National Park, encompassing more than 800,000 acres, is the largest U.S. tract of protected parkland within the Chihuahuan Desert. The park is home to more than 1,200 plant species, of which 87 species, or 7 percent of the park's plant diversity, are cacti belonging to 15 genera. The collection and removal of natural resources, including cactus plants, found within the park's boundaries are prohibited. Although the level of illegal cactus collecting on park land is not fully understood, documented cases of this activity are expected to be an extremely small percentage of actual incidents ever discovered (Wright 2000). Park officials of Big Bend State Park have observed little direct evidence of cactus poaching along roadsides in and around that park. However, the heavy volume of tourists visiting the Big Bend region, coupled with the area's remoteness, may increase the likelihood of incidental and intentional collecting of wild plants from state park lands that escape the detection of park officials (Wright 2000). Less than a dozen incident reports involving cactus thefts were filed by park rangers between 1997

and June 2000. Most citations were issued to individuals who claimed at the time that the cactus plants or fruits in their possession were for personal consumption. Cactus specimens seized by rangers during this period include the following species: prickly pear cactus (*Opuntia* spp.), living rock cactus (*Ariocarpus fissuratus*), fishhook cactus (*Ferocactus hamatacanthus*), Tobusch fishhook cactus (*Sclerocactus brevihamatus* ssp. *tobuschii*), rainbow cactus (*Echinocereus dasyacanthus*), horse crippler (*Echinocactus texensis*), and nipple cactus (*Mammillaria heyderi*). One of the most recent incidents was reported in April 2000, when a visiting government botanist on a hike noticed 30 holes from which living rock cacti had probably been removed.

Table 8. Cactus Specimen Seizures from Ports of Entry along the U.S.-Mexican Border (1998–1999)

U.S. Port	Taxon	Native to Chihuahuan Desert	Quantity in 1998	Quantity in 1999
Brownsville	Cactaceae, genus unknown	—	0	1
Brownsville	*Cephalocereus senilis*	✔	0	17
Brownsville	*Cereus*	◆	0	23
Brownsville	*Echinocactus*	◆	0	1
Brownsville	*Ferocactus*	◆	0	2
Brownsville	*Mammillaria*	◆	0	34
Brownsville	*Myrtillocactus*	◆	0	6
Subtotal			0	84
El Paso	*Astrophytum myriostigma*	✔	1	0
El Paso	Cactaceae, genus unknown	—	7	2
El Paso	*Cereus*	◆	23	2
El Paso	*Coryphantha*	◆	12	8
El Paso	*Disocactus* (= *Heliocereus*)	—	0	3
El Paso	*Echinocactus*	◆	1	9
El Paso	*Echinocactus horizonthalonius*	✔	7	6
El Paso	*Echinocereus*	◆	29	14
El Paso	*Echinocereus pectinatus*	✔	5	7
El Paso	*Echinopsis* (= *Trichocereus*)	—	12	1
El Paso	*Echinopsis chamaecereus*	—	1	0
El Paso	*Epiphyllum*	—	0	1
El Paso	*Ferocactus*	◆	3	3
El Paso	*Hylocereus*	—	4	3
El Paso	*Mammillaria*	◆	18	19
El Paso	*Myrtillocactus*	◆	11	4
El Paso	*Myrtillocactus geometrizans*	✔	1	2
El Paso	*Opuntia* (= *Cylindropuntia*)	◆	51	32
El Paso	*Opuntia imbricata*	✔	0	2
El Paso	*Opuntia microdasys*	✔	5	0
El Paso	*Pachycereus*	—	7	0
El Paso	*Pachycereus marginatus*	—	8	8
El Paso	*Pygmaeocereus*	—	1	0
El Paso	*Schlumbergera* (= *Zygocactus*)	—	1	0
El Paso	*Stenocactus*	◆	3	2
El Paso	*S. vaupelianus*	✔	0	1
El Paso	*Stenocereus*	◆	3	29
El Paso	*S. martinezii*	—	0	2
Subtotal			214	160

Table 8. Cactus Specimen Seizures from Ports of Entry along the U.S.-Mexican Border (1998–1999) *(continued)*

U.S. Port	Taxon	Native to Chihuahuan Desert	Quantity in 1998	Quantity in 1999
Houston	*Astrophytum myriostigma*	✔	0	1
Houston	Cactaceae, genus unknown		63	36
Houston	*Cereus*	◆	0	2
Houston	*Echinopsis*	—	0	1
Houston	*Echinocereus*	◆	1	0
Houston	*Ferocactus*	◆	0	3
Houston	*Mammillaria*	◆	3	2
Houston	*Melocactus*	—	0	1
Houston	*Opuntia*	◆	4	6
Houston	*O. cylindrical*	—	0	1
Houston	*Pachycereus*	—	0	3
Houston	*Parodia* (= *Notocactus*)	—	0	1
Subtotal			71	56
Nogales	Cactaceae, genus unknown	—	215	0
Nogales	*Carnegiea gigantea*	—	4	5
Nogales	*Cephalocereus*	◆	4	0
Nogales	*Cereus*	◆	20	48
Nogales	*Coryphantha*	◆	0	7
Nogales	*Disocactus* (= *Heliocereus*)	—	3	0
Nogales	*Echinocereus*	◆	19	9
Nogales	*Echinopsis* (= *Chamaecereus*, = *Lobivia*)	◆	8	5
Nogales	*Epiphyllum*	—	0	10
Nogales	*Ferocactus*	◆	4	1
Nogales	*Ferocactus cylindraceus*	—	100 seeds	0
Nogales	*Gymnocalycium*	—	1	0
Nogales	*Mammillaria*	◆	7	15
Nogales	*Melocactus*	—	1	0
Nogales	*Myrtillocactus*	◆	4	5
Nogales	*Opuntia*	◆	26	24
Nogales	*Opuntia fulgida*	✔	4	0
Nogales	*Pachycereus* (= *Lemaireocereus*, = *Marginatocereus*)	—	15	19
Nogales	*Stenocereus*	◆	0	1
Nogales	*Stetsonia*	—	0	1
Nogales	*S. coryne*	—	0	1
Subtotal			435	151
San Diego	Cactaceae, genus unknown	—	43	23
San Diego	Cactaceae skeletons	—	16	0
San Diego	*Ferocactus*	◆	3	2
San Diego	*Mammillaria*	◆	0	1
San Diego	*Opuntia*	◆	0	2
Subtotal			62	28
Total			**782**	**479**

Source: U.S. Department of Agriculture.
Key: ◆ Genus includes species endemic or native to the Chihuahuan Desert; ✔ Taxon is endemic or native to the Chihuahuan Desert; — Taxon is not native to the Chihuahuan Desert.

Seizures of peyote (*Lophophora williamsii*), a cactus species native to the Chihuahuan Desert of Texas and Mexico, purportedly imported illegally into the United States from Mexico at or near Big Bend National Park, increased in 1999 (Wright 2001). Peyote, a source of the hallucinogen mescaline that is a controlled substance in the United States and Mexico, has been traded illegally; in the 1990s, the U.S. government reported 15 seizures of peyote—in Arizona, California, Louisiana, New Mexico, and Texas (Myrick 2000). Peyote, which Native Americans value for traditional and religious purposes, may be collected and sold under federal and Texas law by licensed *peyoteros*, or traditional collectors, for ceremonial use. As of 1995, 11 peyoteros participated in the legal collection of peyote, primarily in southern Texas, harvesting annually 200,000 peyote tops, or buttons, valued at US$150–170 per 1,000 buttons (Anderson 1995). According to the state of Texas, an average 2.1 million peyote buttons were harvested each year from 1995 to 2000 (Patterson 2001). Habitat alteration is believed to pose the greatest threat to peyote in the United States because it reduces the number and size of populations and may result in more intensive visiting and harvesting of extant sites by harvesters (Anderson 1995).

Unauthorized commercial collecting of cacti has been a periodic problem in the portion of southern New Mexico that is within the Chihuahuan Desert. Much of that region consists of public land managed by the U.S. Bureau of Land Management, which maintains two field offices: the Las Cruces office and the Carlsbad office. Officials of the Las Cruces field office, which is responsible for managing 6 million acres in the southwestern portion of New Mexico, reported an annual average of two violations of commercial cactus poaching in the past five years. Only a small fraction of illegal activity is documented; hence, the actual number of violations is probably much higher than what is reported. Poachers primarily target yucca (*Yucca* spp.) and ocotillo (*Fouquieria* spp.), although barrel cactus (*Ferocactus* spp.) that is generally taller than one foot and hedgehog cactus (*Echinocereus* spp.) are also sought for the landscaping trade (Howard 2000). The Carlsbad field office, which manages 2.2 million acres in the southeastern corner of the state, believes a significant portion of cacti harvested from lands within its jurisdiction is undocumented.

Cactus Management, Protection, and Conservation Status

International

CITES protects the Cactaceae family from international trade. About 115 cactus taxa are listed in CITES Appendix I, under which commercial trade in wild specimens is prohibited. Plants of Appendix I species propagated in a nursery are treated as species listed in CITES Appendix II, in which most cactus species (1,500–2,000) are listed. Commercial exports and reexports of Appendix II species are regulated under a system of CITES permits, which must be issued by the country of origin or country of reexport before specimens enter or reenter international trade. CITES export permits are issued only after the CITES authorities conclude that wild specimens have been harvested legally and without compromising the survival of the species in the wild. The United States exported more than 405,000 artificially propagated specimens of cacti in 1998; another 4,200 specimens were seeds or live plants of Appendix I cacti.

IUCN produces a Red List of Threatened Plants in which threat categories (endangered, rare, vulnerable, indeterminate) are assigned to the world's rarest plant species. A number of Chihuahuan Desert cactus species fall into these threat categories: 11 in Arizona, 12 in New Mexico, and 14 Texas (table 9). The state conservation rank and geographical distribution of succulents documented in trade between Texas and Arizona was obtained for 26 taxa whose native ranges include Arizona, New Mexico, and Texas (table 10). Of those taxa, seven are ranked as vulnerable, imperiled, or critically imperiled in New Mexico; one is ranked as imperiled in New Mexico; and another, Texas fishhook barrel (*Ferocactus wislizenii*), is considered critically imperiled in

Table 9. CDE Cacti Native to the United States Included in the IUCN Red List of Threatened Plants, and Their CITES Status

Species	Conservation Status (U.S. Distribution)[1]	CITES Appendix
Coryphantha ramillosa	Vulnerable (Tex.)	II
C. robustispina	Indeterminate (N.M.), rare (Tex.)	II
Echinocactus horizonthalonius ssp. *Nicholii*[2]	Vulnerable (Ariz.)	II
Echinocereus chisoensis ssp. *chisoensis*	Endangered (Tex., Chisos Mts.)	II
E. coccineus ssp. *paucispinus*[2]	Rare (Tex.)	II
E. fendleri ssp. *kuenzleri*[2]	Endangered (N.M.)	II
E. xlloydii (= E. xroetteri)	Extinct/Endangered (N.M.), Vulnerable (Tex.)	II
E. nicholii	Indeterminate (Ariz.)	II
E. viridiflorus ssp. *davisii*	Endangered (Tex., Brewster County)	II
Epithelantha bokei	Endangered (Tex.)	II
Escobaria minima	Endangered (Tex.)	I
E. orcuttii	Indeterminate (Ariz.), Rare (N.M.)	II
E. organensis	Vulnerable (N.M.)	II
E. robbinsorum	Endangered (Ariz.)	II
E. sandbergii	Vulnerable (N.M.)	II
E. sneedii ssp. *leei*	Vulnerable (N.M.)	II
E. sneedii ssp. *sneedii*	Vulnerable (N.M., Tex.)	II
E. villardii	Vulnerable (N.M.)	II
Mammillaria wrightii var. *wrightii*	Endangered (Ariz., Tex.), Rare (N.M.)	II
Opuntia aureispina	Endangered (Tex.)	II
O. clavata	Indeterminate (Ariz., N.M.)	II
O. polyacantha ssp. *juniperiana*[2]	Indeterminate (Ariz., N.M.)	II
O. santa-rita	Indeterminate (Ariz., N.M., Tex.)	II
O. whipplei ssp. *multigeniculata*	Indeterminate (Ariz.)	II
O. wigginsii	Indeterminate (Ariz.)	II
Peniocereus greggii ssp. *greggii*[2]	Indeterminate (Ariz., N.M.), Vulnerable (Tex.)	II
Thelocactus bicolor ssp. *flavidispinus*	Vulnerable (Tex.)	II

Source: 1997 IUCN Red List of Threatened Plants.

1 Conservation status is a reflection of local threat status as defined by the Red List (pre-1994) categories developed by the IUCN.
2 Taxonomy standardized to Hunt (1999); taxa included in checklist not recognized by Hunt (1999) may be valid and accepted locally or regionally.

Texas. Most taxa for which conservation ranks were sought are simply "reported," an indicator of confirmed occurrence but not of their population status. The number of reported or unranked taxa is highest in Texas, where a significant portion of wild populations are confined to private lands and, as a result, can be inaccessible to researchers for monitoring and ranking purposes.

United States

The U.S. government protects the natural habitat and wild populations of flora and fauna vulnerable to natural or human disturbance by adding eligible species to the List of Endangered or Threatened Wildlife or the List of Endangered or Threatened Plants (50 Code of Federal Regulations [CFR] 17.11, 50 CFR 17.12). Species listed as endangered are those facing the greatest threat of extinction, whereas species listed as threatened will likely qualify as endangered in the near future. Once listed, species receive protection under the U.S. Endangered Species Act of 1973 (ESA), which restricts human activities that could interfere with the survival or recovery of listed species.

Table 10. Distribution and State Rank of Succulents of the Chihuahuan Desert Identified in Trade from Texas to Arizona (1998–June 2001)

Taxon	Common Name(s)	Distribution of Taxa	State Rank[1]	Range-Wide Rank[1]
Agave parryi	Perry eye century plant	Ariz., N.M.	Secure	Widespread, abundant, secure
Ariocarpus fissuratus	Living rock	Tex.	Apparently secure	Apparently secure
Dasylirion leiophyllum	Sotol	N.M., Tex.	Reported	Widespread, abundant, secure
D. wheeleri	Desert spoon	Ariz., N.M., Tex.	Reported	Apparently secure, widespread, abundant, secure
Dioscorea villosa	Wild yam	Tex.	Reported	Apparently secure, widespread, abundant, secure
Echinocactus horizonthalonius	Blue barrel, eagle claw	Ariz. N.M. Tex.	Imperiled Vulnerable Reported	Apparently secure
Echinocactus texensis	Horse crippler, cow crippler	N.M. Tex.	Vulnerable Apparently secure	Widespread, abundant, secure
Echinocereus dasyacanthus	Rainbow hedgehog	Ariz. N.M. Tex.	Apparently secure Reported Reported	Widespread, abundant, secure
E. reichenbachii	Lace hedgehog	N.M. Tex.	Reported Unranked	Widespread, abundant, secure
E. russanthus	Russanthus	Tex.	Reported	Apparently secure
E. stramineus	Strawberry hedgehog	N.M. Tex.	Reported Reported	Apparently secure
E. triglochidiatus (*coccineus*)	Claretcup hedgehog	Ariz. N.M. Tex.	Apparently secure Reported Unranked	Widespread, abundant, secure
E. viridiflorus	Green hedgehog	N.M. N.M. Tex.	Reported Vulnerable Unranked	Widespread, abundant, secure
Euphorbia antisyphilitica	Candelilla	N.M. Tex.	Critically imperiled Reported	Widespread, abundant, secure
Ferocactus hamatacanthus	Texas barrel, Turk's head	N.M. Tex.	Imperiled Reported	Apparently secure
F. wislizenii	Fishhook Texas barrel	Ariz. N.M. Tex.	Reported Reported Critically imperiled	Apparently secure
Fouquieria splendens	Ocotillo	Ariz. N.M. Tex.	Reported Reported Reported	Apparently secure
Jatropha dioica	Rubber plant, leatherstem	Tex.	Reported	Apparently secure
Opuntia macrocentra	Purple prickly pear	Ariz. N.M. Tex.	Reported Reported Reported	Vulnerable, apparently secure

Table 10. Distribution and State Rank of Succulents of the Chihuahuan Desert Identified in Trade from Texas to Arizona (1998–June 2001)*(continued)*

Taxon	Common Name(s)	Distribution of Taxa	State Rank[1]	Range-Wide Rank[1]
Peniocereus greggii	Queen of the night	Ariz. N.M. Tex.	Apparently secure Imperiled Unranked	Vulnerable, apparently secure
Sclerocactus intertextus (= *Neolloydia intertexta*)	Chichuahua pineapple cactus, white fishhook cactus	Ariz.	Reported	Apparently secure, widespread, abundant, secure
Yucca faxoniana	Eve's needle, giant white dagger, palm yucca	N.M. Tex.	Imperiled Reported	Apparently secure
Y. filifera	Yucca tree	Unknown	Unknown	Unknown
Y. rigida	Mexican blue yucca	Unknown	Unknown	Unknown
Y. thompsoniana (= *Y. rostrata*)	Thompson, beaked yucca	Tex.	Reported	Apparently secure
Y. torreyi	Spanish dagger, Torrey's yucca	N.M. Tex.	Apparently secure Reported	Apparently secure

[1] Source: Natureserve explorer: An online encyclopedia of life [Web application]. 2001. Version 1.5. Arlington, Va.: Available at <http://www.natureserve.org/explorer>. [Accessed: 2 November 2001].

For instance, the ESA prohibits listed plants from entering interstate or international trade unless the purpose of this trade is to enhance the conservation of the species and unless a permit is obtained from the U.S. Fish and Wildlife Service, the agency administering the law for terrestrial and freshwater species.

Federal agencies are required to adhere to ESA rules for the protection of endangered or threatened species. For instance, if a proposed activity (e.g., development) is likely to adversely affect an ESA-listed species or its critical habitat on federal lands, the federal agency proposing to undertake the activity must implement measures intended to protect the species or habitat in question from those effects. Removing or disturbing listed plants on private property, unlike wildlife species protected by the ESA, neither requires the approval of the federal government nor would violate the act. Thus, federally listed plants receive protection on federal lands only where damaging or destroying any federally protected endangered plant is a violation of the ESA. In addition, the ESA prohibits the removal and physical possession of any listed plant from federal lands. Some states protect plants listed as endangered or threatened under the ESA or state law on privately owned lands by regulating activities that would likely affect protected plants. For instance, states (e.g., Texas) may regulate the commercial collection of endangered plant species on private lands by issuing mandatory permits. Moreover, destroying or removing listed plants on private property without the consent of the landowner would be a violation of state trespass laws.

Ten cactus species occurring within the Chihuahuan Desert of the United States are protected by the ESA, with six listed as endangered and four listed as threatened (table 11). Three of these species are endemic to Texas, two occur exclusively in New Mexico, and another two are confined to Arizona. Natural populations of three ESA-listed species, *Coryphantha ramillosa*, *Escobaria robbinsorum*, and *Escobaria sneedii* ssp. *sneedii*, occur in Texas and Mexico (Coahuila), Arizona and Mexico (Sonora), and New Mexico and Texas, respectively.

Arizona

The Chihuahuan Desert is restricted to the extreme southeastern corner of Arizona and

Table 11. Distribution and Protection Status of Cacti of the Chihuahuan Desert Ecoregion within the United States

Species[1]	Common Name	Arizona	New Mexico	Texas	Federal Status (USFWS)	BLM Status	U.S. Forest Service	National Forest Occurrence
Ariocarpus fissuratus[2]	Living rock, star cactus	X	X	✔				
Coryphantha echinus		X	X	✔				
C. macromeris ssp. *macromeris*		X	✔	✔				Lincoln
C. ramillosa[3]	Bunched cory cactus	X	X	✔ (TXST)	T			
C. robustispina ssp. *scheeri (C. scheeri)*	Scheer's beehive cactus (Scheer's pincushion cactus)	X	✔ Rare (NMSE)	✔				
Echinocactus horizonthalonius		X	✔	✔				Lincoln
E. horizonthalonius ssp. *nicholii*	Nichol's Turk's head cactus	✔ (HSPNP)	X	X	E			
E. texensis	Horse crippler	X	✔	✔				
Echinocereus chisoensis	Chisos Mountain hedgehog cactus	X	X	✔ (TXST)	T			
E. coccineus ssp. *coccineus*[4] *(= E. coccineus* ssp. *paucispinus, = E. coccineus* var. *rosei)*		✔	✔	✔				Coronado, Gila, Cibola, Lincoln
E. coccineus ssp. *gurneyi*[5]		X	✔	✔				Lincoln, Gila
E. dasyacanthus	Texas rainbow	X	✔	✔				Lincoln
E. enneacanthus ssp. *brevispinus*[6]		X	X	✔				
E. enneacanthus ssp. *enneacanthus*[7]		X	X	✔				
E. fendleri	Cluster hedgehog cactus	✔	✔	X				
E. fendleri ssp. *fendleri*	Fendler hedgehog cactus	✔ (SRPNP)	✔	✔				Cibola, Coronado, Gila, Lincoln
E. fendleri ssp. *kuenzleri*[8]	Kuenzler hedgehog cactus	X	✔ Rare (NMSE)	X	E	BLMS		Lincoln
E. fendleri ssp. *rectispinus*	Fendler needle-spine hedgehog	✔ (SRPNP)	✔	X				Coronado, Gila
E. lloydii (= E. x roetteri)	Lloyd's hedgehog cactus	X	✔	✔				
E. nicholii		✔ (SRPNP)	X	X				

Key: ✔ = occurs in CDE, ✔ (?) = occurrence in CDE unconfirmed, X = does not occur in CDE of state, HSPNP = highly safeguarded protected native plants of Arizona, SRPNP = salvage restricted protected native plants of Arizona (salvageable by permit only), TXSE = listed as endangered in Texas, TXST = listed as threatened in Texas, NMSE = listed as endangered in New Mexico, E = federally endangered under U.S. Endangered Species Act (ESA), T = federally threatened under ESA, BLMS = designated "special status" or "sensitive" by the Bureau of Land Management for monitoring and management, LCFOS = designated (unofficially) as sensitive by BLM Las Cruces field office because of rarity or declining wild populations. National Forests in U.S. CDE: Cibola (New Mexico); Coronado (Arizona); Gila (New Mexico); Lincoln (New Mexico).

[1] Taxonomy standardized to Hunt (1999); taxa included in checklist not recognized by Hunt (1999) may be valid and accepted locally or regionally.
[2] Common in parts of Trans-Pecos, Texas (Ferguson 2000), but heavily threatened by collection in the region (Poole 2001).
[3] Conflicting information concerning taxon's status; considered a weed in Mexico (Ferguson 2000); not abundant in Texas (Poole 2001).
[4] Occurs in Chisos Mountains and near Pecos River on the Stockton Plateau, Texas (Ferguson 2000).
[5] Not recognized by Hunt (1999).
[6] Big Bend to Del Rio, Texas (Ferguson 2000).
[7] Reports on U.S. status vary from rare (Ferguson 2000) to common (Poole 2001) from central to West Texas.
[8] Not recognized by Hunt (1999).

Table 11. Distribution and Protection Status of Cacti of the Chihuahuan Desert Ecoregion within the United States *(continued)*

Species	Common Name	Arizona	New Mexico	Texas	Federal Status (USFWS)	BLM Status	U.S. Forest Service	National Forest Occurrence
E. pectinatus ssp. *neomexicanus*[9]	Yellow pitaya	✔ (SRPNP)	✔	✔				
E. pectinatus ssp. *wenigeri*		X	X	✔				
E. pseudopectinatus		✔ (SRPNP)	✔	X				
E. reichenbachii	Lace hedgehog	X	✔	✔				
E. rigidissimus	Arizona rainbow hedgehog	✔ (SRPNP)	✔	X				
E. russanthus		X	✔	✔				
E. stramineus ssp. *stramineus*		X	✔	✔				Lincoln
E. triglochidiatus ssp. *arizonicus*[10]	Arizona hedgehog cactus	✔ (HSPNP)	X	X	E			
E. triglochidiatus ssp. *neomexicanus*[11]	Mexican claretcup cactus	X	✔	X				
E. triglochidiatus ssp. *triglochidiatus*		X	✔	X				
E. viridiflorus ssp. *chloranthus* (= *E. chloranthus* ssp. *neocapillus*)		X	✔	✔				Lincoln
E. viridiflorus ssp. *cylindricus*[12]		X	✔	✔				Lincoln
E. viridiflorus ssp. *correllii*		X	X	✔				
E. viridiflorus ssp. *davisii*	Davis's green pitaya	X	X	✔ (TXSE)	E			
E. viridiflorus ssp. *viridiflorus*		X	✔	X				Cibola, Lincoln
Echinomastus intertextus ssp. *dasyacanthus*[13]		X	✔	✔				Cibola, Gila, Lincoln
Epithelantha bokei[14]		X	✔	✔				
E. micromeris[15]		X	✔	✔		BLMS		
Escobaria albicolumnaria		X	X	✔				
E. dasyacantha ssp. *chaffeyi*		X	X	✔				
E. dasyacantha ssp. *dasyacantha*		X	✔	✔				
E. dasyacantha ssp. *duncanii*[16]		X	✔	✔				
E. duncanii	Duncan's pin-cushion cactus	X	✔ Rare (NMSE)	✔	Species of concern	BLMS		

[9] Not recognized by Hunt (1999).
[10] Not recognized by Hunt (1999).
[11] Not recognized by Hunt (1999).
[12] Generally, a montane or grassland species (Ferguson 2000).
[13] Not recognized by Hunt (1999).
[14] Grows in shale limestone soils (Ferguson 2000).
[15] Grows in shale limestone soils, among other habitats (Poole 2001), in southwestern and south central New Mexico (Ferguson 2000; Howard 2001).
[16] Not recognized by Hunt (1999).

Table 11. Distribution and Protection Status of Cacti of the Chihuahuan Desert Ecoregion within the United States *(continued)*

Species	Common Name	Arizona	New Mexico	Texas	Federal Status (USFWS)	BLM Status	U.S. Forest Service	National Forest Occurrence
E. guadalupensis		X	✔ Rare, species of concern	✔			Sensitive[17]	Lincoln
E. hesteri		X	X	✔				
E. minima	Nellie's cory cactus	X	X	✔ (TXSE)	E			
E. missouriensis ssp. *missouriensis*[18]		X	✔	X				
E. orcuttii[19]	Orcutt's pin-cushion cactus	✔	✔ Rare, species of concern	X			Sensitive	
E. organensis	Organ Mt. pin-cushion cactus	X	✔ Rare (NMSE)	X		BLMS		
E. robbinsorum	Cochise pin-cushion cactus	✔ (HSPNP)	X	X	T			
E. sandbergii	Sandberg's pin-cushion cactus	X	✔ Rare, species of concern	X		BLMS		
E. sneedii ssp. *leei*	Lee's pincushion cactus	X	✔ Rare (NMSE)	X	T	Special status		
E. sneedii ssp. *sneedii*	Sneed's pin-cushion cactus	X	✔ Rare (NMSE)	✔ (TXSE)	E	BLMS		
E. tuberculosa		X	✔	✔				
E. tuberculosa ssp. *varicolor*[20]		X	X	✔				
E. villardii	Villard's pin-cushion cactus	X	✔ Rare (NMSE)	X	Species of concern	BLMS	Sensitive[21]	Lincoln
E. vivipara ssp. *arizonica*[22]		X	✔	X				Cibola, Lincoln
E. vivipara ssp. *bisbeeana*[23]	Bisbee beehive cactus	✔ (SRPNP)	X	X				
E. vivipara ssp. *neomexicana*[24]		X	✔	X				Cibola, Lincoln
E. vivipara ssp. *radiosa*[25]		X	X	✔ (?)				
Ferocactus hamatacanthus	Texas barrel, Turk's head	X	✔	✔				
F. hamatacanthus ssp. *hamatacanthus*	Fishhook barrel cactus	X	✔	✔		BLMS		
F. hamatacanthus ssp. *sinnatus*[26]		X	X	✔				
F. wislizenii[27]	Southwestern Texas fishhook barrel cactus	✔ (SRPNP)	✔	✔		LCFOS		Coronado

[17] USDA Forest Service List of Sensitive Species (7/21/99).
[18] Occurs in U.S. CDE in Socorro and Valencia Counties (New Mexico) (Ferguson 2000).
[19] Species considered very rare in Arizona; common in Mexico (Ferguson 2000).
[20] Occurs in U.S. CDE in Trans-Pecos Mountains; not recognized by Hunt (1999).
[21] USDA Forest Service List of Sensitive Species (7/21/99).
[22] Not recognized by Hunt (1999).
[23] Not recognized by Hunt (1999).
[24] Inhabits broken terrain and limestone soils (Ferguson 2000).
[25] Not recognized by Hunt (1999).
[26] Found at southeast edge of CDE in Texas (Ferguson 2000).
[27] BLM designation LCFOS is only for Sierra County where species is rare; common elsewhere on public lands in southwestern New Mexico (Howard 2001).

Table 11. Distribution and Protection Status of Cacti of the Chihuahuan Desert Ecoregion within the United States *(continued)*

Species	Common Name	Arizona	New Mexico	Texas	Federal Status (USFWS)	BLM Status	U.S. Forest Service	National Forest Occurrence
Lophophora williamsii[28]	Peyote	X	X	✔				
Mammillaria grahamii ssp. *grahamii*[29]		✔ (SBP)	✔	✔				Coronado
M. heyderi ssp. *heyderi*		✔	✔	X				Lincoln, Gila, Coronado
M. heyderi ssp. *macdougalii*		✔ (SRPNP)	X	X				
M. heyderi ssp. *meiacantha*		✔ (SRPNP)	✔	✔				
M. lasiacantha	Golf ball pincushion	✔ (SRPNP)	✔	✔				Lincoln
M. wrightii ssp. *wilcoxii*	Wilcox pincushion	✔ (?)	✔ (NMSE)	X				
M. wrightii ssp. *wrightii*		X	✔	✔				Gila, Lincoln, Cibola
Neolloydia conoidea[30]		X	X	✔				
Opuntia aggeria	Big Bend prickly pear	X	X	✔				
O. atrispina		X	X	✔				
O. aureispina[31]		X	X	✔				
O. cacanapa[32]		X	X	✔				
O. camanchica[33]		✔	✔	X				Coronado, Cibola, Gila, Lincoln
O. chisosensis[34]		X	X	✔				
O. chlorotica	Pancake prickly pear	✔ (SRPNP)	✔	X				
O. clavata[35]	Club cholla	✔ (SRPNP)	✔	X				Cibola
O. cyclodes[36]		X	✔	✔				Lincoln
O. cymochila[37] *(= O. mackensenii)*		X	✔	X				Cibola, Lincoln (?)
O. emoryi[38]	Devil cholla	✔ (SRPNP)	✔	✔				
O. engelmannii[39] *(= O. microcarpa; = O. subarmata)*		X	X	✔				
O. engelmannii ssp. *engelmannii*[40]	Engelmann's prickly pear	✔ (SRPNP)	✔	✔				Gila, Coronado, Cibola, Lincoln
O. erinacea ssp. *hystricina*[41]		X	✔	X				

[28] Extremely rare in the Chihuahuan region of Texas; infrequent to locally abundant in southern Texas (Poole 2001).
[29] Not recognized by Hunt (1999).
[30] Relatively common in western part of Edwards Plateau and eastern part of Trans-Pecos (Poole 2001).
[31] Restricted to south end of Big Bend, Texas (Ferguson 2000).
[32] Present but rare in CDE in Texas near Ft. Stockton and in Chisos Mountains (Poole 2001); common in cultivation and trade (Ferguson 2000); not recognized by Hunt (1999).
[33] Most common Opuntia in northern CDE (Ferguson 2000).
[34] Distribution limited to Chisos Mountains, where it is very common (Ferguson 2000; Poole 2001).
[35] Occurrence in Arizona is highly questionable (Ferguson 2000).
[36] Not recognized by Hunt (1999).
[37] Enters U.S. CDE in eastern Trans-Pecos, Texas (Ferguson 2000).
[38] Taxonomic uncertainty regarding the epithet *emoryi* (Ferguson 2000).
[39] Occurs along Rio Grande and lower Pecos River; rare in CDE (Ferguson 2000).
[40] Not recognized by Hunt (1999).
[41] Found in CDE in central New Mexico (Ferguson 2000); not recognized by Hunt (1999).

Table 11. Distribution and Protection Status of Cacti of the Chihuahuan Desert Ecoregion within the United States *(continued)*

Species	Common Name	Arizona	New Mexico	Texas	Federal Status (USFWS)	BLM Status	U.S. Forest Service	National Forest Occurrence
O. imbricata	Tree cholla	X	✔	✔				Gila, Lincoln, Cibola, National
O. imbricata ssp. *argentea*		X	X	✔				
O. kleiniae ssp. *kleiniae*[42]		X	✔	✔				Lincoln
O. kleiniae ssp. *tetracantha*[43]		✔ (SRPNP)	✔	X				Coronado
O. laevis		✔ (?)	X	X				
O. leptocaulis	Desert Christmas cactus	✔ (SRPNP)	✔	✔				Coronado, Cibola, Gila, Lincoln
O. macrocentra	Purple prickly pear	✔ (SRPNP)	✔	✔				Coronado, Cibola, Gila, Lincoln
O. macrorhiza ssp. *pottsii*[44]	Pott's prickly pear	✔ (SRPNP)	✔	✔				
O. phaeacantha ssp. *major*[45] *(= O. gilvescens)*		X	✔	✔				
O. phaeacantha ssp. *phaeacantha*[46]		✔ (SRPNP)	✔	✔				Coronado, Cibola, Gila, Lincoln
O. polyacantha (= O. arenaria)	Sand prickly pear; sandbur cactus	X	✔ (NMSE)	✔	Species of concern	BLMS		
O. polyacantha ssp. *juniperiana*[47]		X	✔	X				Cibola, Lincoln
O. polyacantha ssp. *trichopora*[48]		✔ (?) (SRPNP)	✔ (?)	✔				
O. riparia[49]		✔	✔	X				Gila
O. rufida[50]		X	X	✔				
O. santa-rita	Santa Rita prickly pear	✔ (SRPNP)	✔	X				Coronado
O. schottii ssp. *grahamii*[51]		X	✔	✔				
O. schottii ssp. *schottii*[52]		X	✔	✔				
Opuntia x spinosibacca[53]		X	X	✔				
O. spinosior	Cane cholla	✔ (SRPNP)	✔	X				Coronado, Gila
O. strigil[54]		X	X	✔				

[42] Not recognized by Hunt (1999).
[43] Not recognized by Hunt (1999).
[44] Not recognized by Hunt (1999).
[45] Not recognized by Hunt (1999).
[46] Not recognized by Hunt (1999).
[47] Not recognized by Hunt (1999).
[48] Not recognized by Hunt (1999).
[49] Rare in CDE (Ferguson 2000); not recognized by Hunt (1999).
[50] Common in Big Bend, Texas (Ferguson 2000), but a rare plant in Mexico (Poole 2001).
[51] Not recognized by Hunt (1999).
[52] Not recognized by Hunt (1999).
[53] Hybrid (Poole 2001); lower Big Bend, Texas; probably rare (Ferguson 2000)
[54] Common on Stockton Plateau, Texas (Ferguson 2000).

Table 11. Distribution and Protection Status of Cacti of the Chihuahuan Desert Ecoregion within the United States *(continued)*

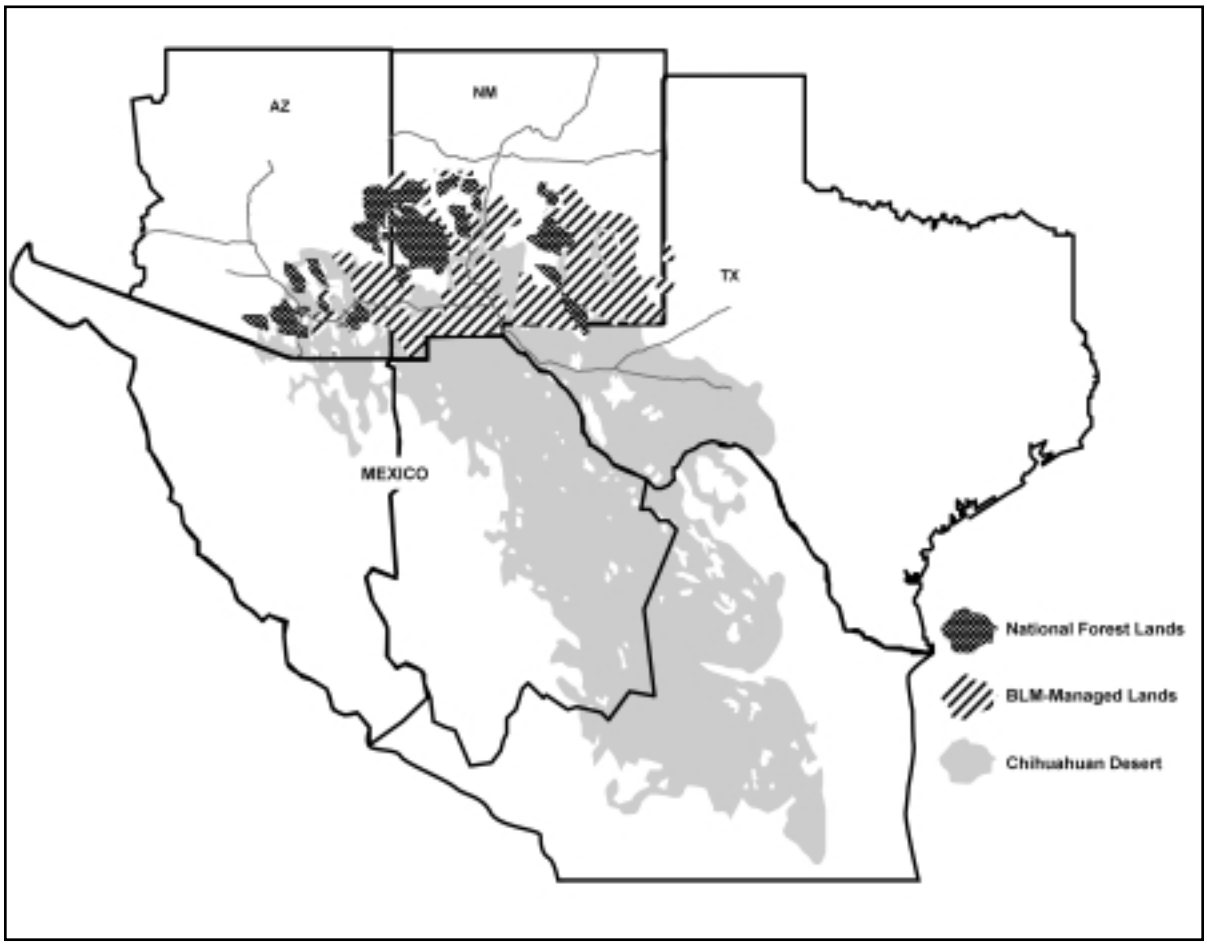
Species	Common Name	Arizona	New Mexico	Texas	Federal Status (USFWS)	BLM Status	U.S. Forest Service	National Forest Occurrence
O. tortispina[55]		✔	✔	✔ (?)				Cibola, Gila, Coronado, Lincoln
O. trichophora[56]		X	✔	✔				Cibola, Lincoln
O. valida[57]		X	✔	✔				
O. whipplei ssp. *multigeniculata*[58]		✔ (?) (SRPNP)	X	X				
O. whipplei ssp. *whipplei*[59]	Whipple cholla	(SRPNP)	✔ (?)	X				
O. wigginsii		✔ (?) (SRPNP)	X	X				
O. wootonii	Wooton's prickly pear	X	✔	X				
O. zuniensis[60]		X	✔ (?)	X				
Peniocereus greggii ssp. *greggii*[61]	Night-blooming cereus	✔ (SRPNP)	✔ Rare (NMSE)	✔	Species of concern	BLMS		
P. greggii ssp. *transmontanus*[62]	Queen of the Night cereus	✔ (?) (SRPNP)	X	X				
Sclerocactus intertextus	Chichuahua pineapple cactus	✔	✔	✔				
S. intertextus ssp. *intertextus*[63]		✔	✔	✔				Coronado
S. mariposensis	Lloyd's mariposa cactus	X	X	✔ (TXST)	T			
S. papyracanthus		✔	✔	✔				
S. parviflorus	Brack hardwall cactus	✔ (?) (SRPNP)	✔ (?)	X	Species of concern	BLMS		
S. pubispinus		✔ (?) (SRPNP)	X	X				
S. warnockii[64]		X	X	✔				
Thelocactus bicolor ssp. *flavidispinus*[65]		X	X	✔				
T. bicolor ssp. *schottii*[66]		X	X	✔				
Toumeya papyracantha	Grama grass cactus	X	✔	✔		BLMS		

[55] Grassland species (Ferguson 2000); not recognized as a good species and, therefore, cannot be confirmed in Texas (Poole 2001).
[56] Not recognized by Hunt (1999).
[57] Not recognized by Hunt (1999).
[58] Not recognized by Hunt (1999).
[59] Not recognized by Hunt (1999).
[60] Found at northern limits of CDE in New Mexico (Ferguson 2000); not recognized by Hunt (1999).
[61] Not recognized by Hunt (1999).
[62] Not recognized by Hunt (1999).
[63] Not recognized by Hunt (1999).
[64] Restricted distribution; possibly rare (Ferguson 2000).
[65] Locally common but highly restricted to an extremely confined geographic area (Poole 2001).
[66] Occurs in West Texas near Rio Grande on volcanic substrates (Ferguson 2000) and in southern Texas (Poole 2001); not recognized by Hunt (1999).

Sources: A. Michael Powell, Sul Ross State University, Alpine, Texas; David Ferguson, Albuquerque Botanical Garden; Mike Howard, Bureau of Land Management, Las Cruces, New Mexico field office; New Mexico Rare Plant Technical Council, 1999, New Mexico Rare Plants. <http://nmrareplants.unm.edu> (15 March 2002).

occupies portions of Cochise, Graham, Pima, Santa Cruz, and Greenlee Counties. The state or federal government manages more than half of the land in these counties. In Cochise County, 40 percent of the land is in private ownership, whereas only 7 percent of the land in Graham County is privately owned (Appendices 6 and 7). Much of the federally managed land in Cochise and Graham Counties is under the jurisdiction of the U.S. Bureau of Land Management (BLM) (figure 3). The other significant federally managed land in the Chihuahuan Desert of southeastern Arizona includes the Chiricchua Mountains, which fall under the management of the Coronado National Forest of the U.S. Forest Service (USFS) (figure 3). According to the Safford field office of BLM, located in southeastern Arizona, commercial cactus collection is limited to dead cholla (*Opuntia imbricata*) skeletons. A Tucson-based company has had an annual permit for the last 10 years to harvest 26 cords of cholla wood, which is used to produce perches for birdcages (Goodman 2000). Actual amounts of cholla harvested under the permit are not recorded or known. A harvest permit from the relevant federal agency and possibly from the state for

Figure 3. Distribution of USFS and BLM Lands within the Chihuahuan Desert of the United States



designated cactus species is needed when collecting on federal lands in Arizona.

The state of Arizona has explicit and exemplary laws concerning the destruction, removal, and trade of plants native to and protected by the state. Those laws apply to state-managed and privately owned lands, although the state may authorize plant collection on federally managed land with the approval of the relevant federal agency. It is still not clear to what extent the state or relevant federal agency regulates and monitors the harvesting of native plants from federally managed lands. For instance, cholla (*Opuntia imbricata*) is legally collected for commercial purposes on BLM lands, but the level of harvest is not documented.

Depending on the type and degree of endangerment of individual species, plant species native to Arizona are included in four lists or categories for state protection. Three cactus species believed to occur in the Chihuahuan Desert in Arizona are listed as "highly safeguarded protected native plants." That category includes species whose survival in the state is in jeopardy or that are in danger of extinction. The category also includes species resident to the state that are designated as endangered or threatened under the U.S. Endangered Species Act. Approximately 30 cacti considered Chihuahuan Desert species are listed as "salvage restricted protected native plants," a category that includes species at risk from damage caused by collecting or vandalizing. No cacti are listed as either "salvage assessed protected native plants" or as "harvest restricted protected native plants" (table 11). The former category refers to native plants of commercial value that may be harvested to "support the cost of salvage" while the latter includes species that are subject to "excessive harvesting or overcutting because of their intrinsic value."

Private landowners have the right to destroy or salvage protected native plants on their property, as long as the state has sufficient notice of the landowner's intent to disturb the vegetation or land in question. Landowners planning to develop natural habitat must notify the Arizona Department of Agriculture about whether this activity will affect native plants listed in any of the four categories of state protection. If so, they are required to disclose to the state whether the affected plants are to be transplanted on the same or different property, salvaged, destroyed, or disposed of in some other manner. State agencies planning to remove or destroy protected native plants by clearing or developing state land over an area exceeding one-fourth of an acre must follow procedures similar to those outlined for private landowners.

Salvaging and transporting protected native plants from private land is legal, provided that the necessary harvest permits, plant tags, or seals are obtained in advance from the Department of Agriculture. Prices for native plant tags depend on the size of the species, and range from US$.50 to US$6.00 for individual plants. Permits issued for the removal of highly safeguarded protected native plants are issued for scientific or non-commercial purposes only. Before any protected plant can be legally transported within, from, or into Arizona, valid written permits, inspection certificates, or both must be obtained, and relevant tags and seals must be attached to the plants. Tags and seals attached to salvaged plants intended for commerce may not be removed until the plants have reached their final destination.

Importers are also required to declare and disclose at agricultural inspection stations any plants or plant material that they are bringing into the state and must obtain the necessary moving permits for importing plants protected under Arizona law.

New Mexico

The Chihuahuan Desert is primarily confined to the southern portion of New Mexico and comprises part or all of the following counties from west to east: Hidalgo, Grant, Luna, Sierra, Dona Ana, Otero, Chaves, and Eddy. In general, a disproportionately large amount of land in this region is managed either by the state or by a federal agency, typically BLM or USFS (figure 3, p. I-30). For instance, the federal government manages 83 percent, 60 percent, and 63 percent of the surface area in Dona Ana, Eddy, and Otero Counties, respectively (appendices 8–15).

The Las Cruces field office of BLM manages 6 million acres spread across six counties (Grant, Hidalgo, Luna, Sierra, Dona Ana, and Otero), which are located in the southwestern and south central part of the state. Parts of the Las Cruces BLM management area that receive attention for their unique natural value are called Areas of Critical Environmental Concern (ACEC). Some of these areas harbor cactus populations. The BLM authorizes cactus harvesting in a few designated areas in the vicinity of Las Cruces. The federal agency sells harvest permits for specific species, excluding small, globular, or columnar cacti, for noncommercial purposes only. Most plants collected under such permits, including yucca (*Yucca* spp.) and prickly pear cactus (*Opuntia* spp.), are transplanted to private residences for landscaping; a total of 86 harvest permits were sold for prickly pear from 1996 to 1999. The Las Cruces field office also allows salvaging of cactus plants that will likely be damaged or destroyed because of construction or development (e.g., road or pipeline construction). Between 1998 and July 2000, more than 40 separate operations were approved to salvage 5 different cactus taxa, including 19 Turk's head (*Echinocereus coccineus*), 8 prickly pear (*Opuntia* spp.), 5 miscellaneous cacti, 4 fishhook Texas barrel (*Ferocactus wislizenii*), 4 nipple beehive (*Coryphantha macromeris*), and 3 Christmas cholla (*Opuntia leptocaulis*), in the BLM Las Cruces management area (Howard in litt. 2000).

The Carlsbad field office of BLM manages over 2 million acres in Eddy and Lee Counties, which are located in southeastern New Mexico and occupy the northeastern fringe of the Chihuahuan Desert in the United States. BLM issues harvest permits, most of which are requested by New Mexico residents, for personal use of cacti growing wild in the Carlsbad Resource Area. Between April 4, 1998, and May 17, 2000, 41 harvest permits were granted for the collection of a variety of plants, including the following cactus taxa: cholla (*Opuntia* spp.), rainbow pincushion cactus (*Mammillaria rhodantha*), and claretcup cactus (*Echinocereus triglochidiatus*). The latter is among the most popular cactus species sought by collectors in the Carlsbad Resource Area (Sherman 2000). The agency does not actively manage or monitor natural populations of individual plant species. According to BLM officials, the Carlsbad field office does not receive or set aside enough resources to manage cactus species and their wild populations on a systematic or scientific basis (Sherman 2000). If funding were available, BLM officials could justify an inventory of the Carlsbad Resource Area for cactus species, determine safe levels of exploitation, and manage cactus habitat and populations appropriately.

Lincoln, Cibola, and Gila National Forests, which are managed by the U.S. Forest Service, are not entirely within the boundary of the Chihuahuan Desert Ecoregion, as defined by World Wildlife Fund, but share common plant communities and cactus species with the Chihuahuan Desert of New Mexico. Cactus collection in the Lincoln National Forest is regulated by the USFS, which issues harvest permits for scientific research only. The public may collect wild succulents, cacti included, without permits for personal use from a designated area in which USFS officials have determined that no rare species occur. According to the officials, illegal cactus collection has occurred in the Lincoln National Forest, as evidenced by discernible depressions created by excavating cactus tubers from the soil. Two federally protected species are found in the Lincoln National Forest: *Echinocereus fendleri* var. *kuenzleri* is listed as endangered and *Coryphantha sneedii* as threatened under the U.S. Endangered Species Act. The former was listed in 1979 because of concerns about collecting pressures.

The New Mexico Rare Plant Technical Council, composed of professional botanists, maintains a list of plants native to New Mexico that are considered rare, which the council generally defines as taxa limited to a "specific geographic feature" and whose entire range is fewer than 100 miles. Taxa are also rare if they are uncommon throughout a wider range or abundant in only a few habitats throughout their range. Council members gather and analyze information on the distribution, status, and ecology of flora from literature and field observations to determine whether a species meets the criteria of rarity, endangerment, and distribution for inclusion in the rare plant list. At present, the council lists 11 cactus species occurring in the Chihuahuan Desert of New Mexico as rare; 3 of these are also species of

concern in New Mexico (table 11, p. I-24). Species on the list are not afforded any legal protection, unless they are also listed as endangered by the state or federal government.

New Mexico's Energy, Minerals, and Natural Resources Department, Forestry and Resources Conservation Division, is the state agency responsible for maintaining a list of legally protected species that are considered endangered within the state. Endangered species, as defined under the New Mexico Endangered Species Act, include plant species already listed as endangered or threatened under the U.S. Endangered Species Act, as well as those of such limited distribution and population size that unregulated collection could threaten their survival in the state. A total of 11 cactus species that occur in the Chihuahuan Desert within New Mexico are listed as endangered by the state (table 11).

New Mexico strictly regulates the taking of endangered species. The state issues permits for the collection of endangered species only if the proposed activity will benefit—or at least not jeopardize—the survival of a particular species. Specifically, collecting permits may be issued only for scientific research, botanical inventory and verification, propagation, and transplantation. Federal collecting permits for species listed as endangered or threatened under ESA must be obtained from the U.S. Fish and Wildlife Service. Neither a state nor a federal collecting permit exempts permit holders from state trespass laws. Individuals may be fined between US$300 and US$1,000, imprisoned for up to 120 days, or both for violating New Mexico's Endangered Plant Species Act.

Plant collectors, dealers, and growers are regulated under the Plant Protection Act, which is implemented and enforced by the New Mexico Department of Agriculture (NMDA). The act's primary purpose is to protect state agriculture by guarding crops against the introduction and proliferation of harmful plant pests and diseases. The act requires individuals intending to collect wild plants for commercial purposes to first obtain from NMDA a "collected plants permit." Commercial plant collectors are not required to disclose to NMDA the species or location of wild plants that they plan to harvest. Plants of wild origin imported into New Mexico from another state must be accompanied by a bill of sale showing the state of origin. Plant collectors are exempted from harvest permits if the plants to be collected are not offered for sale. Dealers, landscapers, and nurseries must obtain licenses from NMDA before they engage in the trade, import plants into the state, or distribute nursery or floral stock. New Mexico's Plant Protection Act defines *nursery stock* as any plant, excluding field, vegetable, and flower seeds, that is grown, propagated, or collected from wild populations for landscaping or decorative use. *Floral stock* refers to parts of plants, including cut flowers, evergreens, annuals, or perennials, used for decoration (Sanderson 2002). Approximately 1,800 retail establishments selling plants are routinely inspected by NMDA for evidence of pests or diseases.

Texas

Texas, under the authority of the Texas Parks and Wildlife Department (TPWD), regulates the harvest on private and public land of native plants that are listed as threatened or endangered under state and federal law. Currently, Texas includes only federally protected endangered and threatened plant species in its state list of endangered and threatened plants. But in theory, any native plant of conservation concern can be legally added to the state list. The state protects six federally threatened or endangered cactus species that occur in the Chihuahuan Desert of Texas (table 11). TPWD monitors the status of the following protected cactus species in the Big Bend area of West Texas: Nellie's cory cactus (*Escobaria minima*); Lloyd's mariposa cactus (*Echinomastus mariposensis*); and Davis's green pitaya (*Echinocereus viridiflorus* var. *davisii*). In addition, Texas tracks the status of rare species, of which a dozen are Chihuahuan Desert cacti, and an agave species (*Agave glomeruliflora*), but it does not afford legal protection to species on the Rare Plant List maintained by the Wildlife Diversity Program (table 12).

The Texas Parks and Wildlife Code and Texas Administrative Code specify the requirements under which the collection of threatened or endangered plant species is allowed. Individuals may collect such species for

Table 12. Conservation Status and Distribution of Cactus Species Listed as "Rare" by Texas

Scientific Name	Common Name	Range-Wide Rank	State Rank	Texas Counties of Occurrence
Echinocereus chloranthus ssp. *neocapillus*	Brownspine hedgehog cactus	Apparently secure	Critically imperiled	Brewster, Presidio
Echinocereus viridiflorus ssp. *correllii*	Correll's hedgehog cactus	Widespread, abundant, secure	Imperiled	Brewster, Coke, Pecos
Escobaria albicolumnaria	Column foxtail cactus	Imperiled to vulnerable	Imperiled to vulnerable	Brewster, Pecos, Presidio
Escobaria dasyacantha var. *chaffeyi*	Chaffey's foxtail cactus	Vulnerable	Critically imperiled	Brewster, Zacatecas
Escobaria dasyacantha ssp. *dasyacantha*	Big Bend foxtail cactus	Vulnerable	Imperiled	Brewster, El Paso, Hudspeth, Jeff Davis, Pecos
Escobaria dasyacantha ssp. *duncanii*	Duncan's foxtail cactus	Vulnerable	Critically imperiled	Brewster, Presidio
Escobaria guadalupensis	Guadalupe Mountain foxtail cactus	Critically imperiled	Critically imperiled	Culberson
Escobaria hesteri	Hester's foxtail cactus	Imperiled	Imperiled	Brewster, Pecos, Terrell
Opuntia arenaria	El Paso prickly pear	Imperiled	Imperiled	El Paso, Hudspeth
Opuntia aureispina	Rio Grande prickly pear	Critically imperiled	Critically imperiled	Brewster
Opuntia imbricata var. *argentea*	Tree cholla	Widespread, abundant, secure	Critically imperiled	Brewster
Peniocereus greggii var. *greggii*	Night-blooming cereus	Apparently secure	Imperiled	Brewster, El Paso, Hudspeth, Jeff Davis, Pecos, Presidio, Reeves, Terrell
Sclerocactus papyracanthus	Paperspine fishhook cactus	Vulnerable to apparently secure	Critically imperiled	Hudspeth
Thelocactus bicolor var. *flavidispinus*	Glory of Texas	Apparently secure	Imperiled	Brewster, Starr

Source: Dana Price, Botanist, Wildlife Diversity Program, Texas Parks and Wildlife Department.

scientific purposes from public lands, provided that their qualifications and research objectives are justified and benefit the management of the relevant species. Commercial harvesting of endangered or threatened species from private lands in Texas is permissible, provided that a valid commercial plant permit costing US$50 is obtained prior to collecting. According to TPWD officials, no commercial plant permit has ever been issued for the collection of ESA-listed endangered or threatened species, and no request for one has ever been received (Price 2000). The state acknowledges that because nobody has submitted a formal request to TPWD to collect threatened or endangered species from private property, the agency has not created the necessary permit requirements to process such requests. The agency is concerned that by establishing rules to harvest protected species on privately owned land it may actually facilitate the harvesting of sensitive species, thereby undermining its own efforts to protect species of conservation concern.

Inspectors of the Texas Department of Agriculture use identification materials

prepared by TPWD to detect endangered and protected cactus species in shipments leaving the state. However, federal officials familiar with the endangered species identification manual say that it is either outdated or not routinely consulted by inspection personnel in the field (Dulik 2001a).

Prioritization of CDE Issues, Species, and Sites

During the past two decades, cactus plants of wild origin have been increasingly replaced in trade by plants grown from seeds and tissue culture. In general, international legal trade, supplied largely by artificially propagated cacti, does not contribute significantly to the exploitation of cactus of the Chihuahuan Desert Ecoregion in the United States. The availability and affordability of artificially propagated cacti along with CITES requirements have tempered commercial demand for wild-dug cactus plants in the foreign marketplace. Today, CDE cacti legally harvested from natural populations in the United States are primarily destined for U.S. cities and states where xerophytic (desert) plants are used in landscaping. The level of interstate trade in several cactus taxa occurring in the U.S. portion of the Chihuahuan Desert appears high compared to that of international trade, potentially posing a conservation problem to wild populations of some species. A thriving demand for wild CDE cacti exists in the Southwest region, particularly in Arizona. The size and scope of that market may be more significant than available trade data indicate.

The likelihood of illegal or unsustainable collection of CDE cacti is greatest among species that are newly named to science, rare, profitable, or otherwise popular among private collectors or among well-meaning, but naively conscientious consumers hoping to conserve water by purchasing desert plants. The theft and illegal trade in newly discovered species are problems that have been limited largely to Mexico, where most discoveries of new cacti have occurred in recent years. Nonetheless, U.S. cactus populations are not invulnerable to commercial and private collectors, as evidenced by the illegal removal of cactus plants from public lands in California, Arizona, New Mexico, and Texas (Inman 2000).

Commercial demand for cacti (especially *Ferocactus*, *Melocactus*, and *Echinocactus*) in traditional Mexican foods and medicines causes some concern because of the large amount of plant material needed to satisfy market demands (FitzMaurice and Anderson 1997). Cactus poaching in the Mojave Desert to supply Mexican candy to California markets testifies to the importance of monitoring the legality and sustainability of commercial trade in CDE cactus used in local foods. Although an analysis of CDE cacti harvested and traded for food or medicine falls outside the scope of this report, the issue merits closer study to determine the biological impact of this trade on CDE cactus species, populations, and habitats.

Other succulent plant species whose trade levels may be unsustainable were also identified. Another important finding is the pivotal role individual states and counties play as producers or consumers in the CDE cactus trade. The following prioritization of areas within the CDE takes into account several criteria, including the volume of specimens traded, the number and location of threatened species, opportunities for collaborative conservation among organizations positioned to conserve species, the adequacy of harvest or trade controls, and pressures such as habitat loss and grazing that affect the resource base.

Arizona

The Chihuahuan Desert Ecoregion does not feature as prominently in Arizona as it does in New Mexico or Texas. However, WWF considers six sites within the Chihuahuan Desert of Arizona first- or second-tier priorities for conservation work, and endangered cacti have been documented on all of these sites. Although the harvesting of cacti in the CDE portion of Arizona does occur, collecting is generally limited to plants salvaged from natural habitat that is targeted for development. At present, the level of salvaging does not appear significant, although this activity should be monitored as Tucson's population and demand for developable land continue to grow. Cactus species occurring in the CDE of Arizona receive adequate protection from the state, as the harvest of such plants on private and state lands, as well as their intrastate commerce, is strictly regulated under a system of permits and tags. Less is known about the

types of threats to cactus and other plants of ecological significance on federal (BLM, USFS) lands within the Chihuahuan Desert of Arizona or about what strategies either agency employs to protect species or habitat of conservation concern from the threat of exploitation or habitat degradation.

New Mexico

In the United States, New Mexico contains the second largest tract of Chihuahuan Desert after Texas. A minimum of 85 cactus species occur within the Chihuahuan Desert of New Mexico; 39 species (46 percent) are believed to occur in the Cibola, Gila, and Lincoln National Forests managed by the U.S. Forest Service. Of these, the Lincoln may be considered outside the boundary of the Chihuahuan Desert, although many of the cactus species occurring within Lincoln are also native to the Chihuahuan Desert. Lands managed by the U.S. Bureau of Land Management provide suitable habitat for an unknown number of cactus taxa. Collectively, the two districts of the BLM (Las Cruces and Carlsbad) include 8 million acres of surface area in southern New Mexico. BLM issues harvest permits to the public for cactus and other succulents. The agency also allows the salvaging of plants from habitat designated for development or for uses (for example, roads) not compatible with cactus management or survival. The unauthorized removal of live cacti from wild populations in the Las Cruces BLM Resource Area for landscaping is believed to be more widespread than reported violations. However, very little is known about which species or sites are affected by harvest or the extent of their exploitation. Although cactus management is not a priority of the Carlsbad BLM Resource Area because of insufficient funding, BLM officials expressed an interest in developing a management plan for cactus.

Two military installations, White Sands Missile Range (2.14 million acres) and Fort Bliss (1.1 million acres) under the U.S. Department of Defense, located adjacent to each other in south central New Mexico, occupy a significant portion of the Tularosso Basin, a site of high conservation importance to WWF within the Chihuahuan Desert. Thirty-six cactus species have been documented on the White Sands Missile Range. All requests to collect wild plants must be submitted to and approved by the Environmental Stewardship Division (Anderson 2002). Approximately 1,200 species of vascular plants, comprising 25 percent of New Mexico's botanical diversity, have been documented within the boundaries of Fort Bliss, of which 90 percent occurs in New Mexico and 10 percent in Texas. All rare or threatened plants, including cacti, and sites harboring such species are protected from military activities under an endangered species management program at Fort Bliss. Under the program, educational materials, including laminated field cards, advising against the collection of wild plants are distributed to military personnel (Corral 2002). Restricted public access to White Sands Missile Range and Fort Bliss, and high penalties for trespassing in either installation may help protect rare or sensitive plants that might otherwise be more prone to collection without these deterrents.

Though species listed as endangered or threatened under the U.S. Endangered Species Act are fully protected on military lands now, the Department of Defense has recently submitted draft legislation to the U.S. Congress to seek exemption from environmental regulations, including ESA requirements, perceived as interfering with military activities (Seelye 2002).

A cactus conservation plan for the Chihuahuan Desert Ecoregion in New Mexico should focus on improving the management of cactus populations and species on federal (USFS, BLM) and state (State Land Office) lands, which comprise a significant amount of the Chihuahuan Desert in that state. Adoption of land-use policies and practices that address cactus conservation is a high priority of BLM and the New Mexico State Land Office.

Texas

The Chihuahuan Desert is distributed over 13 counties in West Texas, accounting for a significant share of the ecoregion's geographic representation within the United States. The taxa of greatest conservation interest are those harvested by the thousands from wild populations in Texas counties located inside the CDE and subsequently traded to regional

or local markets, primarily for landscaping. Approximately 107 cactus taxa (77 species and 30 varieties) within Texas occur in Trans-Pecos Texas, the area that comprises most of the Chihuahuan Desert (Powell 2000). The prominence of Texas in CDE cactus exploitation suggests conservation efforts should be aimed at those counties and species affected most by this activity. The CDE of West Texas is also an appropriate region for cactus conservation work owing to its high concentration of native species whose habitat may be degraded by incompatible human activities (for example, overgrazing, oil mining, natural gas development, agriculture, urbanization, and introduction of exotic plant species) (Poole 2000). The apparent absence of trade monitoring or controls at the state or county level for exploited species is another compelling reason to focus attention on Texas. Insufficient monitoring and trade information undermine efforts to quantify commerce and make informed management decisions.

Although the volume of cacti and other succulents harvested in Texas today is significantly lower than it was 20 years ago, a considerable number of plants are still extracted from wild populations between El Paso and the Pecos River on the eastern edge of the Trans-Pecos mountain ranges (table 13). The informal nature of business transactions between collectors and dealers hinders efforts to quantify harvest totals, to identify localities affected by collection, and to evaluate the effects of collection on CDE cactus populations within the state. According to Texas export documents, 91 percent of live cactus plants traded legally from Texas to Arizona between 1998 and June 2001 originated in Hudspeth (39 percent), Presidio (29 percent), and Culberson (23 percent) Counties. The large volume of wild-harvested plants in Hudspeth, Presidio, and Culberson Counties raises questions about the sustainability of this activity and the status of local populations affected by collecting. Those counties should be scrutinized more closely to ensure that collection is sustainable and legal, and that wild populations receive adequate protection from exploitation and other human activities.

In 2000, the U.S. Fish and Wildlife Service uncovered a succulent smuggling operation involving Presidio County, which had been used as a conduit for importing illegally collected succulents from Mexico into the United States for redistribution to U.S. cities. Close and continued monitoring of the succulent trade within and from Presidio County by U.S. customs, the Texas Department of Agriculture, and the U.S. Fish and Wildlife Service is necessary to detect and deter illegal trade of those plants.

According to the trade data, Terrell, Brewster, Reeves, El Paso, Cameron, and Sutton Counties are secondary producers of wild cacti, and each plays a role in the conservation of cactus diversity within the Chihuahuan Desert. For instance, Brewster County is an exceptional center of CDE cactus diversity and, as such, has historically been a prime source of specimens for the trade. According to a recent market survey, a high percentage of cactus species documented for sale on the Internet appear to have originated from wild populations in Brewster County, suggesting that this county's cactus species are especially popular among collectors and may be subject to collection in the future. For these reasons, Brewster County is a priority for cactus conservation. The proximity and accessibility of local cactus populations to the public in urban El Paso County heighten the risk and effect of collection there. Moreover, pressure from development (habitat loss) is a greater concern in El Paso County than in other counties. For those reasons, El Paso County is also a priority for the conservation of cacti and their natural habitat. Cactus harvesting in Terrell, Reeves, Cameron, and Sutton Counties, as well as in other West Texas counties not mentioned here, should be monitored for changes in levels or species composition that might indicate a shift in harvest toward or away from those counties.

CDE cacti traded from West Texas counties to Arizona markets in volumes that raise initial concerns about sustainability are hedgehog (*Echinocereus* spp.), fishhook barrel (*Ferocactus wislizenii*), Texas barrel (*Ferocactus hamatacanthus*), and blue barrel (*Echinocactus horizonthalonius*) (tables 13, 15, 16, 18). Of those hedgehog species identified in trade, claretcup hedgehog (*Echinocereus triglochidiatus* [*coccineus*]) and rainbow hedgehog (*E. dasyacanthus*) were the most heavily and frequently traded between 1998

and June 2001. Commercial demand for succulents from West Texas is not limited to cactus species, as is evident from the significant volume of imports of ocotillo (*Fouquieria* spp.), yucca (*Yucca* spp.), and agave (*Agave* spp.) that entered Arizona from 1998 to 2001 (tables 14, 17, 19).

Obtaining the commitment of private landowners to cactus conservation poses a significant challenge in West Texas but also represents an unexplored opportunity to integrate private lands into conservation programs. To a lesser extent, the University of Texas and General Land Office of Texas in West Texas are relevant collaborators. Both institutions own enough land in Hudspeth and Culberson Counties to make a contribution to cactus conservation.

Table 13. Wild-Harvested Succulents Whose Trade from Texas to Arizona Exceeded 1,000 Specimens (1998–June 2001)

Taxon	Trade Name(s)	Quantity
Fouquieria	Ocotillo	67,712
Echinocereus	Hedgehog	10,466
Yucca	Yucca	5,592
Ferocactus wislizenii	Fishhook Texas barrel	2,938
Echinocereus triglochidiatus (*coccineus*)	Claretcup hedgehog	2,813
Echinocereus dasyacanthus	Rainbow hedgehog	2,258
Agave	Agave	2,468
Ferocactus hamatacanthus	Texas barrel, Turk's head	1,878
Echinocactus horizonthalonius	Blue barrel, eagle claw	1,472

Source: Arizona Department of Agriculture.

Table 14. *Fouquieria* spp. Imports into Arizona from CDE West Texas Counties (1998–June 2001)

County	Number Imported
Presidio	26,491
Hudspeth	18,932
Culberson	12,204
Brewster	4,806
Terrell	3,389
Reeves	1,420
El Paso	370
Sutton	100
Total	**67,712**

Source: Arizona Department of Agriculture.

Table 15. *Echinocereus* spp. Imports into Arizona from CDE West Texas Counties (1998–June 2001)

County	Number Imported
Hudspeth	5,994
Culberson	2,205
Terrell	1,598
Presidio	367
El Paso	121
Brewster	181
Total	**10,466**

Source: Arizona Department of Agriculture.

Table 16. *Ferocactus* spp. Imports into Arizona from CDE West Texas Counties (1998–June 2001)

County	Number Imported
Hudspeth	4,205
Presidio	341
El Paso	126
Culberson	98
Brewster	46
Total	**4,816**

Source: Arizona Department of Agriculture.

Table 17. *Yucca* spp. Imports into Arizona from CDE West Texas Counties (1998–June 2001)

County	Number Imported
Hudspeth	4,205
Culberson	546
Presidio	401
Brewster	376
Cameron	353
Terrell	300
Unkkown	240
El Paso	33
Total	**5,592**

Source: Arizona Department of Agriculture.

Table 18. *Echinocactus* spp. Imports into Arizona from CDE West Texas Counties (1998–June 2001)

County	Number Imported
Hudspeth	1,589
Culberson	451
Terrell	28
Presidio	13
Brewster	9
Total	**2,090**

Source: Arizona Department of Agriculture.

Table 19. *Agave* spp. Imports into Arizona from CDE West Texas Counties (1998–June 2001)

County	Number Imported
Hudspeth	1,407
Terrell	460
Culberson	262
Cameron	150
Brewster	109
El Paso	45
Presidio	35
Total	**2,468**

Source: Arizona Department of Agriculture.

Conclusions and Recommendations

Research Constraints and Caveats

The amount and specificity of information on cactus collection and trade in the U.S. portion of the CDE used in this analysis varied widely among states. For example, relatively detailed data on cacti imported into Arizona from Texas were useful in quantifying and analyzing trade volumes and patterns between those states. However, data on cacti trade within Texas and New Mexico could not be obtained owing to the absence of any reporting system or centralized repository of information in those states. Therefore, incomplete data may distort the findings by showing a disproportionately active trade between Arizona and Texas. It suffices to say, however, that Arizona is a prominent market for xerophytic plants and probably accounts for a substantial share of the domestic market for wild cacti harvested from natural populations in the Chihuahuan Desert of the United States.

Another important consideration in selecting "priority" species was the confusion in taxonomy and nomenclature. This confusion was especially evident for cacti documented in interstate trade between Texas and Arizona whose trade names were either unfamiliar or multiple, thereby complicating the identification of cacti to the species level. Synonomy compounded difficulties in matching trade names with their corresponding scientific (Latin) binomials. For example, *eagle claw cactus* is the trade name appearing on permits issued by the Texas Department of Agriculture for plants destined for Arizona. However, in the absence of a Latin name, the trade name could potentially apply to a number of taxa: *Echinocactus horizonthalonius*, *E. texensis*, or *Glandulicactus wrightii* (Ferguson 2001). Adding to the confusion is the practice of cactus dealers assigning common, general names to plants of similar appearance when obtaining permits from Texas agricultural officials. For instance, fishhook barrel cactus can be used interchangeably with eagle claw as both refer to barrel-shaped cacti with hooked spines. In this context, a taxon whose trade name is fishhook barrel can be one of several species that share those physical traits. In some cases, the reliable identification of taxa to the species level was possible where common names of cacti on trade permits were cross-referenced with Web sites of companies known to have imported such plants from Texas.

Despite the barriers to complete information and accurate nomenclature, a better understanding of U.S. interstate trade and exports of CDE cacti has emerged from an assessment of available information.

General Recommendations

WWF, in close partnership with local conservation groups, should convene a forum for stakeholders to gather information and opinions on the direction and development of a cactus conservation strategy for the Chihuahuan Desert Ecoregion of the United States, building on the priorities and recommended activities outlined herein. Toward this end, it is essential that a range of relevant stakeholders participate in discussions and decisions that contribute to WWF's priorities and goals for conserving CDE cactus species, populations, and habitat. Stakeholder "buy-in" and support should yield a wide range of opinions and options reflecting local concerns and realities for developing conservation strategies in the field. All or a subset of the following organizations, which reflect the diversity of stakeholders, should participate in a workshop to address CDE cactus conservation needs and priorities:

- U.S. Forest Service (Lincoln National Forest, New Mexico)
- Bureau of Land Management (Las Cruces and Carlsbad field offices, New Mexico)
- Animal and Plant Health Inspection Service under U.S. Department of Agriculture
- Ports of Nogales and El Paso
- Arizona Department of Agriculture (Tucson office)
- California Department of Agriculture
- National Park Service (Big Bend National Park, Texas)

- Albuquerque Botanical Garden
- New Mexico State Land Office
- Desert Botanical Garden (Phoenix, Arizona)
- Sul Ross State University (Alpine, Texas)
- Texas General Land Office
- Texas Parks and Wildlife Department
- Chihuahuan Desert Research Institute
- Texas Agricultural Experiment Station
- Cactus and Succulent Society (Chapters of Tucson, El Paso, Austin, Las Cruces, Houston, San Antonio)
- New Mexico Department of Agriculture
- Texas Department of Agriculture
- U.S. Fish and Wildlife Service (Ken Dulik, San Antonio, Texas)
- Private landowners, especially from priority counties in West Texas
- Cactus nurseries and retailers in key markets
- Cactus dealers from West Texas
- Water management authorities of Phoenix and Tucson, Arizona, and Las Vegas, Nevada

Specific Recommendations

Engage Private Landowners in West Texas

The geographic area most heavily affected by commercial cactus exploitation is West Texas (Hudspeth, Culberson, and Brewster Counties). Much of the land in these counties is privately owned by absentee landowners from whom ranchers lease the land for grazing, mining, and oil or gas extraction. Cacti are harvested under informal arrangements between diggers and ranchers, or their designated managers. Conservationists question whether permission from private landowners is always obtained before live cacti and other succulents are removed from private property in West Texas, a region that is perhaps more susceptible to unauthorized collecting owing to its extreme isolation and vastness. Moreover, research biologists cannot fully measure the level and impact of harvest on natural populations owing to the general inaccessibility of private lands. For those reasons, investigating and possibly conserving cacti on privately owned lands in the CDE of West Texas are high priorities for WWF. A critical step toward developing conservation strategies for cacti on private property is acquiring a better understanding of what species inhabit these lands, the condition of natural habitats, present and planned land uses, and specific actions to mitigate the effects of human activities detrimental to cactus populations.

The support of private landowners is critical to the success of a conservation strategy for CDE cactus species and habitats in West Texas. Cultural perceptions about outside interference with land-use practices will likely be an initial constraint in working with private landowners in West Texas. Although landowner recalcitrance is a potential obstacle, seeking and securing the support of landowners is not necessarily an impossibility. Biologists affiliated with local academic institutions and state agencies have already laid the foundation for cooperation with landowners by obtaining permission to conduct field research on private property (Anderson 2000). According to local biologists, establishing sustainable harvesting programs for cacti on private lands is realistic (Powell 2000a). Because they have a history of interacting with private landowners, officials from the Texas Agricultural Experiment Station and biologists from the Texas Parks and Wildlife Department are positioned to engage that group of stakeholders in discussions of cactus management. The Texas chapter of the Nature Conservancy may be able to assist WWF with managing cactus habitat by identifying and consulting cooperative landowners in the region. County assessor offices maintain information on local landholdings and may be a useful vehicle for contacting landowners.

A realistic program for managing cactus populations on private lands used for grazing in Texas will likely involve some degree of commercial exploitation because cacti (particularly *Opuntia*) and other succulents (*Yucca, Agave, Dasylirion, Nolina* spp.) are perceived as competing with grass and other forage species important to the diet of livestock (Poole 2001). The defense mechanisms of succulents, whether morphological (spines) or

biochemical (toxins), also pose a direct threat to livestock, further harming their image among private ranchers. Practicing cactus conservation through sustainable use of wild plants might be more appealing to most landowners than advocating a policy of no exploitation. After all, the estimated retail market value of Chihuahuan Desert succulents harvested from mostly private lands in West Texas and sold in Arizona during the three-year period between 1998 and June 2001 is substantial. Thus, landowners stand to gain financially by leasing lands to diggers for cactus removal if the activity can be conducted in a sustainable manner. Establishing sustainable thresholds for harvest will pose an initial hurdle but may be achieved effectively and scientifically with the assistance and expertise of credible local research organizations (such as the Chihuahuan Desert Research Institute), academic institutions (such as Sul Ross State University), and state agencies (such as the Texas Parks and Wildlife Department and Texas Agricultural Experiment Station). Another potential source of income to private landowners is leasing the rights of harvesting cacti to cactus and succulent societies or to clubs whose members may pay a premium for the opportunity to harvest wild specimens from carefully managed wild populations on a rotational basis.

Improve Protection for Species and Habitat on Federal Lands in Arizona and New Mexico

Arizona

USFS and BLM manage a significant amount of land in Graham and Cochise Counties where native plant conservation efforts should involve the participation of these agencies. For instance, endangered cacti are distributed throughout southeastern Arizona to the south, east, and northeast of Tucson, an area largely managed by USFS and BLM (Dinerstein et al. 2000). An evaluation of current management and protection for endangered, exploited, or otherwise sensitive cacti and other succulents on USFS and BLM lands is recommended to determine what, if any, additional measures are needed to safeguard these plants and their habitat from the threats of collection, development, and livestock grazing. Specifically, conservation priorities should focus on the Coronado National Forest, as well as in the Safford BLM District. USFS officials inform TRAFFIC that the management plan for the Coronado National Forest will be revised from 2002 to 2004, providing an opportunity for the public to recommend measures for conserving and protecting botanically or biologically significant areas (Ciapusci 2002). Similarly, BLM is planning to reevaluate sensitive or outstanding plant communities for protection through a land-use planning initiative.

New Mexico

The state or federal government manages more than 80 percent of surface lands in southern New Mexico, which constitutes the largest swath of Chihuahuan Desert in the state. A significant percentage of this area is under the management of the federal government, including such agencies as the Bureau of Land Management, U.S. Forest Service, and Department of Defense. Each agency has a different set of priorities and strategies for managing and protecting botanical resources and critical habitats from deleterious activities. These federally managed lands are either within or near eight sites that are considered significant priorities to WWF's conservation efforts in the Chihuahuan Desert in New Mexico. For instance, the Chiracahua–Sierra Madre Complex and Big Hatchet–Alamo Hueco Mountains in the southeastern corner of the state, the Guadalupe Mountains–Carlsbad Escarpment and Sierra Blanca in the south central corner, and the Mescalero Grasslands in the southeastern corner are considered highest or high priority sites. Much of the territory east of Las Cruces, New Mexico, north of El Paso, Texas, and south or west of Alamogordo, New Mexico, is confined to two military installations totaling 3.2 million acres, to which public access is tightly controlled. These military lands overlap with the Tularosa Basin, a site identified by WWF as a very high priority for conservation owing to a rare habitat type (gypsum dunes) characterized by its unique flora and fauna (Dinerstein et al. 2000).

A review of land-use policies of state and federal land management agencies should be undertaken to identify whether management of critical habitat for cacti and other native plants

needs more attention and improvement. In particular, the Lincoln National Forest (Guadalupe Ranger District) and the BLM Las Cruces and Carlsbad field areas should be the focus of efforts to identify gaps in the conservation of native plants, especially cacti. BLM is undertaking a land-use planning initiative, which represents an opportunity to work with that agency to advance the conservation of threatened, sensitive, or otherwise rare plants on BLM lands.

Texas

The Chihuahuan Desert spans 13 West Texas counties, where more than 2.1 million acres of land are managed by Texas Parks and Wildlife Department (512,448 acres), General Land Office (645,679 acres), and the University of Texas (1,025,537 acres). Most of the TPWD-managed sites (state parks, wildlife management areas, natural areas) are protected areas where plant collecting is strictly regulated under a permit system. Together the University of Texas (UT) and General Land Office (GLO) of Texas own about 32 percent of the land in Culberson County and at least 10 percent of the land in Hudspeth County; both counties are a priority for conservation because of the significant volume of cacti in trade originating from them. An inventory of UT and GLO lands for areas of cactus diversity should be undertaken. Land-use policies and practices of UT and GLO considered detrimental to native cacti and their habitat might be confined to low-risk sites and minimized or eliminated in fragile environments. In addition, Texas game wardens, whose jurisdiction does not include GLO-managed lands, should be given the authority to patrol GLO lands to deter and pursue thefts of plantlife.

Improve State and Federal Trade Monitoring Protocols

New Mexico regulations require individuals to obtain harvest permits for native plants from its Department of Agriculture. However, these forms do not document information essential for monitoring and managing the resource, such as harvest location, species collected, and number of plants to be removed from the wild. Improving the specificity of information on harvest permits would augment their value to resource managers, biologists, and conservationists, while increasing the transparency of collecting activities. Moreover, New Mexico's Department of Agriculture neither inspects shipments nor maintains records of cacti and other plants imported into or reexported from the state. New Mexico's existing regulations for plant imports should be amended to require state agricultural inspectors to report the quantity, source, and species of plants brought into the state. Arizona's regulations and native plant salvaging forms serve as promising models (see <www.agriculture.state.az.us/PSD/nativeplants.htm>). Plants entering Arizona must be declared, documented, and tagged on importation into that state.

Recent cases involving the smuggling of wild-harvested ocotillo and cacti into the United States from Mexico through rural West Texas counties highlight the importance of enforcing state and federal plant trade regulations. Discussions with government officials indicate that a significant number of plants imported illegally into Texas from Mexico were subsequently reshipped to other states under valid Texas agricultural permits. It is possible that officials working for the Texas Department of Agriculture issued permits without performing a full visual inspection of plant shipments leaving the state. To help deter the falsification of agricultural documents under which native succulents are traded, the Texas Department of Agriculture should conduct visual inspections of all plant material removed from the wild prior to sale within and outside of Texas. WWF should work with the Texas Department of Agriculture to improve the agency's procedures and capacity for inspecting shipments of native plants harvested from the wild in Texas.

Support Field Research and Possible Regulatory Action

The following cacti and other succulents are collected from the wild in quantities that raise questions about the biological impact of this practice: *Fouquieria* spp. (ocotillo); *Echinocereus* spp. (hedgehog); *Ferocactus* spp. (Texas barrel, fishhook); and *Yucca* spp. (yucca). Each taxon serves an important ecological function in Chihuahuan Desert ecology. For instance, unlike many desert

plants, ocotillos bloom in dry conditions and provide a critical source of nectar and energy for hummingbirds during the spring migration from Mexico to northern North America (Phillips and Wentworth 1999). Field research is needed to generate information on the reproductive biology (germination and recruitment rates of such plants), their population size and dynamics, their phenological needs and constraints, and their habitat requirements. In addition, further trade research should be conducted, building on baseline trade information by quantifying trade in key cacti and other succulents between Texas and neighboring states such as Arizona, California, Nevada, New Mexico, and Oklahoma.

Regulation is not a recommended first course of action to control cactus (and succulent) harvest and trade in Texas. A regulatory approach would meet significant opposition and could undermine WWF's efforts by alienating private landowners whose participation in cactus conservation is paramount. Moreover, the conservation value of regulating harvest on private lands in Texas would be questionable. Under existing Texas law, federally and state protected plant species may be harvested from private land as long as commercial take permits are obtained from the Texas Parks and Wildlife Department and specimens do not enter interstate or international commerce. However, if harvest clearly exceeds the capacity of populations and slow-growing species to regenerate and if other conservation measures are inadequate, then protecting species of concern from trade by regulating harvest might be necessary. TRAFFIC recommends that the species listed in table 20 be monitored more carefully in Texas trade, be considered for additional protection in Texas, and be included in management plans focusing on *in situ* sustainable harvest or *ex situ* commercial cultivation. Plant species found in interstate commerce can be added to the Texas Threatened and Endangered List, but that action would prohibit trade from the state and could eliminate economic incentives to manage wild populations on private property.

According to state law, individuals collecting cacti on private property in Texas are not required to obtain written permission from landowners; only spoken authorization is needed. The percentage of plants removed from private lands without landowner consent is unknown. In an effort to reduce unauthorized collecting on private property in Texas, the state should require collectors to obtain written authorization from private landowners or designated staff members before harvesting. The Texas Parks and Wildlife

Table 20. Species Qualifying for Additional Monitoring or Conservation Measures in Texas

Scientific Name	Trade Name	Reasons for Conservation Action
Ariocarpus fissuratus	Living rock cactus	Is popular among collectors; is heavily harvested from the wild; is slow growing and long lived; has a restricted geographic range in the United States
Fouquieria splendens	Ocotillo	Is significantly traded for landscaping; is subject to illegal trade; is slow growing and long lived; is receiving limited commercial cultivation
Ferocactus wislizenii	Fishhook Texas barrel	Is traded in high volumes; is a popular landscaping species; is critically imperiled in Texas; is slow growing and long lived
Echinocactus horizonthalonius	Eagle claw, blue barrel	Is heavily traded from Texas; is imperiled in Arizona; is vulnerable in New Mexico
Echinocereus dasyacanthus	Rainbow hedgehog	Is heavily collected in Texas for intra- and interstate trade
Echinocereus triglochidiatus (*coccineus*)	Claretcup hedgehog	Is heavily collected in Texas for interstate trade

Department could prepare a landowner consent form that would need the signature of the person who owns or manages the land where harvesting is to take place. Agents of the Texas Department of Agriculture could validate the landowner consent forms when cactus specimens were inspected before exportation. Proof of written landowner consent should improve the transparency of cactus collection within, and commerce from, the state and should provide law enforcement officials with a paper trail to verify the legality of harvesting.

Promote Local Propagation and Independent Certification of Native Cacti

Conservationists should support the establishment of local cactus propagation projects in priority West Texas counties to reduce reliance on field-collected cactus plants, while providing local communities with economic opportunities to grow plants for commercial sale. Native wild cacti can be used as a source of initial and supplemental nursery stock for cultivation efforts. Community-based propagation centers might be created in conjunction with local chambers of commerce and state universities (for example, Sul Ross State University) near zones of high cactus diversity and density. A useful model for extracting plant species and mother stock from wild populations for commercial propagation is Turkey's flower bulb management system. Turkish villages, under the supervision of academic institutions and conservation organizations, propagate flower bulb species for export to western Europe. The effectiveness of local bulb propagation projects coupled with strict adherence to quotas for harvesting and exporting wild bulbs is contributing to the successful management of heavily exploited flower bulbs in Turkey.

The feasibility of independent, third-party certification for the sustainable harvest of cacti from wild populations in the Chihuahuan Desert should also be examined. A "certified sustainable" label or tag on cactus plants would help consumers identify plants in the marketplace for which harvest practices met minimum environmental and quality standards. By adhering to voluntary standards, cactus diggers and dealers would be able to use a certified sustainable label on field-collected plants that might appeal to consumers interested in supporting cactus conservation. The first step in establishing a certification or eco-labeling scheme for wild desert plants would be to conduct consumer research to gauge market receptivity.

Institutionally, WWF already actively promotes the production of, and assists in finding markets for, timber from operations certified by organizations approved by the Forest Stewardship Council, a certification accreditation body. Certification is a promising market-based tool for conserving natural populations of heavily harvested cacti and other succulents in the Chihuahuan Desert.

Promote Public Education and Responsible Purchasing

WWF should integrate conservation into government literature and consumer purchasing decisions, encouraging consumers to buy cactus plants that have been artificially propagated or whose sustainable harvest can be verified by the vendor. Buyers of CDE cactus and other succulents should be better informed about the source of plants that they or their contractors buy for landscaping jobs. The growing popularity of arid plants native to the Chihuahuan, Sonoran, and Mojave Deserts, resulting from local campaigns advocating the use of desert plants to conserve water, is contributing to great commercial demand for some species. City water conservation offices promote xeriscaping to reduce water consumption but may unintentionally increase demand for mature plants taken from fragile desert populations. Xeriscaping literature distributed by city governments in Arizona, Nevada, and southern California where succulents from the Chihuahuan Desert are sold should advise homeowners to ask local nurseries, vendors, and garden centers about the availability of propagated or sustainably harvested plants.

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APPENDICES
PART I

Appendix 1
U.S. Exports and Reexports of Wild Cacti (1995–1998)

Year	Genus	Number of Species Reported	Number of Specimens Reported	Countries of Destination
1995	*Carnegiea*	1	24	Japan, Netherlands, Qatar
	Cleistocactus	1	2	Switzerland
	Echinocactus	2	98	Japan, Netherlands
	Echinocereus	4	95	Japan, Netherlands
	Echinopsis	1	6,845	Australia, Bermuda, Canada, Cayman Islands, Denmark, Germany, Spain, France, Great Britain, Hong Kong, Italy, Japan, Netherlands, Netherlands Antilles, New Zealand, Singapore, Switzerland, Taiwan (ROC)
	Eriosyse	1	10	Japan
	Eulychnia	2	13,398	Australia, Bermuda, Canada, Cayman Islands, Denmark, France, Germany, Great Britain, Hong Kong, Italy, Japan, Malaysia, Netherlands, Netherlands Antilles, New Zealand, Singapore, Spain, Switzerland, Taiwan (ROC)
	Ferocactus	2	68	Japan, Netherlands
	Opuntia	3	17,471	Germany, Japan
1996	*Carnegiea*	1	30	Great Britain, Netherlands
	Coryphantha	1	50	Netherlands
	Echinocactus	2	152	Japan, Netherlands
	Echinocereus	7	535	Germany, Netherlands
	Echinopsis	1	2,787	Australia, Canada, Cayman Islands, Denmark, Finland, France, Great Britain, Hong Kong, Israel, Italy, Portugal, Singapore, Spain, Venezuela
	Eriosyce	1	22	Japan
	Escobaria	2	100	Netherlands
	Eulychnia	2	39,215	Australia, Bermuda, Canada, Cayman Islands, Denmark, Finland, France, Great Britain, Hong Kong, Israel, Italy, Japan, Germany, Netherlands, Netherlands Antilles, New Zealand, Philippines, Portugal, Singapore, Venezuela, Spain, Switzerland
	Ferocactus	2	90	Netherlands
	Opuntia	6	23,619	Germany, Netherlands
	Sclerocactus	3	150	Netherlands
1997	*Carnegiea*	1	50	Netherlands
	Echinocactus	2	176	Japan
	Echinocereus	4	166	Japan, Netherlands
	Echinopsis	2	75	Bermuda, Canada, Germany, Great Britain, Japan, New Zealand, South Africa
	Eriosyce	1	3	Japan
	Eulychnia	1	16,392	Australia, Bermuda, Brazil, Canada, France, Germany, Great Britain, Italy, Japan, Netherlands Antilles, New Zealand, Saint Lucia, Saudi Arabia, Spain, Switzerland
	Ferocactus	1	304	Japan
	Gymnocalycium	1	22	Great Britain
	Haageocereus	1	20	Great Britain
	Opuntia	Unknown	1,458	Japan, Netherlands
	Sclerocactus	Unknown	50	Japan
1998	*Carnegiea*	1	55	Egypt, Netherlands
	Echinocactus	2	73	Japan, Netherlands
	Echinocereus	6	60	Great Britain, Netherlands
	Echinopsis	1	13	Canada, Great Britain, Italy
	Eriosyce	1	74	Japan, Netherlands
	Escobaria	1	2	Netherlands
	Eulychnia	1	5,194	Canada, Cyprus, Great Britain, Italy, Saint Lucia
	Ferocactus	3	180	Japan, Netherlands
	Opuntia	5	14	Great Britain
	Sclerocactus	2	35	Japan, Netherlands

Appendix 2
U.S. Exports or Reexports of Wild Cacti by Importing Country (1998)

	Reported as Imports by Country of Destination		Reported as Exports by U.S Authorities		
Country of Destination	**Quantity**	**Specimen(s) Exported**	**Quantity**	**Specimen(s) Exported**	**Total**
Canada	—	—	3,007	Live plants, carvings	3,007
Unknown	—	—	1,035	Carvings	1,035
Great Britain	—	—	723	Live plants, carvings	723
Cyprus	—	—	235	Carvings	235
Netherlands	224	Live plants, stems, timber pieces	47	Live plants	271
Japan	—	—	187	Live plants	187
Italy	—	—	181	Carvings	181
Saint Lucia	—	—	33	Carvings	33
Egypt	—	—	32	Live plants	32
Germany	2	Timber pieces	—	—	2
All destinations	226	—	5,480	—	5,706

Appendix 3
U.S. Exports or Reexports of Wild Cacti by Importing Country (1995)

	Reported as Imports by Country of Destination		Reported as Exports by U.S Authorities		
Country of Destination	**Quantity**	**Specimen(s) Exported**	**Quantity**	**Specimen(s) Exported**	**Total**
Canada	—	—	3,007	Live plants, carvings	3,007
Germany	—	—	19,410	Timber pieces	19,410
Australia	—	—	6,818	Timber pieces	6,818
Canada	—	—	4,896	Timber pieces	4,896
Japan	142	Carvings, live plants	3,494	Live plants, timber pieces	3,636
Great Britain	—	—	1,016	Timber pieces	1,016
Netherlands	246	Live plants	399	Carvings, timber pieces	645
Unknown	—	—	377	Timber pieces	377
Hong Kong	—	—	360	Timber pieces	360
New Zealand	—	—	286	Timber pieces	286
Switzerland	2	Live plants	245	Timber pieces	247
Italy	—	—	170	Timber pieces	170
Cayman Islands	—	—	96	Timber pieces	96
Denmark	—	—	47	Timber pieces	47
Netherlands Antilles	—	—	46	Timber pieces	46
France	—	—	43	Timber pieces	43
Bermuda	—	—	42	Timber pieces	42
Taiwan (ROC)	—	—	20	Timber pieces	20
Qatar	—	—	14	Live plants	14
Singapore	—	—	12	Timber pieces	12
Spain	—	—	9	Timber pieces	9
All destinations	390	—	37,800	—	38,190

Appendix 4
Top 10 Importers of Artificially Propagated Cacti from the United States (1998)

Country of Destination	CITES Appendix I Cacti	CITES Appendix II Cacti	Total
Canada	—	2,188,842	2,188,842
Netherlands	—	316,792	316,792
Germany	—	41,594	41,594
Italy	1,798	23,136	24,934
Thailand	1,694	17,236	18,930
Hong Kong (PRC)	—	10,647	10,647
Japan	—	9,877	9,877
El Salvador	—	6,052	6,052
Dominican Republic	—	5,000	5,000
Denmark	—	4,497	4,497
Other destinations (32)	699	19,338	20,037
All destinations	4,191	2,643,011	2,647,202

Appendix 5
U.S. Imports of Cacti from Mexico (1998)

Taxon	Specimen(s) Imported	Quantity	Source	Chihuahuan Taxon
Cactaceae	Carvings	16	Unknown (seized)	
Cactaceae	Live plants	323	Unknown (seized)	
Cactaceae	Live plants	415	Artificially propagated	
Carnegiea gigantea	Carvings, timber	61,565 (3,500 kg; 2 m3)	Wild	
Carnegiea gigantea	Timber	62	Unknown (seized)	
Cephalocereus senilis	Live plants	4	Unknown (seized)	✔
Cereus spp.	Live plants, stems	43	Unknown (seized)	✔(?)
Coryphantha spp.	Live plants	15	Unknown (seized)	✔(?)
Disocactus	Live plants	3	Unknown (seized)	
Echinocactus horizonthalonius	Live plants	8	Unknown (seized)	✔
Echinocereus spp.	Live plants	34	Unknown (seized)	✔(?)
Echinocereus pectinatus	Live plants	18	Unknown (seized)	✔
Echinocereus rigidissimus	Live plant	1	Unknown (seized)	✔
Echinopsis ssp.	Live plants	16	Unknown (seized)	
Echinopsis chamaecereus	Live plants	3	Unknown (seized)	
Ferocactus spp.	Live plants	11	Unknown (seized)	✔(?)
Ferocactus cylindraceus	Seeds	100	Unknown (seized)	
Gymnocalycium spp.	Live plant	1	Unknown (seized)	
Hylocereus spp.	Live plants	3	Unknown (seized)	
Mammillaria spp.	Live plants	26	Unknown (seized)	✔ (?)
Melocactus spp.	Live plant	1	Unknown (seized)	
Myrtillocactus spp.	Live plant	1	Unknown (seized)	
Myrtillocactus geometrizans	Live plants	3	Unknown (seized)	✔
Opuntia spp.	Live plants	70	Unknown (seized)	✔(?)
Opuntia spp.	Timber	52	Unknown (seized)	✔(?)
Opuntia fulgida	Carvings, timber	8,116	Wild	✔
Opuntia fulgida	Live plants	11	Unknown (seized)	✔
Opuntia imbricate	Live plants	3	Unknown (seized)	✔
Opuntia microdasys	Live plants	5	Unknown (seized)	✔
Pachycereus spp.	Live plants	4	Unknown (seized)	
Pachycereus marginatus	Live plants	8	Unknown (seized)	
Pachycereus pringlei	Live plants	4	Unknown (seized)	
Pygmaeocereus ssp.	Live plant	1	Unknown (seized)	
Schlumbergera ssp.	Live plant	1	Unknown (seized)	
Stenocactus spp.	Live plants	6	Unknown (seized)	
Stenocactus gummosus	Carvings	5 kg	Wild	
Stenocactus thurberi	Live plants	7	Unknown (seized)	
Stenocactus thurberi	Timber	6	Unknown (seized)	

Key: ✔= taxon occurs in Chihuahuan Desert; ✔ (?) = taxon's occurrence in Chihuahuan Desert not known.

Appendix 6
Distribution and Ownership of Land in Graham County, Arizona

Tenure Type	Acres	Percent of Total
Indian reservation	1,096,384	37
BLM	740,800	25
State lands	533,376	18
USFS (national forests)	385,216	13
Private lands	207,424	7
Total	**2,963,200**	**100**

Source: County Assessor's Office.

Appendix 7
Distribution and Ownership of Land in Cochise County, Arizona

Tenure Type	Acres	Percent of Total
Private lands	1,591,040	40
State lands	1,376,250	35
BLM/USFS	883,027	22
Other public lands	127,283	3
Total	**3,977,600**	**100**

Source: Arizona Department of Commerce.

Appendix 8
Distribution and Ownership of Land in Chaves County, New Mexico

Tenure Type	Acres	Percent of Total
Federal	1,203,729	31
State	1,023,069	26
Private	1,672,002	43
Total	**3,898,800**	**100**

Source: New Mexico State Land Office.

Appendix 9
Distribution and Ownership of Land in Dona Ana County, New Mexico

Tenure Type	Acres	Percent of Total
Public	2,141,789	47
State	332,762	7
Federal	1,780,128	39
New Mexico State University	12,614	<1
Other	16,285	<1
Private	292,771	6
Total	**4,576,349**	**100**

Source: County Assessor's Office.

Appendix 10
Distribution and Ownership of Land in Eddy County, New Mexico

Tenure Type	Acres	Percent of Total
Federal	1,627,826	60
State	577,225	20
Private	452,304	17
County	88,064	3
Total	**2,675,200**	**100**

Source: County Assessor's Office.

Appendix 11
Distribution and Ownership of Land in Grant County, New Mexico

Tenure Type	Acres	Percent of Total
Private	878,238	35
State	367,685	15
BLM	385,575	15
USFS (national forests)	884,383	35
Total	**2,515,881**	**100**

Source: Southwestern Land Sales.

Appendix 12
Distribution and Ownership of Land in Hidalgo County, New Mexico

Tenure Type	Acres	Percent of Total
Private	957,970	42
BLM	882,679	39
State	354,431	16
USFS (national forests)	77,220	3
Indian reservation	11,000	<1
Total	**2,283,300**	**100**

Source: County Assessor's Office.

Appendix 13
Land Tenure in Luna County, New Mexico

Tenure Type	Acres	Percent of Total
Federal	1,627,826	60
State	577,225	20
Private	452,304	17
County	88,064	3
Total	**2,745,419**	**100**

Source: County Assessor's Office.

Appendix 14
Land Tenure in Otero County, New Mexico

Tenure Type	Acres	Percent of Total
BLM	1,125,422	26
Military	889,229	21
Private	546,114	13
State	543,012	13
USFS (national forests)	544,129	13
Indian reservation	460,167	11
DOI (national monuments)	140,247	3
Total	**4,248,320**	**100**

Source: County Assessor's Office.

Appendix 15
Distribution and Ownership of Land in Sierra County, New Mexico

Tenure Type	Acres	Percent of Total
BLM	822,175	32
USFS (national forests)	378,665	15
Department of Defense	405,506	16
State	360,175	14
Private	462,535	18
Other miscellaneous	134,688	5
Total	**2,562,744**	**100**

Source: County Assessor's Office.

Part II

Chihuahuan Desert Cacti in Mexico:

An Assessment of Trade, Management, and Conservation Priorities

by
Rolando Tenoch Bárcenas Luna

PART II CONTENTS

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Executive Summary

The Chihuahuan Desert Ecoregion (CDE) has been identified as one of the most diverse and threatened arid regions in the world (Ricketts et al. 1999). Its designation by World Wildlife Fund (WWF) as one of 200 globally outstanding ecoregions of the world provides the basis for future conservation studies and monitoring strategies to protect its unique biodiversity, including cacti.

TRAFFIC North America, on behalf of WWF–US, reviewed the trade and management of cacti native to the Chihuahuan Desert in Mexico and the United States in an effort to identify species and localities for conservation attention. TRAFFIC's study reveals a thriving international market for and continuing illegal trade in cactus species native to the Chihuahuan Desert of Mexico. This report summarizes those findings and makes recommendations for reducing the pressure of cactus collection on wild populations in areas of the Chihuahuan Desert that are especially important for the conservation of exploited, rare, or protected species.

Greater percentages of rare and highly restricted cacti are found in the Chihuahuan Desert than in any other desert in the Americas, with as many as 35 species confined to areas no larger than 2,500 square kilometers in the CDE in Mexico (Hernández and Bárcenas 1995, 1996). Mexico, home to more cacti species than any other country in the Americas, covers about 80 percent of the Chihuahuan Desert, with Arizona, New Mexico, and Texas making up the remaining 20 percent of the desert's total area (Bravo Hollis 1978; Bravo Hollis and Sánchez Mejorada 1992a, 1992b; Hunt 1999; Hernández and Godínez 1994; Hernández and Bárcenas 1995, 1996).

Mexico's cactus diversity attracts the interest of international markets and collectors who employ illegal tactics to obtain wild-collected specimens of desirable species, some of which may be newly named to science, rare, or threatened with extinction. Even though collecting wild plants in Mexico for the sole purpose of resale or export is strictly prohibited, cactus specimens, such as seeds and live plants, are the target of unscrupulous collectors, uninformed tourists, and impoverished villagers. Additional threats such as habitat loss and grazing exist for many species, especially those whose wild populations are limited to only a few locations.

A survey of nurseries in more than 100 Mexican establishments in 13 states reveals 94 cactus species native or endemic to the Chihuahuan Desert in domestic trade, with three genera (*Mammillaria*, *Turbinicarpus*, and *Ferocactus*) accounting for 53 percent of the total species traded. Approximately 300 cactus species native to the Chihuahuan Desert of Mexico were also documented in the international marketplace, with the maximum number of species offered in the United States, the United Kingdom, Germany, and Sweden. More than half of the species documented in international trade are listed in CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora) Appendix I and, therefore, cannot be commercially traded unless artificially propagated; are included in the list of threatened species recognized by the World Conservation Union (IUCN); or receive special status under Mexican law.

Regrettably, many of the species now commercially available as artificially propagated plants in foreign markets are descendants of seeds or live plants that were illegally exported from Mexico by private collectors. Illegal trade continues to threaten many cactus species of limited distribution and of conservation concern in the Chihuahuan Desert in Mexico, as is evident from the number of seizures involving several endemic taxa: *Astrophytum myrisotigma*, *Ariocarpus retusus*, *Aztekium hintonii*, *Cephalocereus senilis*, *Geohintonia mexicana*, and *Lophophora williamsii*.

The illegal trade in cactus species of the Chihuahuan Desert is a symptom of a combination of problems, including a lack of nurseries propagating rare species to meet international demand, confusing and often contradictory Mexican laws posing a barrier to establishing commercial plant breeding

operations, and insufficient outreach efforts to rural villages to communicate the economic benefits of sustainable cactus harvest. Stronger enforcement of existing Mexican laws is also needed to deter individuals, particularly foreign private collectors, from collecting and bringing into their countries protected cactus plants. These issues require a multifaceted approach, ranging from investing in commercial propagation to improving monitoring and law enforcement. Unless these issues are addressed, they will continue to undermine the conservation of Mexico's outstanding, yet dwindling cactus populations.

Introduction and Background

The Cactaceae family is native to the American continent, and the greatest diversity of species is distributed in arid and semiarid regions. Cacti are also distributed, however, in damper regions, such as pine-oak forests, deciduous and evergreen tropical forests, and cloud forests. Two main centers of cactus diversity are recognized in the American continent. The first ranges from the north-central region of Mexico to the southwestern United States, which is the general boundary of the Chihuahuan Desert Ecoregion (CDE), as defined by World Wildlife Fund (WWF). The other, located in South America in the arid and semiarid zone of the southwestern Andean region, includes parts of Peru, Chile, and Argentina. Other regions known for a high diversity of cacti are eastern Brazil and the region of Central America that includes a part of southeastern Mexico, where a significant group of humid-zone epiphytic species are distributed (Barthlott and Hunt 1993; Hernández and Godínez 1994; Hernández and Bárcenas 1995, 1996; Rzedowski 1978).

The highest concentration of cacti in the world is found in Mexico, which is home to approximately 684 species known to science (Hunt 1999). Within the country, two regions are recognized as being particularly rich in species and with high degrees of endemism: the southeastern and eastern regions of the CDE, and the Queretaroan-Hidalgoan Arid Zone (QHAZ). Those arid and semiarid regions of north-central Mexico also possess the world's highest concentrations of threatened cacti (Hernández and Bárcenas 1995, 1996). Other important centers of high cacti diversity also exist in Mexico, such as the Sonoran Desert (Turner et al. 1995), the Tehuacán-Cuicatlán Valley (Arias et al. 1997), and the Balsas River Basin by the Tehuantepec Isthmus (Torres et al. 1997).

The CDE is the largest arid region in North America, although its geographic boundaries are imprecise, particularly concerning its northern and southern limits (Shreve 1942; Contreras 1955; Henrickson and Straw 1976; Johnston 1977; Morafka 1977; Schmidt 1979, 1990; Medellín-Leal 1982; Instituto Nacional de Ecología and SEMARNAP 1996). However, for the purposes of this study, the CDE is delineated by an irregular and discontinuous polygon extending across the center of Mexico in a northwesterly direction from lat. 20° N and long. 98° W to lat. 34° N and long. 107° W in the United States. Approximately 80 percent of the CDE is in Mexico, whereas between 15 and 20 percent of the CDE's total area extends into southeastern Arizona and the Rio Grande and Pecos river basins in New Mexico and Texas to the east.

In Mexico, the CDE is located between the mountainous massifs of the western and eastern Sierra Madre ranges. Two important xerophytic regions that are within the Mexican portion of the CDE are the Jaumave Valley and the QHAZ. The Jaumave Valley in Tamaulipas is important for its considerable concentration of endemic species such as *Obregonia denegrii* and *Turbinicarpus gielsdorfianus*, among others. The QHAZ is located in the arid regions of Guanajuato, Querétaro, and Hidalgo. It is inhabited by cactus species that occur nowhere else in the CDE and includes such species as *Cephalocereus senilis*, *Lophophora diffusa*, *Strombocactus disciformis*, and *Turbinicarpus pseudomacrochele*.

The Cactaceae family possesses unique physical attributes that help cactus plants survive in climatically harsh environments. Despite having evolved adaptations beneficial to tolerating arid climates, cacti are among the most threatened group of plants in the world (Hernández and Bárcenas 1996). For instance, approximately 35 percent of the species (197 species) native to Mexico are threatened; no fewer than 115 of these native Mexican cacti are known to occur naturally within or adjacent to the CDE (Hernández and Godínez 1994; Hernández and Bárcenas 1996). High levels of endemism, long life cycles, and low recruitment rates are among the ecological and biological characteristics of cacti that increase their vulnerability to natural disturbances such as climatic changes and to man-made problems such as livestock grazing that results in habitat loss. Commercial collection may not destroy as many wild plants as development or livestock grazing, but its intensity has serious

implications for the conservation of species whose populations are already extremely restricted or threatened by other factors.

The main objectives of TRAFFIC North America's review of trade and management of cactus of the Chihuahuan Desert of Mexico were to identify CDE cactus taxa in Mexico's domestic and international trade and to prioritize monitoring and conservation efforts in geographic areas within the CDE that harbor those species. TRAFFIC gathered information by visiting domestic markets and local nurseries; analyzing trade data and government seizures; developing indices to rate the availability, frequency, and popularity of species in trade; and cross-referencing taxa in trade with their distribution within the CDE to identify areas of high diversity and importance for conservation attention. A more detailed methodology and explanation of TRAFFIC's study of CDE cactus trade is provided in the next section.

Methods and Sources of Information

The following sources of information were consulted and reviewed for this analysis during the period December 1999 to September 2000: the Internet (price lists, catalogues); newspapers (classifieds); surveys of local markets and nurseries in Mexico, which included interviews with nursery owners and vendors; and government statistics on cactus seizures in Mexico and abroad. Information about the identity, availability, price, size, and location of cacti documented in local, domestic, and international trade were put in a database, which is organized into a commercial and taxonomic grouping and is further divided into 22 fields. The genus, species, variety, and common names of taxa identified in trade were recorded in the database, as were trade-related data on size, price, source (wild or cultivated), type (live plant or seeds), and quantity of specimens offered, as well as any observations that might help determine whether cactus specimens were collected in the wild or artificially propagated.

The Internet proved a valuable source of market information for this study. An exhaustive Internet search using different combinations of 41 key words (for example, *cacti* and *sale*, *cactus* and *venta*, *cacti* and *propagation*, *nursery* and *cacti* and *trade*) in Spanish and English identified 3,743 initial sites of relevance to the study. Of those sites, 400 were screened for their utility to the project, as defined by the availability of CDE taxa. Not every Internet site identified in this manner provided information relevant to the project. Some sites advertised species that do not occur naturally within the CDE and, therefore, fell outside the scope of this study. Relevant information obtained from 60 Web sites and hard copy catalogues was entered into a database, producing 6,112 records, of which 5,772 were used to identify CDE taxa marketed worldwide. An additional 221 records reflected market information compiled from visits to nurseries and retail outlets in Mexico. The remaining 119 records were irrelevant and not used in the market analysis but were maintained in the database for future reference.

Field visits to nurseries in Mexico and the southwestern United States, a large market for cacti from the CDE, complemented market information compiled from the Internet. TRAFFIC visited 104 nurseries in 31 cities within and bordering the CDE. Sixteen additional cities located outside of the CDE were also visited upon TRAFFIC's learning from interviews with nurseries that these cities may be commercial outlets for CDE cacti (table 1). TRAFFIC consulted the directory of the National Ecology Institute (Instituto Nacional de Ecología—INE) for a list of legally registered nurseries and identified 96 establishments offering cacti (figure 1). TRAFFIC inventoried the nursery stock at many registered and unregistered establishments, including growers and street vendors. Information from vendors on species identities, availability, price, production and propagation methods, and business practices was elicited through in-person surveys (appendix 1). TRAFFIC's investigator observed the appearance of plants offered for sale in an effort to determine whether they originated from the wild or were grown from artificially propagated stock. For instance, the condition of the plant's epidermic tissue and root system was used to verify the source of the plant; damaged plants were indicative of wild origin owing to exposure to insects, livestock, and outdoor climate (for example, frost or lack of hydration).

The Federal Attorney General for Environmental Protection (Procuraduría Federal de Protección al Ambiente—PROFEPA), the government agency in Mexico that enforces wildlife laws, provided data on cactus seizures for the period 1996 to 2000. Additional information on illegal trade in Mexican cacti was compiled from reports in newspapers, magazines, and other publications.

Unclear taxonomy was a limiting factor in identifying and analyzing taxa documented in trade. In general, Cactaceae taxonomy is complex and fluid because of the size of the family and the range of interpretations and treatments used by taxonomists and private collectors. The inconsistency of taxonomic treatments stems from the lack of sufficient herbarium specimens upon which to describe and name taxa and the inherent natural

Table 1. Mexican States and Cities Visited by TRAFFIC for Cactus Market Research

State	City	Nurseries or Vendors Visited
Aguascalientes	Aguascalientes	6
Baja California	Cabo San Lucas	1
	Ciudad Constitución	0
	La Paz	3
	San José del Cabo	5
Chihuahua	Chihuahua City	7
	Ciudad Delicias	1
	Ciudad Camargo	1
	Ciudad Jiménez	0
	Ciudad Juárez	6
	Ojinaga	1
Coahuila	Saltillo	4
	Torreón	3
Distrito Federal	México D.F.	5
Guanajuato	Dolores Hidalgo	1
	San Felipe	1
	San Miguel Allende	8
Jalisco	Ajijic	2
	Guadalajara	7
Morelos	Cuernavaca	3
	Tepoztlán	2
Nuevo León	Monterrey	11
Puebla	Cholula	3
	Puebla City	4
	Teziutlán	4
Querétaro	Cadereyta	1
	Juriquilla	1
	Querétaro City	1
	Tequisquiapan	2
San Luis Potosí	San Luis Potosí City	4
Tamaulipas	Ciudad Victoria	6
Total	**31**	**104**

variability in wild specimens (Clover 1952; Baker et al. 1985; Leuenberger 1987; Hernández et al. 1993; Hernández and Godínez 1994). The abundance of invalid and synonymous scientific and trade names, perpetuated by commercial or amateur collectors, poses yet another barrier to the standardization of cactus taxonomy (Gibson et al. 1986). An estimated 50 percent of the 7,000 names referring to some cactus species do not have a nomenclatural type (Hunt 1991). Thus, for the purposes of these analyses, the taxonomic scheme proposed by Hunt (1999) for the CITES Cactaceae checklist was adopted with some modifications. Species names that could not be harmonized with the checklist were omitted from the analyses, with the exception of the analysis of index of collection intensity.

Results and Discussion

Cactus Markets in Mexico

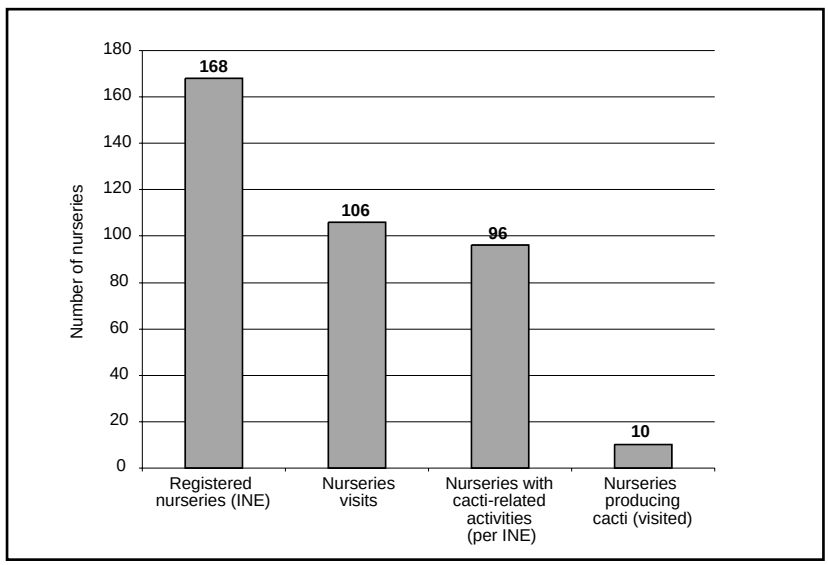
Many nurseries visited by TRAFFIC were not listed in INE's directory, and many of those listed were no longer in operation (figure 1). Some of the reasons reported for the closing of businesses include complex and onerous government licensing procedures and reporting requirements, as well as low profitability and high costs of nursery maintenance. The high number of unregistered nurseries conducting business as compared to the low number of registered growers still in business reflects the fluidity and instability of the cactus-growing industry in Mexico.

Although an exhaustive inventory of CDE cacti available on the Mexican market is impossible, the taxa in trade identified by TRAFFIC demonstrate the diversity of cacti endemic or native to the Chihuahuan Desert that are available for sale. Based mostly on field visits to local nurseries, TRAFFIC's survey of the Mexican market documented 94 species in domestic trade (appendix 2). Some taxa were offered more frequently than others. For instance, the genera *Mammillaria*, *Turbinicarpus*, and *Ferocactus* accounted for 53 percent of the taxa identified on the Mexican market. More than 32 percent of taxa belong to the genus *Mammillaria*, with a lower but significant share of *Turbinicarpus* and *Ferocactus*.

A *Mammillaria* species of interest found in domestic trade is *Mammillaria luethyi*, a species endemic to the state of Coahuila that was only recently described by scientists. Specimens of that species are available only in the form of grafted plants because artificial propagation from seed is difficult. Propagating that species by tissue culture is a more promising method of growing them. It is still under experimentation and could produce enough specimens of a highly prized species to meet domestic and international demand. Several Mexican nurseries are cultivating *M. luethyi* and had arranged to export cultivated plants to the United Kingdom. However, the U.K. authorities were unable to approve the importation of cultivated *M. luethyi* plants from Mexico. Moreover, seeds of *M. luethyi* have apparently been documented for sale in Europe, suggesting that they have been removed from Mexico without valid CITES permits (FitzMaurice and FitzMaurice 2000).

Ferocactus and *Turbinicarpus*, of which eight species were documented in domestic trade,

Figure 1. Number of Cactus Growers and Vendors in Mexico Visited by TRAFFIC



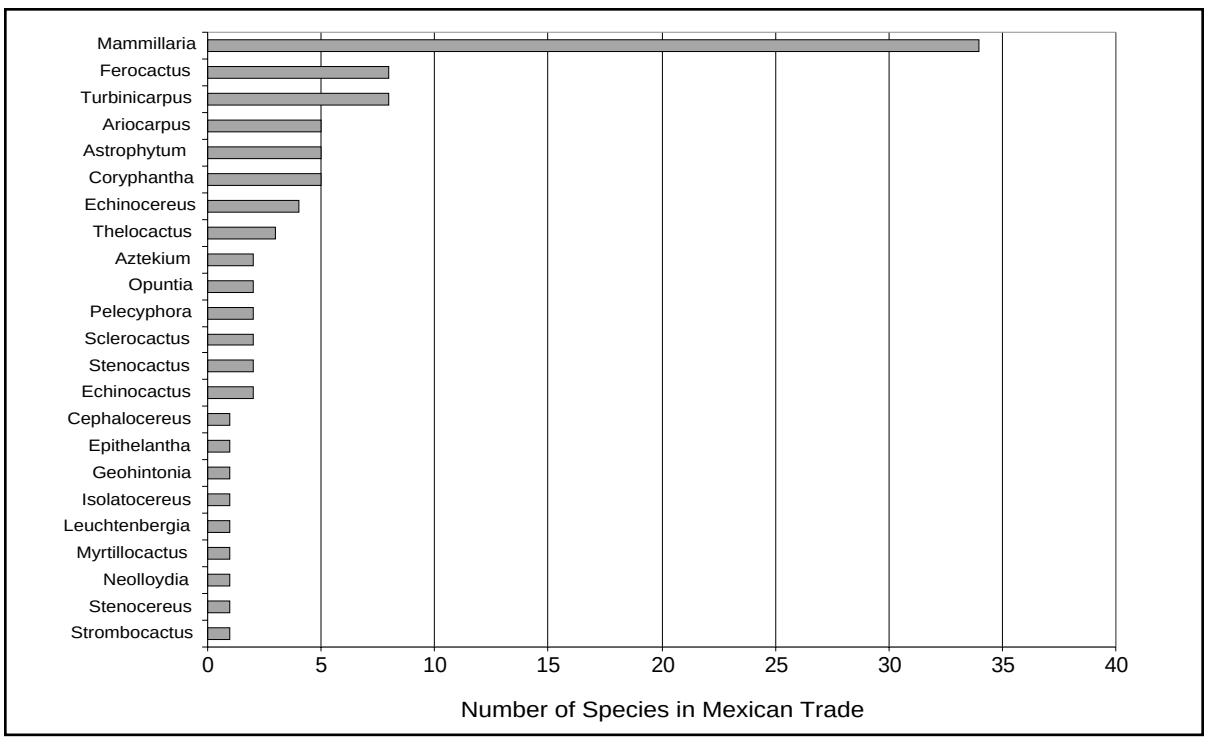
account for 17 percent of the diversity of species in domestic trade (figure 2). Notable among them is *Turbinicarpus alonsoi*, a species endemic to the state of Guanajuato and recently named to science. Wild populations of *T. alonsoi* were purportedly visited on several occasions for the sole purpose of removing live plants (Glass 1997). The severe depletion of wild *T. alonsoi* plants by opportunistic collectors even before the discovery and formal description of the species demonstrates the problems of illegal or opportunistic collection of rare CDE cacti in Mexico. Live plants of this species available outside Mexico either were exported in violation of international (CITES) or Mexican law or are descendants of specimens previously and illegally removed from the country.

Other rare taxa in trade are *Geohintonia mexicana* and *Aztekium hintonii*, both of which are endemic to the state of Nuevo León. Illegal collection of plants and seeds of *G. mexicana* and *A. hintonii* was suspected shortly after their discovery, as foreign nurseries propagated and offered specimens before the species had been described to the general public. The frequency and intensity of visits by illegal collectors prompted residents of Nuevo León to restrict access to visitors in order to prevent further illegal collection (Glass 1997).

International Trade

More than 300 CDE cactus species belonging to 28 genera are commercially available outside Mexico, according to a review of Web-based and printed sales catalogues. The figure of species in international trade is high, considering only 176 species from the CDE are listed in an unpublished checklist, "Flora of the Chihuahuan Desert" by Zimmerman et al. One reason for the discrepancy is that TRAFFIC's market research captured CDE taxa whose distribution includes the QHAZ, a region outside of the delineation of the CDE in the cacti checklist. Moreover, 45 species reported in the checklist were not among those identified in trade, for reasons that are unknown but possibly because of differences in taxonomy used or the lack of commercial demand for some species (table 2). For instance, according to TRAFFIC's research, *Opuntia* species did not appear in trade as frequently as other species, but *Opuntia* account for a significant portion of the cactus

Figure 2. Taxonomic Analysis of CDE Cactus Species in Mexican Trade



diversity in the Chihuahuan Desert. About 39 percent of species traded internationally are among those listed in "Flora of the Chihuahuan Desert." A second reference, prepared by the Chihuahuan Desert Arboretum, identifies 167 cactus species distributed in the CDE. Fifteen species in that checklist were not documented in international trade (table 3).

TRAFFIC encountered many names that could not be verified or did not conform to the standard taxonomic reference (Hunt 1999) used for this study (appendix 4). Although those names may be superfluous, they refer to cactus specimens in international commerce and should be noted in the event the taxonomy can be clarified in the future. In addition, 26 cactus hybrids were retained in the interest of completeness (appendix 4).

Nearly two-thirds (64 percent) of all species in global trade are members of four genera: *Mammillaria, Opuntia, Coryphantha,* and *Echinocereus*. In contrast, only 2 percent of species are represented by seven genera: *Geohintonia, Hamatocactus, Isolatocereus, Leuchtenbergia, Neolloydia, Obregonia,* and *Strombocactus,* which contains a single species (figure 3). The other two genera, *Aztekium* or *Lophophora,* have two species each. The most widely available species were those of the genus *Mammillaria,* of which 93 species, or 28 percent of all cactus species documented, were identified in international trade. About 47 species, or 14 percent of all cactus species on the global market, belong to *Opuntia*. *Coryphantha,* with 37 species, and *Echinocereus,* with 35 species, account for 21 percent of cactus plants marketed

Table 2. Taxa Reported in the Flora of the Chihuahuan Desert Not Found on the International Market

Ariocarpus bravoanus spp. *bravoanus*	*Mammillaria runyonii*
Coryphantha bergeriana	*Mammillaria trichacantha*
Coryphantha exuriata	*Opuntia aggeria*
Coryphantha gracilis	*Opuntia anteojoensis*
Coryphantha robustispina	*Opuntia arenaria*
Echinocereus davisii	*Opuntia azurea*
Echinocereus fendleri	*Opuntia chihuahuensis*
Escobaria asperispina	*Opuntia ellisiana*
Escobaria chaffeyi	*Opuntia ficus-indica*
Escobaria erythrocarpa	*Opuntia moelleri*
Escobaria pottsiana	*Opuntia pailana*
Escobaria varicolor	*Opuntia polyacantha*
Ferocactus wislizeni	*Opuntia streptacantha*
Mammillaria aurihamata	*Opuntia strigil*
Mammillaria brachytrichion	*Opuntia vilis*
Mammillaria conopsea	*Sclerocactus papyracanthus*
Mammillaria erectohamata	*Stenocactus bodeckerianus*
Mammillaria eschauzieri	*Stenocactus violaciflorus*
Mammillaria freudenbergeri	*Thelocactus buekii*
Mammillaria knebeliana	*Toumeya papyracantha*
Mammillaria mercadensis	*Turbinicarpus gautii*
Mammillaria pachycylindrica	*Turbinicarpus mandragora*
Mammillaria parrasensis	

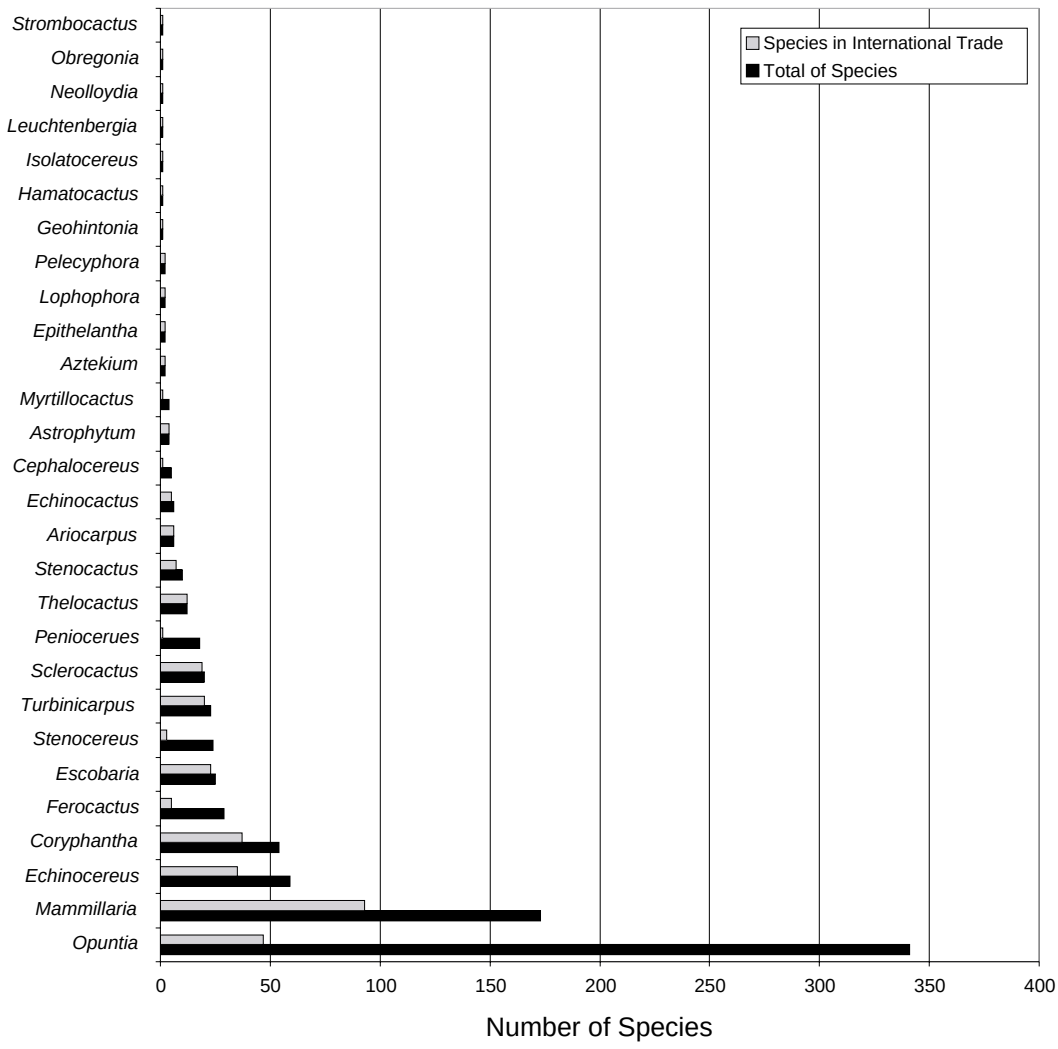
Distribution information based on Zimmerman et al., unpublished.

Table 3. Taxa in the Checklist of the Chihuahuan Desert Arboretum Not Identified in International Trade

Coryphantha bergeriana	*Mammillaria trichacantha*
Echinocereus fendleri	*Opuntia moelleri*
Echinocereus freudenbergeri	*Opuntia polyacantha*
Echinocereus x lloydii	*Opuntia streptacantha*
Echinocereus parryi	*Opuntia strigil*
Ferocactus wislizeni	*Opuntia x spinosibacca*
Mammillaria aurihamata	*Sclerocactus papyracanthus*
Mammillaria mercadensis	

Source: Chihuahuan Desert Arboretum.

Figure 3. Taxonomic Analysis of CDE Cactus Species in International Market



internationally. More than one-third (36 percent) of cactus species offered are distributed among 24 genera.

One measure of the commercial availability and popularity of CDE cacti genera is the ratio of species documented in international trade to the number of species in a particular genus, or the market representation percentage (MRP). The MRP measures the number of species (species diversity) of genera offered in the marketplace, with every species of a genus found in trade having an MRP of 100 percent and no species of a genus offered having an MRP of zero.

Fourteen genera have MRP values of 100 percent, indicating that all species of those genera are available in international commerce; those genera are the most desirable (table 4). Of those genera, 13 are endemic to the CDE, including the QHAZ within the ecoregion. Other genera with a high percentage of species marketed and higher than average MRPs are *Sclerocactus* (95 percent), *Escobaria* (92 percent), *Turbinicarpus* (87 percent), and *Echinocactus* (83.3 percent). Genera with fewer species in the marketplace and lower MRPs include *Ferocactus* (17.2 percent), *Opuntia* (13.8 percent), *Stenocereus* (12.5 percent), and *Peniocereus* (5.6 percent). The lower MRP values for genera such as *Peniocereus* and *Stenocereus* do not necessarily indicate lower interest or demand for species of these genera but may be reflecting that disproportionately fewer species occur naturally in the Chihuahuan Desert.

Table 4. Market Representation Percentages of Cacti Genera in International Trade

Genus	Species in Genus	Species in Trade	MRP
Ariocarpus	6	6	100.0
Astrophytum	4	4	100.0
Aztekium	2	2	100.0
Epithelantha	2	2	100.0
Geohintonia	1	1	100.0
Hamatocactus	1	1	100.0
Isolatocereus	1	1	100.0
Leuchtenbergia	1	1	100.0
Lophophora	2	2	100.0
Neolloydia	1	1	100.0
Obregonia	1	1	100.0
Pelecyphora	2	2	100.0
Strombocactus	1	1	100.0
Thelocactus	12	12	100.0
Sclerocactus	20	19	95.0
Escobaria	25	23	92.0
Turbinicarpus	23	20	87.0
Echinocactus	6	5	83.3
Stenocactus	10	7	70.0
Coryphantha	54	37	68.5
Echinocereus	59	35	59.3
Mammillaria	173	93	53.8
Myrtillocactus	4	1	25.0
Cephalocereus	5	1	20.0
Ferocactus	29	5	17.2
Opuntia	341	47	13.8
Stenocereus	24	3	12.5
Peniocereus	18	1	5.6

Conversely, a relatively high number of species of *Opuntia* are native to the CDE despite *Opuntia's* low MRP, suggesting that species of this genus are not as popular among collectors or horticulturists as species of some of the other genera with higher MRPs.

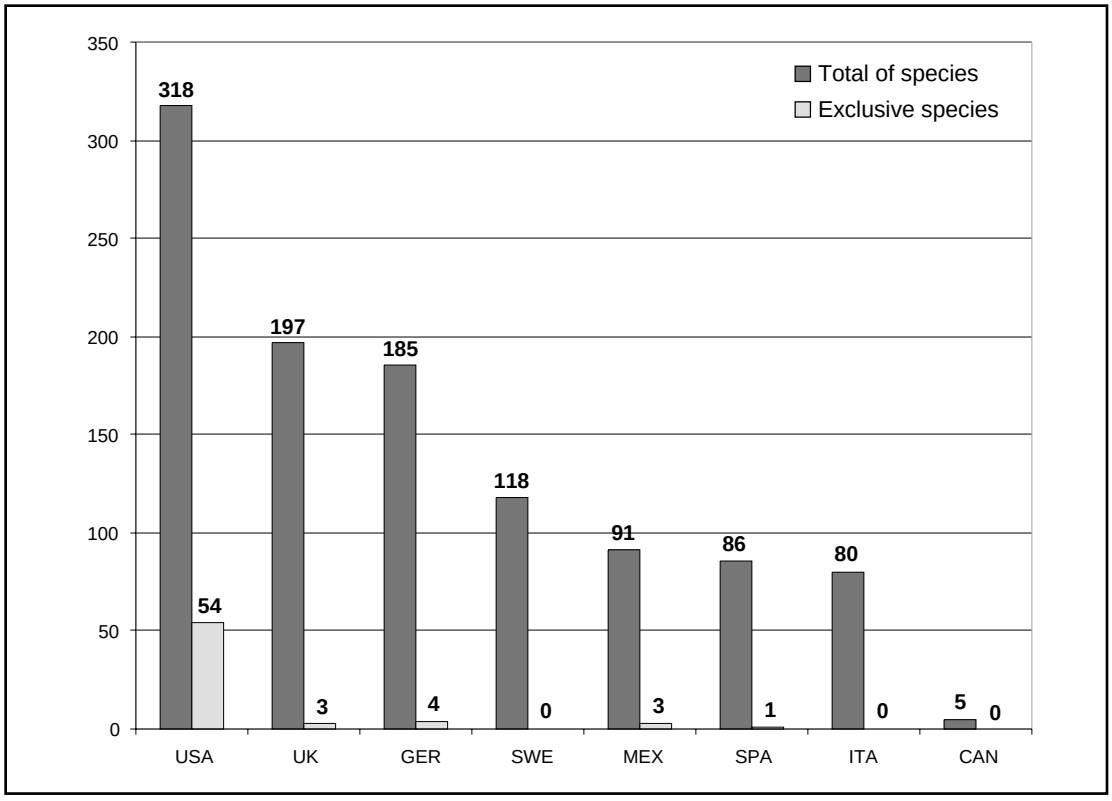
Species Availability by Region and Country

Close to half of the species offered for sale on Web sites and price lists are concentrated in a handful of nurseries distributed throughout North America and Europe. Of CDE species documented in international trade, 96 percent are available in North American markets, primarily in the United States. The number of different species offered commercially is second highest in the United Kingdom, with 197 species documented there. Other notable markets for CDE cacti include Germany (185 species), Sweden (118 species), Spain (86 species), and Italy (80 species) (figure 4). Those five European countries account for 81 percent of the diversity of species marketed worldwide. Interestingly, Asian markets and nurseries, particularly in Japan, which has historically been identified as a destination for Mexican cacti, were not among those advertising species identified in this analysis. The absence of Asian markets reported here may be caused by language restrictions, which would have precluded effective detection of species advertised in Asian languages, rather than by lack of trade.

For comparative purposes, 94 species of CDE cacti were identified on the Mexican market. That figure is low compared with the abundance of species in U.S. and European trade. Fifty-four species, or 17 percent, of CDE cacti offered globally were available exclusively through U.S. vendors. The reasons that a greater proportion of CDE cactus species are available in the United States are unclear but may be attributed to the characteristics of the U.S. market or to the proximity of well-established nurseries in or near the Chihuahuan Desert within the United States.

TRAFFIC assessed the availability of CDE cactus species offered for sale internationally by measuring the general availability of that taxon

Figure 4. Number of CDE Cactus Species Offered for Sale by Country



in international trade weighted by its frequency of occurrence in advertisements and catalogues (for example, how often the species occurred in nurseries or in other outlets in the country) (figure 5). Thus, species availability is determined by the number of countries and nurseries in which a particular taxon is offered (table 5). Regarding the availability of species by country, about 130 species (39 percent) of CDE cacti offered in international trade have low availability, 125 species (38 percent) have medium availability, and another 78 species (23 percent) have high availability (figure 6). In evaluating the availability of species by nursery, TRAFFIC found that a high number of species offered for sale by companies outside Mexico are distributed among only a few vendors (that is, those species have low availability). For instance, 254 CDE cactus species were documented for sale at one to eight nurseries, making the availability of those species low (table 5). However, between 9 and 16 nurseries offered 61 species, which, therefore, had medium availability, and a larger number of nurseries (between 17 and 28) advertised 18 species, making those species highly available.

The availability of CDE cacti based on the number of country or nursery occurrences indicates that availability is high for a limited number of CDE cactus species, whereas

Figure 5. Frequency Distribution of CDE Cactus Species by Foreign Nursery

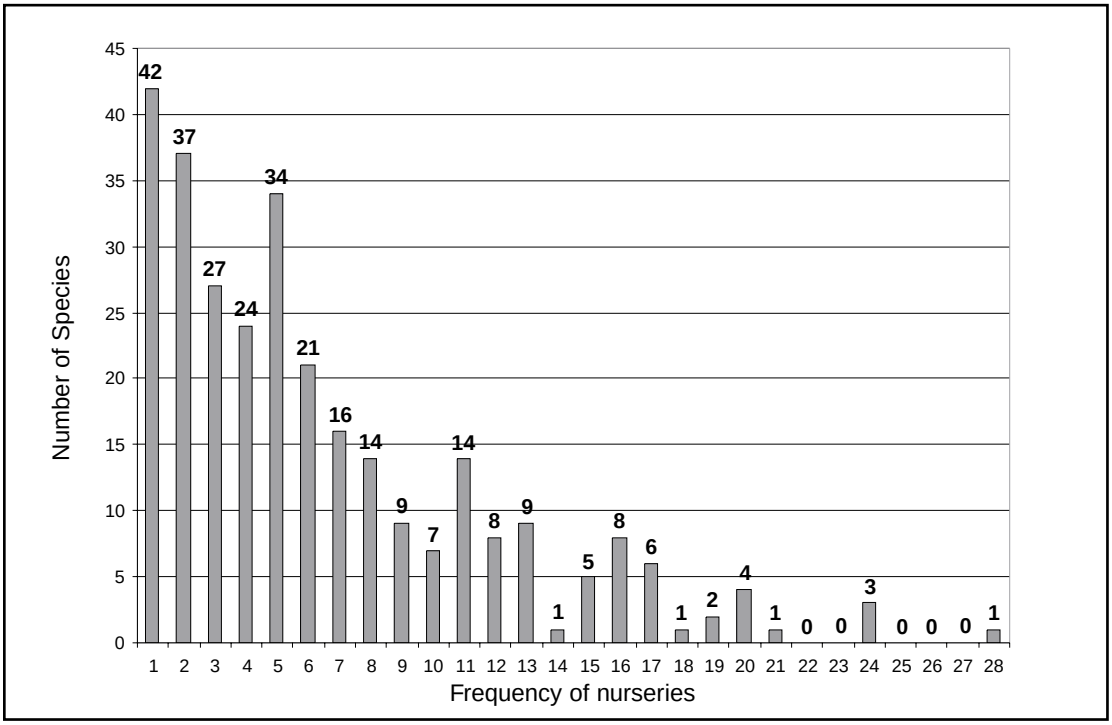


Table 5. Species Availability as Defined by Country and Nursery Frequency

Taxon Availability	Number of Country Occurrences	Number of Nursery Occurrences
Low	1–2	1–8
Medium	3–4	9–16
High	5–7	17–28

availability is low for a larger number of species. The reasons for low availability of so many species marketed are not entirely known, but they may include a highly selective or specialized market for many species without much demand, an emerging market for rare or newly described species that have yet to be propagated for trade, or a combination of those factors.

A proxy was developed for measuring the popularity of specific CDE cactus species in an effort to identify species of the Chihuahuan Desert that might be of greatest interest to collectors and that merit close monitoring by conservation and law enforcement officials. The level of popularity or demand for a particular taxon can be quantified by using the species availability index (SAI). The SAI is the sum of the number of countries in which a taxon is available for sale and the number of nurseries advertising that taxon divided by the total number of countries and nurseries offering that taxon (normalized to a value between 0 and 1) (table 6).

Many species (237) are available only in limited supplies on the international market, possibly because of lower demand (figure 7). Only a fraction (4 percent) of species documented by TRAFFIC is highly available (appendix 3). An example of the former is *Ariocarpus scaphirostris*, whose SAI value is 0.11, indicating that very few specimens of this species are commercially available. In contrast, *Echinocactus grusonii*, a species whose SAI value is 1.00, was widely sold, as evidenced by its availability in seven countries and 28 nurseries.

The popularity of a particular taxon should be evaluated in the context of other information, such as trade restrictions, ease and level of

Figure 6. Category of Availability of CDE Cactus Species by Country and Nursery

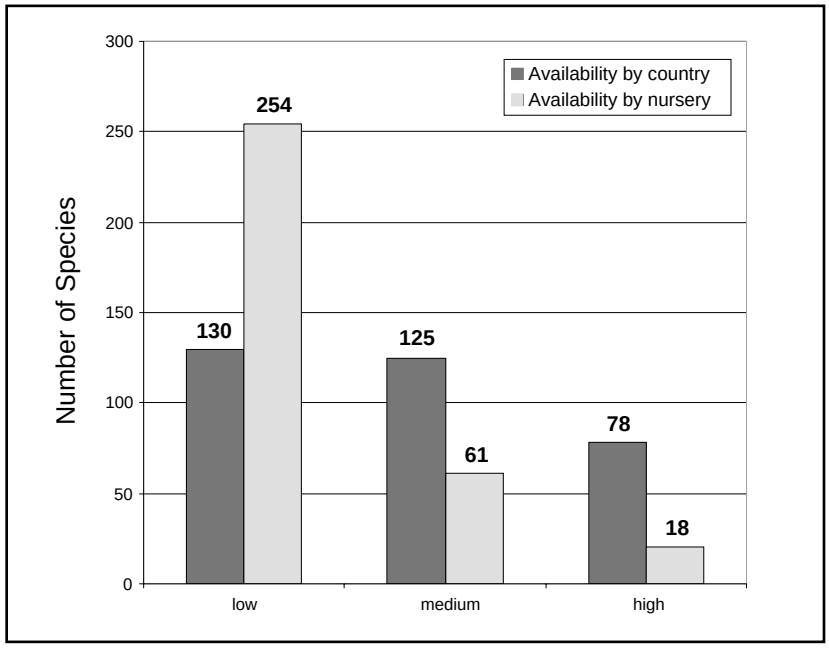
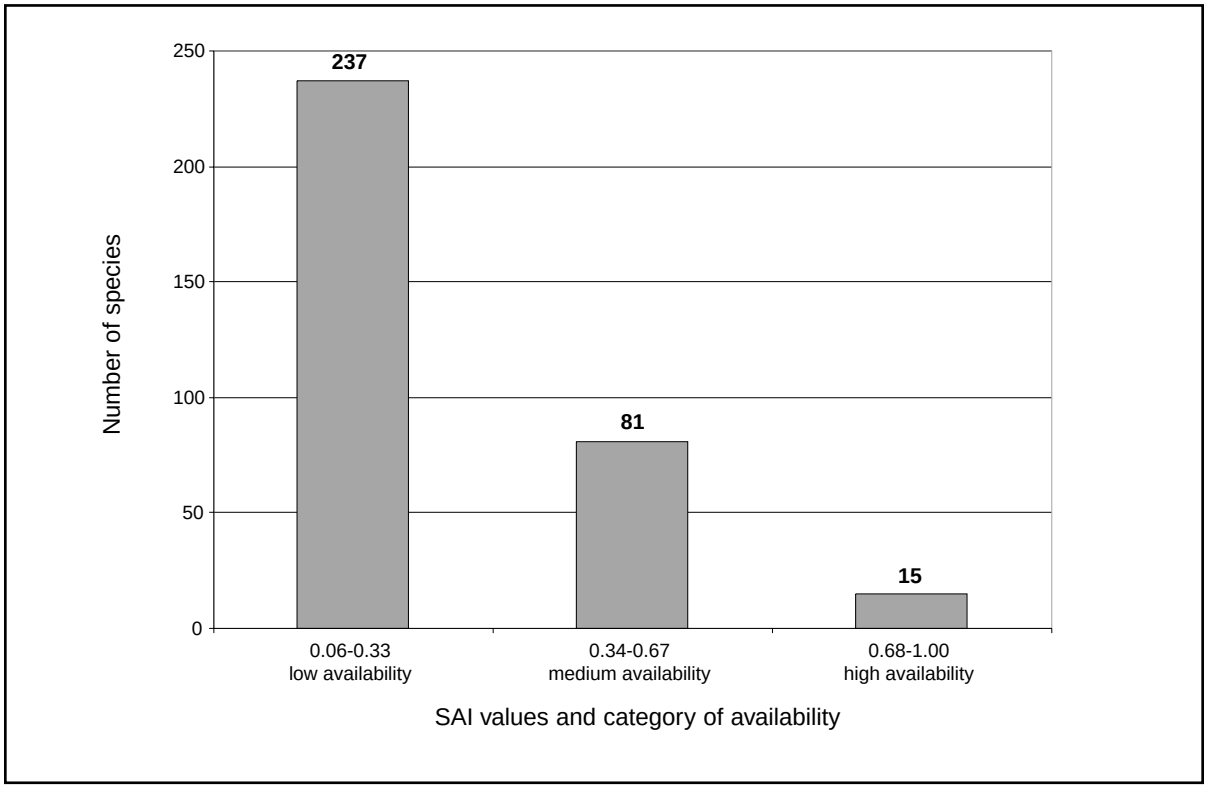


Table 6. Species Availability Index (SAI) Values

SAI	Availability Ranking	# of Species in Availability Ranking
0.06–0.33	Low	237
0.34–0.67	Medium	81
0.68–1.00	High	15

Figure 7. SAI Values and Number of CDE Cactus Species in International Trade



propagation, species distribution, specimen type (plant or seed), price, size, and rarity when assessing the conservation implications of trade for specific species. For instance, 24 CDE species of the Chihuahuan Desert listed in CITES Appendix I and found in trade are among those with the lowest availability (SAI of 0.06 to 0.33), in part because of strict controls prohibiting international trade in wild specimens (table 7). Thus, in the case of Appendix I species, the availability of seeds or plants may be a function of access to a supply of propagated material, of which there may be a paucity for species that are inherently difficult to grow from seed.

Two Appendix I species, *Sclerocactus pubispinus* and *Turbinicarpus rioverdensis*, with SAI values between 0.06 and 0.33, were available to consumers only as seeds. The limited availability of those Appendix I species does not necessarily indicate low demand, but may reflect an undersupply resulting from the prohibition on collecting cactus plants and seeds within Mexico for resale or export. The fact that seeds of *T. rioverdensis* are the only specimens of these species on the global market also raises questions about the location and legality of the initial collection of seeds within Mexico and under what circumstances they became available on the foreign markets. Moreover, the lack of specimens of some species on the market may belie their actual popularity or even contribute to higher demand for such species, as might be the case for newly discovered species for which demand is invariably high but for which a legal and sustainable supply of propagated specimens may not yet exist. Price may be another indicator of species relative demand to supply, although a strong correlation does not appear to exist between price and availability of Appendix I species. Some of the highest prices are associated with species whose availability is neither high nor low, but medium (SAI values of 0.34 to 0.67). *Ariocarpus fissuratus*, a relatively common species in the CDE of Mexico and West Texas whose SAI value is 0.57, was available for as little as US$3 for a

Table 7. SAI Values and Prices of CDE Cactus Species Included in CITES Appendix I

Species	SAI	Plant Size (cm)		Plant Price (US$)		Number of Seeds (per packet)		Price (US$) of Seed Packets[1]	
		Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum
Ariocarpus agavoides	0.69	5.0	8.0	2.50	111.60	5	75	0.86	2.50
Ariocarpus bravoanus ssp. *hintonii*	0.29	1.6	2.5	1.50	11.63	10	100	1.50	12.00
Ariocarpus fissuratus	0.57	1.9	10.2	3.00	125.00	10	500	0.86	12.00
Ariocarpus kotschoubeyanus	0.71	1.0	6.0	4.00	67.50	—	500	0.86	11.00
Ariocarpus retusus	0.63	1.5 1	0.2	4.00	56.00	10	500	0.95	20.00
Ariocarpus scaphirostris	0.11	2.5	3.8	12.50	15.00	—	5	—	2.00
Astrophytum asterias	0.77	1.5	7.6	1.50	27.90	10	100	0.44	4.00
Aztekium hintonii	0.26	2.0	3.0	6.00	17.50	5 50	0.70	5.50	
Aztekium ritteri	0.37	1.0	2.0	5.50	25.00	10	100	0.86	4.00
Coryphantha werdermannii	0.09	—	—	3.00	4.00	25	100	1.00	3.50
Echinocereus schmollii	0.46	1.8	10.0	1.00	12.50	10	500	0.90	6.00
Escobaria minima	0.34	5.0	5.1	3.00	5.00	3	500	0.40	11.00
Escobaria sneedii	0.37	3.2	5.0	3.00	8.50	10	500	0.44	11.00
Obregonia denegrii	0.66	2.0	10.0	3.40	31.00	10	500	0.80	16.00
Pelecyphora aselliformis	0.26	2.5	5.0	4.00	11.70	—	10	—	1.50
Pelecyphora strobiliformis	0.34	1.3	5.0	5.50	37.20	10 75	1.40	10.00	
Sclerocactus brevihamatus	0.23	3.8	17.8	1.90	65.00	10	500	0.45	20.00
Sclerocactus erectocentrus	0.11	—	5.0	—	4.90	25	100	1.25	4.00
Sclerocactus glaucus	0.17	—	—	7.00	10.00	5	500	0.70	20.00
Sclerocactus mariposensis	0.06	—	—	4.50	6.00	10	100	0.80	7.00
Sclerocactus mesae-verdae	0.11	—	—	—	9.00	5	100	1.30	10.00
Sclerocactus pubispinus	0.06	—	—	—	—	10	100	1.25	10.00
Sclerocactus wrightiae	0.06	—	—	—	10.00	10	500	0.45	24.00
Strombocactus disciformis	0.51	1.5	6.0	3.00	68.80	10	500	0.45	3.50
Turbinicarpus alonsoi	0.17	—	—	—	10.00	10 75	0.73	2.10	

[1] Packets contain 5 to 500 seeds.

Table 7. SAI Values and Prices of CDE Cactus Species Included in CITES Appendix I *(continued)*

Species	SAI	Plant Size (cm)		Plant Price (US$)		Number of Seeds (per packet)		Price (US$) of Seed Packets[1]	
		Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum
Turbinicarpus beguinii	0.29	1.0	6.0	2.50	23.30	15	500	0.44	5.00
Turbinicarpus bonatzii	0.14	—	—	—	2.50	10	75	0.73	2.10
Turbinicarpus gielsdorfianus	0.46	2.0	6.0	2.40	11.60	15	100	0.44	1.95
Turbinicarpus hoferi	0.14	—	1.0	—	5.00	10	500	1.00	20.00
Turbinicarpus horripilus	0.40	3.8	5.0	3.00	5.50	15	100	0.44	2.20
Turbinicarpus jauernigii	0.20	1.5	4.5	5.50	8.30	10	75	0.70	2.05
Turbinicarpus knuthianus	0.26	3.0	7.6	1.25	8.95	15	100	0.44	1.60
Turbinicarpus laui	0.31	4.0	6.0	9.30	14.00	10	100	0.73	4.40
Turbinicarpus lophophoroides	0.49	4.0	5.0	1.90	12.50	10	500	0.64	20.00
Turbinicarpus pseudomacrochele	0.51	2.0	7.6	3.00	9.30	10	500	0.60	7.00
Turbinicarpus pseudopectinatus	0.49	1.0	4.0	1.50	16.30	10	500	0.73	8.00
Turbinicarpus rioverdensis	0.06	—	—	—	—	10	75	0.73	2.10
Turbinicarpus saueri	0.20	—	10.0	—	56.00	15	100	0.73	3.00
Turbinicarpus schmiedickeanus	0.69	1.9	7.6	1.40	18.00	10	500	0.50	8.00
Turbinicarpus subterraneus	0.26	2.5	6.0	5.50	18.60	10	500	0.80	11.00
Turbinicarpus swobodae	0.37	2.0	3.0	3.00	6.00	10	500	0.73	20.00
Turbinicarpus valdezianus	0.66	1.3	7.6	2.50	17.30	10	100	0.73	7.00
Turbinicarpus viereckii	0.26	3.8	5.0	3.00	5.00	15	500	0.44	6.00
Turbinicarpus ysabelae	0.31	2.5	5.0	1.90	14.00	10	25	1.50	1.50

[1] Packets contain 5 to 500 seeds.

Source: Web sites, mail-order catalogues, nursery visits.

2 cm plant and for as much as US$125 for a 10 cm plant.

Four CDE cactus species included in Appendix I have an SAI value of 0.68 to 1.00, indicating a high availability of specimens on the open market. *Astrophytum asterias*, with an SAI value of 0.77, was the most frequently encountered Appendix I CDE species in TRAFFIC's survey. Although easily propagated commercially and available in a range of sizes, the species continues to be threatened by collection and habitat destruction, with an estimated 2,000 plants thought to remain in the wild (NatureServe Explorer 2001).

Conservation Status

The conservation status of CDE cactus species found in trade (appendix 3) was evaluated using two international and one Mexican reference: World Conservation Union (IUCN) Red List of Threatened Plants (Walter and Gillet 1998), Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), and the Norma Oficial Mexicana (SEDESOL 1994) listing threatened plants and animals (NOM-059-ECOL-1994).

IUCN's Red List of Threatened Plants determines the degree of a taxon's endangerment on the basis of several biological and ecological criteria, with population size and geographic range of species considered key determinants. The conservation status categories used in this analysis were developed by IUCN before 1994. However, since then new but similar definitions for assessing threat levels were developed and adopted. Species in the IUCN Red List are undergoing revaluation to determine what changes in conservation status are needed to reflect the new criteria and latest level of threat to wild populations.

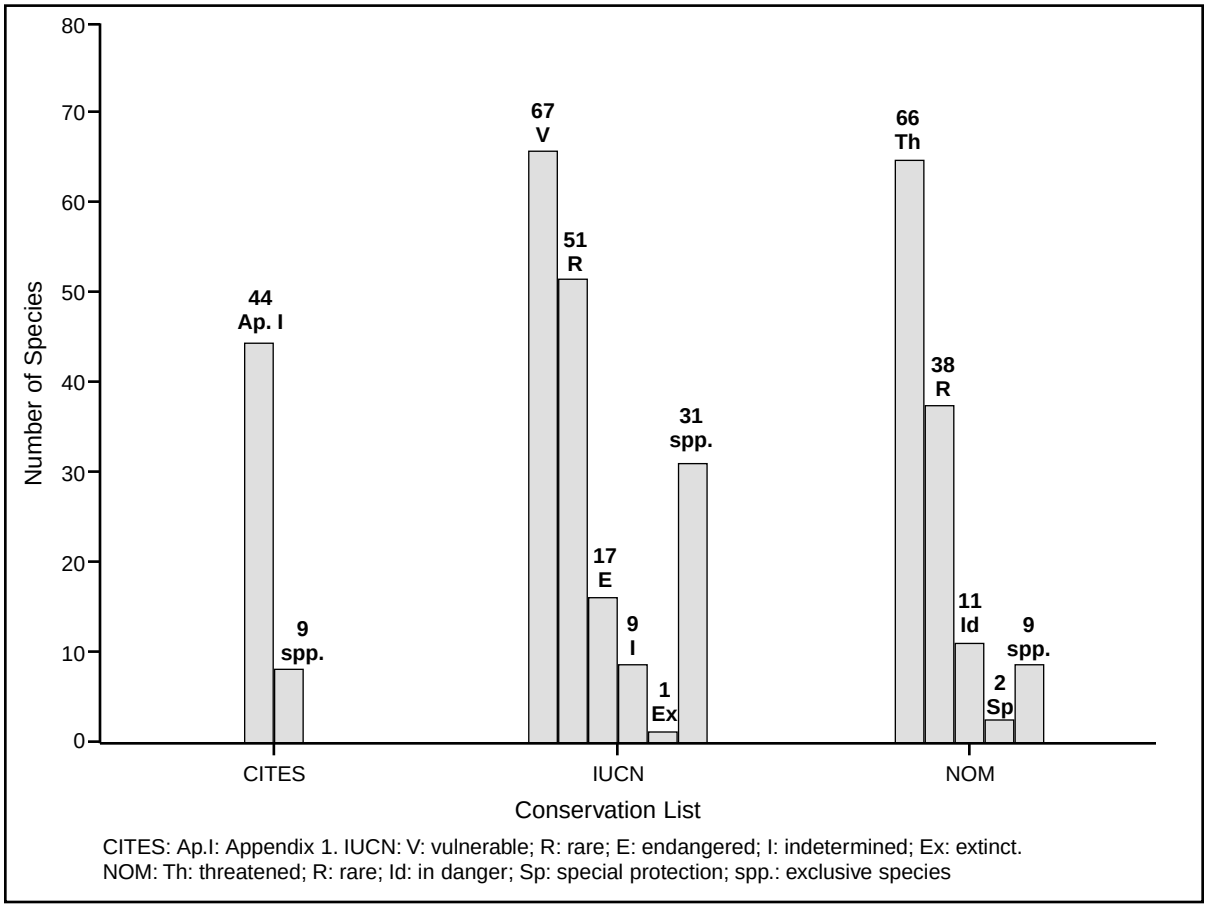
CITES regulates international trade in species that are or could become threatened if this trade is not controlled. Species are listed in Appendix I or II usually by majority vote at the Conference of the Parties or can be unilaterally listed in Appendix III by a CITES party wishing to control exports of a native species. Appendix I is the most restrictive, prohibiting commercial trade in plant species unless specimens of those species are produced from artificially propagated stock. Specimens of species listed in Appendix II that are obtained from the wild or artificially propagated may be traded commercially, provided that all government procedures are followed and all export permits are issued. All Cactaceae are listed in Appendix II, with the exception of more than 100 taxa listed in Appendix I.

Numerous federal laws and regulations in Mexico have been established to protect fragile native wild fauna and flora, including Mexican cacti, from exploitation and trade. NOM-059-ECOL 1994 regulates the harvest and trade in species protected by the Mexican government. Those species are classified into different threat categories according to their level of endangerment and cannot be exploited without prior written consent from the appropriate federal agency. In March 2002, NOM-059-ECOL 2001 entered into force and replaced NOM-059-ECOL 1994, resulting in changes in the definition of threat categories and the removal or inclusion of some species in the NOM. Appendix 5 has additional information on Mexican legislation and regulations concerning cactus harvest, trade, and management.

TRAFFIC identified 170 CDE cactus species, or 51 percent of the total number of species marketed, in the IUCN, CITES, and NOM lists of threatened or protected species. According to IUCN, 136 CDE cactus species are extinct (1), endangered (17), rare (51), or vulnerable (67), and an additional 9 species are of indeterminate status. CITES Appendix I includes 44 species native or endemic to the Chihuahuan Desert of Mexico. The Mexican government has classified 146 species as in danger (14), threatened (96), or rare (36) (figure 8). The distribution of markets for threatened, rare, or protected cacti of the Chihuahuan Desert is similar to the general pattern of species availability; the United States is the largest market for cacti listed in CITES Appendix I, the IUCN Red List, and Mexico's list of protected plants and animals, followed by the United Kingdom, Germany, and Sweden (figure 9).

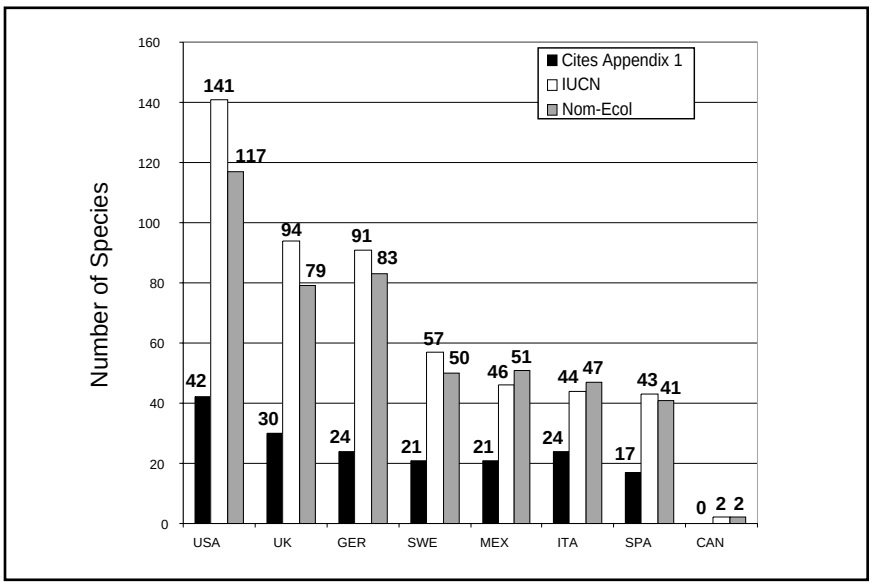
The IUCN, CITES, and NOM lists each contain species that are exclusive to that list (table 8). For instance, nine species listed in CITES Appendix I are neither in the IUCN

Figure 8. Conservation Status of CDE Cactus Species in International Trade



CITES: Ap.I: Appendix 1. IUCN: V: vulnerable; R: rare; E: endangered; I: indetermined; Ex: extinct.
NOM: Th: threatened; R: rare; Id: in danger; Sp: special protection; spp.: exclusive species

Figure 9. Distribution by Country of CDE Cactus Species with Conservation Status



Red List of Threatened Species nor in Mexico's NOM list of protected species. The inclusion of a species in one list and not in another may be partly because of the different criteria used by IUCN, CITES, and the Mexican government to prioritize or designate taxa for protection or a reflection of generic level listings. The disparities in listed species among IUCN's Red List, CITES Appendices, and the NOM lists may also reflect the need to update and harmonize the lists by adding newly described, rediscovered, or increasingly rare species or by removing species of decreasing conservation concern. In particular, two rare cactus species endemic to Mexico, *Aztekium hintonii* and *Geohintonia mexicana*, are protected by that country and listed in CITES Appendix II. Although Mexican law prohibits collection of both species, demand for them has led to the illegal collection and export of wild specimens, undercutting Mexico's efforts to produce a local supply of propagated plants and seeds for international markets. Between 1996 and 2000, Mexican and foreign officials seized more than 200 specimens of *A. hintonii* and *G. mexicana*.

Table 8. Species of Conservation Concern Included in Only One of the Following Lists in CITES, IUCN, or NOM

Species	CITES	IUCN	NOM
Ariocarpus retusus	1	—	—
Aztekium hintonii	—	—	R
Coryphantha longicornis	—	I	—
Coryphantha maiz-tablasensis	—	—	—
Coryphantha radians	—	R	—
Echinocereus chisoensis	—	V	—
Echinocereus coccineus	—-	V	—
Echinocactus horizonthalonius	—	V	—
Echinocereus nicholii	—	V	—
Echinocereus pamanesiorum	—	I	—
Echinocereus papillosus	—	R	—
Echinocereus rayonesensis	—	R	—
Echinocereus poselgeri	—	—	Id
Echinocereus triglochidiatus	—	I	—
Echinocereus viereckii	—	V	—
Echinocereus viridiflorus	—	E	—
Escobaria albicolumnaria	—	V	—
Escobaria cubensis	—	E	—
Escobaria dasyacantha	—	I	—
Escobaria guadalupensis	—	E	—
Escobaria orcuttii	—	R	—
Escobaria organensis	—	V	—
Escobaria robbinsorum	—	E	—
Escobaria sandbergii	—	V	—
Escobaria villardii	—	V	—
Escobaria vivipara	—	—	R
Geohintonia mexicana	—	—	R
Hamatocactus crassihamatus	—	—	Th
Lophophora williamsii	—	—	Sp
Mammillaria glassii	—	—	R
Mammillaria longimamma	—	—	Th

Table 8. Species of Conservation Concern Included in Only One of the Following Lists in CITES, IUCN, or NOM *(continued)*

Species	CITES	IUCN	NOM
Mammillaria wrightii	—	R	—
Opuntia aureispina	—	E	—
Opuntia chaffeyi	—	R	—
Opuntia clavata	—	R	—
Opuntia linguiformis	—	Ex	—
Opuntia microdasys var. *albispina*	—	R	—
Opuntia santa-rita	—	V	—
Sclerocactus brevihamatus	1	—	—
Sclerocactus intertextus	—	—	Th
Sclerocactus parviflorus	—	R	—
Sclerocactus pubispinus	1	—	—
Sclerocactus spinosior	—	V	—
Sclerocactus uncinatus	—	—	Th
Sclerocactus warnockii	—	—	Th
Thelocactus conothelos	—	V	—
Turbinicarpus alonsoi	1	—	—
Turbinicarpus beguinii	1	—	—
Turbinicarpus bonatzii	1	—	—
Turbinicarpus horripilus	1	—	—
Turbinicarpus jauernigii	1	—	—
Turbinicarpus rioverdensis	1	—	—

Source: CITES Appendices; IUCN Red List of Threatened Plants; and Mexican government (NOM-059-ECOL-1994).

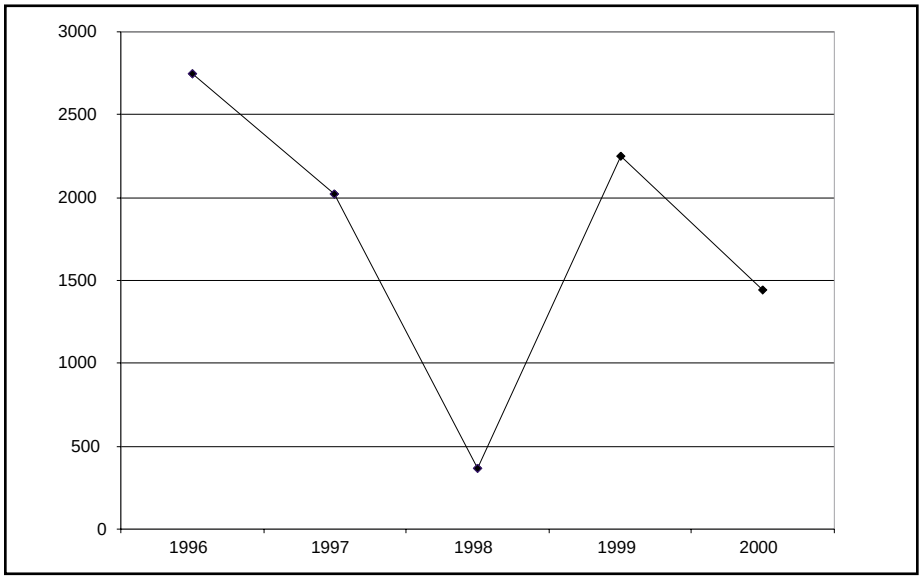
Key: CITES: 1 (Appendix I); IUCN: V (vulnerable); R (rare); E: (endangered); I (indeterminate); Ex (extinct); NOM: Th (threatened); R (rare); Sp (special protection); Id (in danger).

Illegal Trade

TRAFFIC obtained information on the number and location of cactus seizures within Mexico from PROFEPA, the federal agency for environmental protection, for the period 1996 to 2000. Data on cactus seizures acquired from the Netherlands and U.S. governments were also incorporated into this analysis. The quality and quantity of seizure data provided by the Mexican government may be affected by law enforcement officials' lack of expertise in cactus taxonomy; thus, it is likely that the data are incomplete. Specifically, the names of seized taxa provided herein may differ from those taxa actually seized and recorded by the Mexican government, because it is believed that many cacti are wrongly identified when government officials inventory specimens. In addition, the reported number of seized specimens is based on voluntary submissions of reports by state agencies and is probably lower than the actual number of seizures made throughout Mexico.

Between 1996 and 2000, more than 8,000 cactus specimens were seized by the authorities in Mexico and in the Netherlands (figure 10), the latter country being a significant commercial producer and consumer of horticultural material. An additional 1,180 cactus specimens were seized at U.S. ports from travelers returning to or passing through the United States. Of those specimens, 321 (27 percent) were most likely CDE species. Matching seized specimens with their corresponding scientific names revealed that virtually all taxa were native to Mexico and were probably collected from natural populations. Five Mexican states reported 78 percent of all seizures, suggesting that illegal collection may be a greater problem in those

Figure 10. Number of Mexican Cactus Specimens Seized by Mexico and the Netherlands (1996–2000)



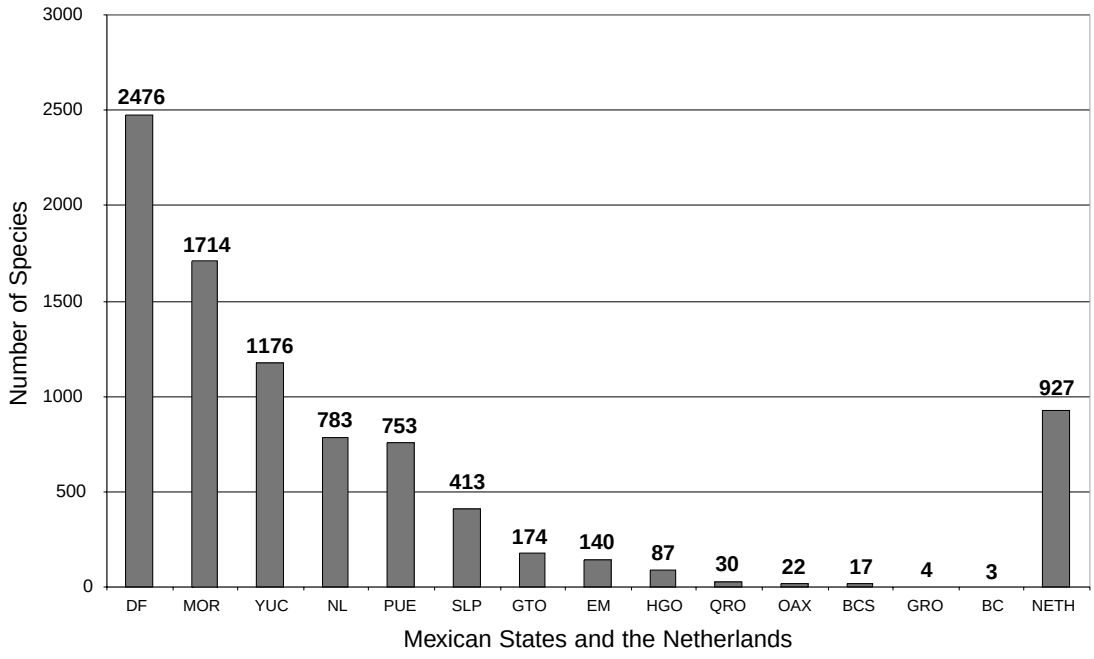
states than in others. However, higher reported seizures could also be attributed to a stronger law enforcement presence or to more reliable submission of seizure information in those states. Mexico City leads all states in the number of cactus seizures reported, accounting for 28 percent of all seizures in Mexico. More than 900 live cactus plants of Mexican origin were reportedly seized in the Netherlands in 2000, surpassing the combined reported seizures for the Mexican states of San Luis Potosí, Guanajuato, Querétaro, Hidalgo, Oaxaca, Baja California Sur, Estado de México, Baja California, and Guerrero (figure 11).

Between 1996 and 2000, the Mexican and Netherlands governments seized more than 5,100 specimens representing 75 species that were presumably collected in the Chihuahuan Desert (table 9). *Mammillaria* was the most widely represented genus in CDE cactus seizures, with 1,000 specimens and 23 species reportedly seized, followed by *Ariocarpus* (639 specimens and 6 species) and *Ferocactus* (558 specimens and 3 species).

The implications of illegal collection for the conservation of CDE cacti vary among the species seized. For instance, *Pachycereus marginatus*, of which nearly 700 plants were seized, is widely cultivated and distributed in the wild throughout Mexico. Most live plants taken from the wild are probably transplanted in nearby gardens and, thus, may not result in death or the complete isolation of individuals from natural populations. *Lophophora williamsii*, also known as peyote, is a species for which conservation concerns are more justified, given the volume of plant material seized and the persistent pressure and demand on wild populations. Native Americans use peyote, a source of the hallucinogenic compound mescaline, in religious ceremonies in Mexico and the United States, where its collection, commerce, and consumption are strictly regulated. Peyote's reputation as a natural hallucinogen may contribute to the illegal collection of wild plants as is evident from the seizure of 921 kg in Mexico over a five-year period. Continued illegal harvest of peyote poses a threat to the species' conservation and to the subsistence or spiritual needs of indigenous cultures that rely on wild plants for traditional use. Propagation of peyote is limited in Mexico and the United States, partly because of government restrictions, but peyote is extensively propagated in Europe.

Cephalocereus senilis, of which 580 wild-collected specimens were seized between 1996 and 2000, is particularly sensitive to harvest owing to the species' reproductive biology. This species, populations of which are

Figure 11. Seizures of Cactus Species by State or Country



Key: Distrito Federal, DF; Morelos, MOR; Yucatan, YUC; Nuevo Leon, NL; Puebla, PUE; San Luis Potosi, SLP; Guanajuato, GTO; Estado de Mexico, EM; Hidalgo, HGO; Queretaro, QRO; Oaxaca, OAX; Baja California Sur, BCS; Guerrero, GRO; Baja California, BC

confined to a few ravines in the QHAZ, grows a single branch from which flowers emerge at the end to produce fruits and seeds. The removal of this branch from sexually mature plants can preclude flowering and seed production, the prolonged reduction of which can destabilize populations. Moreover, cut stems that do not undergo a posterior period for rooting are less likely to survive in cultivation, thereby undermining the conservation benefits of cultivation.

Other species that are traded illegally and appear frequently in seizures are *Ferocactus latispinus*, *Ariocarpus kotschoubeyanus*, *Mammillaria carmenae*, *Astrophytum myriostigma*, and *Aztekium hintonii*. According to the species availability index, more than half (54 percent) of the species seized in Mexico are in short supply on the international market. Illegal collection and trade would appear to be more prevalent for commercially uncommon species than for those encountered more frequently in the marketplace (figure 12).

Chihuahuan Desert Localities of Importance for Cactus Conservation

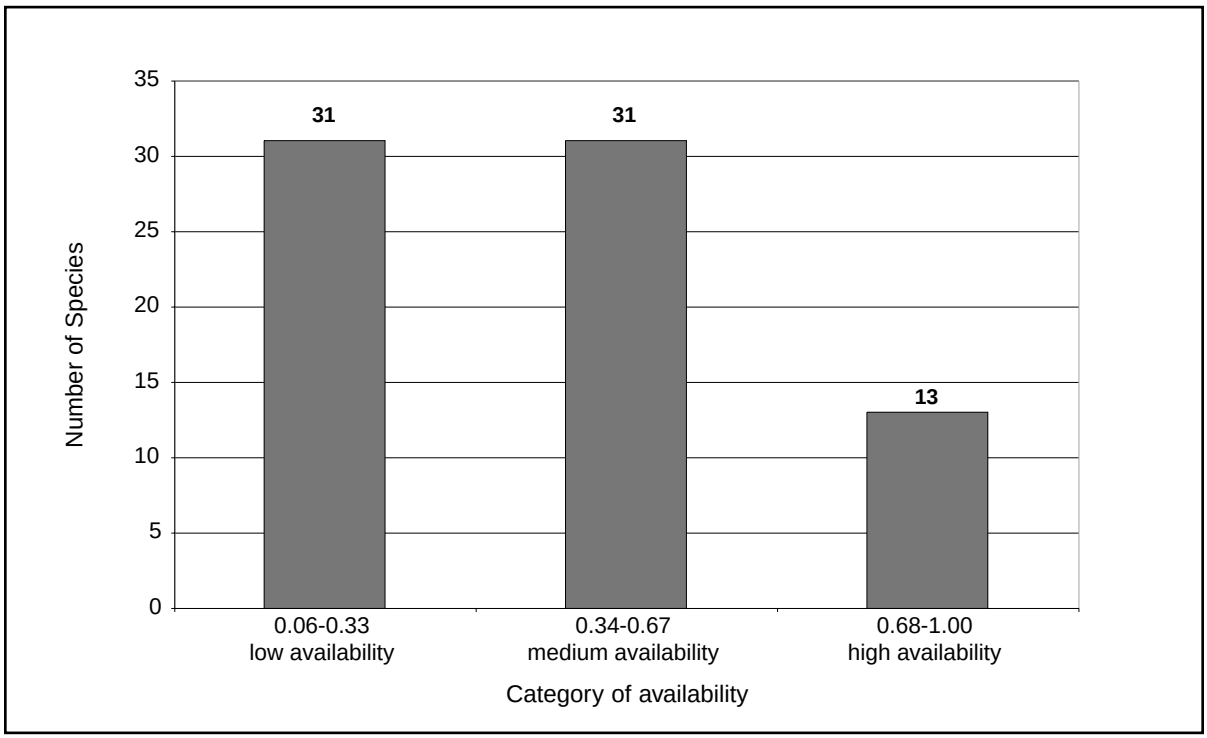
TRAFFIC cross-referenced information on cacti offered in trade with the natural distribution of taxa to determine localities of the CDE that harbor the most cactus species or specimens entering domestic and international trade. CDE localities were plotted and prioritized for conservation attention on the basis of the ratio of total number of accessions recorded in trade from each locality to the total number (131) of localities, each of which covers an area (square) of 2,500 square kilometers. An indicator, called the index of trade frequency (ITF), was calculated to determine the extent to which species identified in trade correspond with a particular CDE locality where the species in question is believed to occur naturally. A record of a species in trade does not necessarily indicate harvest from the wild in the corresponding locality, but it is evidence of the commercial availability of that species and the importance of the locality as the likely source of

Table 9. CDE Cactus Species Seized in Mexico and the Netherlands (1996–2000)

Species	Specimens	Species	Specimens
Ariocarpus bravoanus	82	*Mammillaria compressa*	70
Ariocarpus agavoides	42	*Mammillaria crinita*	5
Ariocarpus fissuratus	72	*Mammillaria elongata*	8
Ariocarpus kotschoubeyanus	287	*Mammillaria geminispina*	174
Ariocarpus retusus	128	*Mammillaria herrerae*	25
Ariocarpus scaphirostris	28	*Mammillaria klissingiana*	5
Astrophytum asterias	11	*Mammillaria laui*	4
Astrophytum capricorne	96	*Mammillaria longimamma*	1
Astrophytum myriostigma	194	*Mammillaria parkinsonii*	12
Astrophytum ornatum	9	*Mammillaria perbella*	8
Aztekium hintonii	152	*Mammillaria plumosa*	127
Aztekium ritteri	9	*Mammillaria pringlei*	58
Cephalocereus senilis	579	*Mammillaria rhodantha*	67
Coryphantha bumamma	27	*Mammillaria saboae*	9
Coryphantha duranguensis	11	*Mammillaria saetigera*	2
Coryphantha elephantidens	45	*Mammillaria senilis*	3
Coryphantha ottonis	2	*Mammillaria theresae*	14
Coryphantha werdermannii	20	*Mammillaria uncinata*	2
Echinocactus grusonii	318	*Mammillaria zephyranthoides*	1
Echinocactus platyacanthus	149	*Obregonia denegrii*	29
Echinocactus texensis	12	*Opuntia engelmannii*	3
Echinocereus longisetus	*3*	*Opuntia imbricata*	*30*
Echinocereus pectinatus	14	*Opuntia tunicata*	1
Echinocereus pulchellus	13	*Pachycereus marginatus*	688
Epithelantha micromeres	47	*Pelecyphora aselliformis*	61
Escobaria laredoi	19	*Pelecyphora strobiliformis*	41
Ferocactus histrix	69	*Stenocactus coptonogonus*	7
Ferocactus latispinus	437	*Stenocactus crispatus*	47
Ferocactus pilosus	52	*Stenocereus griseus*	9
Geohintonia mexicana	59	*Strombocactus disciformis*	70
Isolatocereus dumortieri	29	*Thelocactus bicolor*	14
Leuchtenbergia principis	20	*Thelocactus leucacanthus*	2
Lophophora diffusa	50	*Thelocactus rinconensis*	3
Lophophora williamsii	921.5 kg	*Thelocactus tulensis*	2
Mammillaria aureilanata	*6*	*Turbinicarpus lophophoroides*	4
Mammillaria bocasana	10	*Turbinicarpus schmiedickeanus*	44
Mammillaria candida	130	*Turbinicarpus valdezianus*	2
Mammillaria carmenae	245		

Source: PROFEPA (2000)

Figure 12. Number of CDE Cactus Species Seized by PROFEPA and SAI Values (1996–2000)



germplasm (genetic material) for traded specimens. Four categories of prioritization were created, on the basis of ITF values normalized from zero to one. ITF values ranging from 0.76 to 1.00 represent areas of significant species prevalence in trade and, therefore, of high priority for conservation attention, whereas areas with ITF values of 0 to 0.25 are those where the number of species found in trade is comparatively low (figure 13).

Within the CDE of Mexico, the following are regions in which a significant portion of cacti identified on the open market have natural populations: El Huizache (square 600, ITF value of 0.93); Aramberri (square 379, ITF value of 0.93); San Pedro de Las Colonias (square 281, ITF value of 0.84); Hipólito (square 348, ITF value of 0.72); the area just north of Monterrey (square 347, ITF value of 0.58); and Cuatro Ciénegas (square 246, ITF value of 0.53) (table 10). Consequently, those regions may experience higher levels of cactus exploitation and depletion than other localities and should therefore receive the highest priority for cactus conservation within the CDE of Mexico. Though not a notable source of marketed cactus species, the Queretaroan–Hidalgoan Arid Zone, including eastern Guanajuato, is important for cactus conservation because of the region's high levels of endemism and fragmentation from the rest of the Chihuahuan Desert. Within the CDE of the United States, Big Bend National Park (square u44) and its margins in Texas contain the highest concentration of specimens documented in trade by TRAFFIC.

In general, the localities concentrated in the south and southwestern portions of the CDE are the most significant localities for species used in commercial trade, whereas less significant areas for cactus specimens in trade are scattered throughout the northwestern portion of the CDE. Localities with high ITF values overlap with those previously reported as species-rich regions where most of the threatened cactus species of the CDE are also known to occur (Hernández and Bárcenas 1995, 1996). In some regions, an endangered species may be restricted to an area no greater than 2,500 square kilometers, as previously determined for some species such as *Aztekium hintonii* and *Geohintonia mexicana* highlighted

in this analysis (Hernández and Bárcenas, 1995, 1996). Some of these highly restricted, threatened cacti and localities in the CDE are at increasing risk from human uses, including illegal and uncontrolled harvest of wild plants, livestock grazing, and mining operations (Hernández and Bárcenas 1996).

Figure 13. Category of Priority for 131 Squares in the CDE

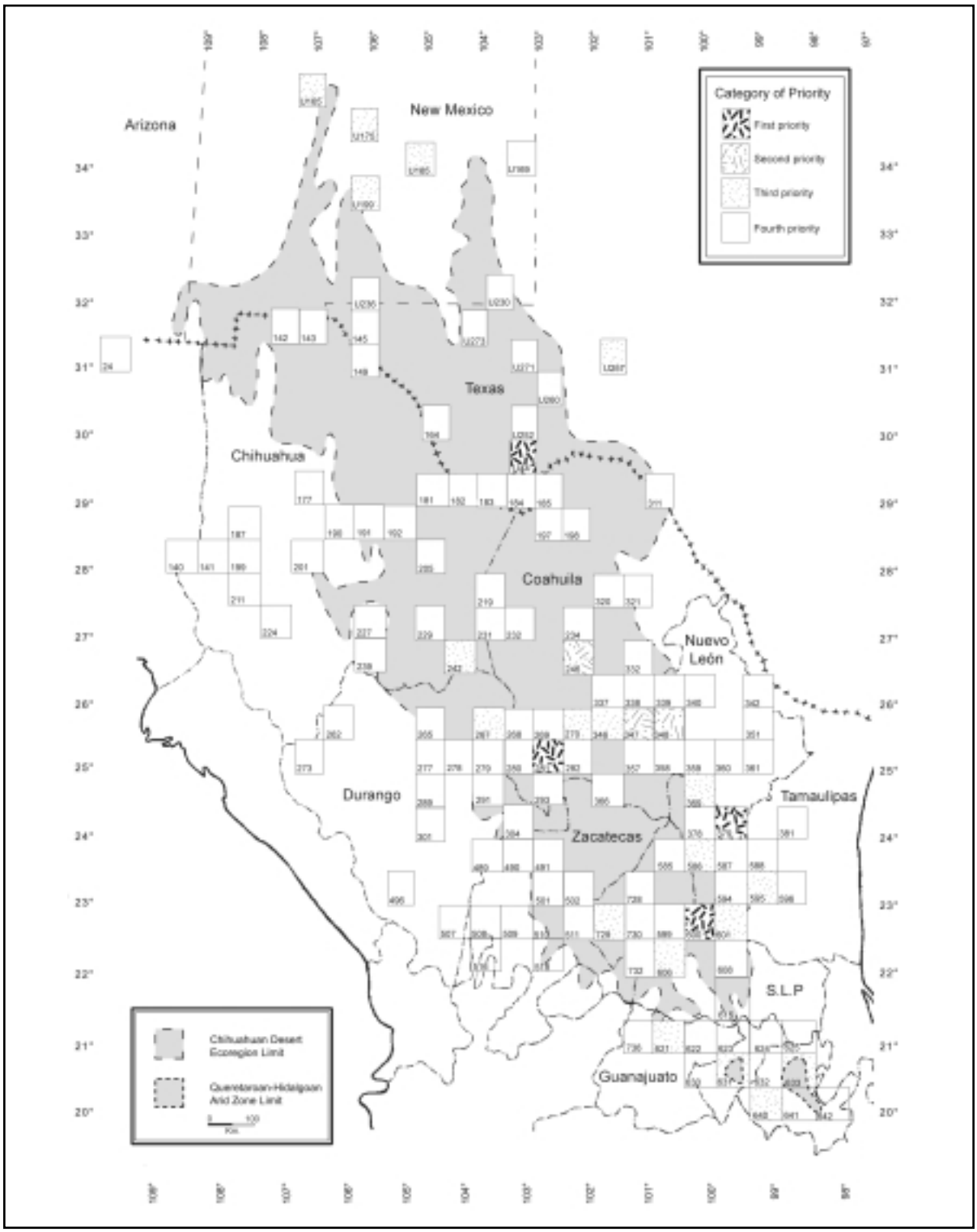


Table 10. Index of Trade Frequency (ITF) and Prioritization of Localities in the CDE

Locality[1]	Number of Species Records	Collection Values	ITF Value	Priority for Conservation
u44	43	0.33	1.00	first
600	40	0.31	0.93	first
379	40	0.31	0.93	first
281	36	0.27	0.84	first
348	31	0.24	0.72	second
347	25	0.19	0.58	second
246	23	0.18	0.53	second
586	21	0.16	0.49	third
u199	20	0.15	0.47	third
606	20	0.15	0.47	third
369	18	0.14	0.42	third
633	16	0.12	0.37	third
601	16	0.12	0.37	third
595	16	0.12	0.37	third
u175	15	0.11	0.35	third
270	15	0.11	0.35	third
729	14	0.11	0.33	third
u257	13	0.10	0.30	third
640	13	0.10	0.30	third
346	13	0.10	0.30	third
267	13	0.10	0.30	third
u165	12	0.09	0.28	third
631	12	0.09	0.28	third
u185	11	0.08	0.26	third
621	11	0.08	0.26	third
242	11	0.08	0.26	third
359	10	0.08	0.23	fourth
357	10	0.08	0.23	fourth
201	10	0.08	0.23	fourth
732	9	0.07	0.21	fourth
632	9	0.07	0.21	fourth
277	9	0.07	0.21	fourth
191	9	0.07	0.21	fourth
622	8	0.07	0.21	fourth
u271	8	0.06	0.19	fourth
599	8	0.06	0.19	fourth
510	8	0.06	0.19	fourth
291	8	0.06	0.19	fourth
269	8	0.06	0.19	fourth
u252	7	0.05	0.16	fourth
730	7	0.05	0.16	fourth
624	7	0.05	0.16	fourth
608	7	0.05	0.16	fourth

Key: Index of trade frequency (ITF) is the relative number of occurrences of specimens identified in trade that occur naturally in CDE localities (squares) plotted in figure 13.

[1] Each locality identified in the CDE corresponds to a square in figure 13 that is 30 minutes latitude by 30 minutes longitude and covers an approximate area of 2,500 square kilometers.

Table 10. Index of Trade Frequency (ITF) and Prioritization of Localities in the CDE *(continued)*

Locality[1]	Number of Species Records	Collection Values	ITF Value	Priority for Conservation
489	7	0.05	0.16	fourth
358	7	0.05	0.16	fourth
282	7	0.05	0.16	fourth
279	7	0.05	0.16	fourth
229	7	0.05	0.16	fourth
145	7	0.05	0.16	fourth
140	7	0.05	0.16	fourth
u236	6	0.05	0.14	fourth
641	6	0.05	0.14	fourth
585	6	0.05	0.14	fourth
265	6	0.05	0.14	fourth
164	6	0.05	0.14	fourth
u273	5	0.04	0.12	fourth
615	5	0.04	0.12	fourth
511	5	0.04	0.12	fourth
502	5	0.04	0.12	fourth
501	5	0.04	0.12	fourth
351	5	0.04	0.12	fourth
321	5	0.04	0.12	fourth
320	5	0.04	0.12	fourth
268	5	0.04	0.12	fourth
509	4	0.03	0.09	fourth
381	4	0.03	0.09	fourth
378	4	0.03	0.09	fourth
332	4	0.03	0.09	fourth
278	4	0.03	0.09	fourth
234	4	0.03	0.09	fourth
190	4	0.03	0.09	fourth
149	4	0.03	0.09	fourth
508	3	0.02	0.07	fourth
366	3	0.02	0.07	fourth
301	3	0.02	0.07	fourth
232	3	0.02	0.07	fourth
219	3	0.02	0.07	fourth
185	3	0.02	0.07	fourth
183	3	0.02	0.07	fourth
177	3	0.02	0.07	fourth
736	2	0.02	0.05	fourth
630	2	0.02	0.05	fourth
625	2	0.02	0.05	fourth
623	2	0.02	0.05	fourth
594	2	0.02	0.05	fourth
587	2	0.02	0.05	fourth
516	2	0.02	0.05	fourth
496	2	0.02	0.05	fourth

Table 10. Index of Trade Frequency (ITF) and Prioritization of Localities in the CDE *(continued)*

Locality[1]	Number of Species Records	Collection Values	ITF Value	Priority for Conservation
361	2	0.02	0.05	fourth
339	2	0.02	0.05	fourth
338	2	0.02	0.05	fourth
337	2	0.02	0.05	fourth
311	2	0.02	0.05	fourth
304	2	0.02	0.05	fourth
289	2	0.02	0.05	fourth
239	2	0.02	0.05	fourth
231	2	0.02	0.05	fourth
199	2	0.02	0.05	fourth
198	2	0.02	0.05	fourth
142	2	0.02	0.05	fourth
141	2	0.02	0.05	fourth
u260	1	0.01	0.02	fourth
u230	1	0.01	0.02	fourth
u169	1	0.01	0.02	fourth
728	1	0.01	0.02	fourth
642	1	0.01	0.02	fourth
596	1	0.01	0.02	fourth
588	1	0.01	0.02	fourth
518	1	0.01	0.02	fourth
507	1	0.01	0.02	fourth
491	1	0.01	0.02	fourth
490	1	0.01	0.02	fourth
360	1	0.01	0.02	fourth
342	1	0.01	0.02	fourth
340	1	0.01	0.02	fourth
293	1	0.01	0.02	fourth
280	1	0.01	0.02	fourth
273	1	0.01	0.02	fourth
262	1	0.01	0.02	fourth
227	1	0.01	0.02	fourth
224	1	0.01	0.02	fourth
211	1	0.01	0.02	fourth
205	1	0.01	0.02	fourth
197	1	0.01	0.02	fourth
192	1	0.01	0.02	fourth
187	1	0.01	0.02	fourth
184	1	0.01	0.02	fourth
182	1	0.01	0.02	fourth
181	1	0.01	0.02	fourth
143	1	0.01	0.02	fourth
24	1	0.01	0.02	fourth
Total: 131	**Total: 909**			

Prioritization of CDE Cactus Issues, Species, and Sites

The issues associated with harvest and management of cactus in the Chihuahuan Desert Ecoregion of Mexico differ from those of the CDE in the United States. Although both countries share the ecoregion, some common species, and similar plant communities, each faces mostly disparate threats to its cactus species, populations, and localities in the Chihuahuan Desert.

Mexico's high diversity of cactus species, many of which are endemic and highly restricted, attracts foreign collectors who knowingly violate Mexican and international law to obtain wild specimens of the rarest species in the wild. In many cases, rural communities and residents, unaware of the endangered status of local cacti or of laws protecting wild plants, generate income by gathering specimens from the field for resale to private collectors or by guiding collectors to cactus populations for a fee. Consumers of wild-collected cacti may be tourists who wish to purchase cacti as "take home" souvenirs but are unfamiliar with laws prohibiting the collection and export of wild plants, including cacti, from Mexico. Many travelers who are apparently ignorant of the laws leave Mexico and return to the United States or to their countries through U.S. ports, where hundreds of specimens are seized annually by U.S. officials.

The high level of illegal collection and trade in Mexican cactus plants and seeds may indicate a lack of supply relative to market demand. Government rules intended to protect native flora may be partly responsible for Mexico's low production of cacti and other native plants for international trade. Interviews with commercial growers suggest that nursery regulations are prohibitively rigid and confusing and may dissuade legitimate nurseries from propagating cactus plants for the export market. This section summarizes the main issues facing cactus species of the CDE of Mexico and concludes with recommendations for improving the conservation of certain taxa and localities in the ecoregion.

Status of Commercial Cactus Propagation in Mexico

Mexico's nursery industry is not meeting its potential as a leading producer and exporter of cacti and other succulents that are endemic to the country. Mexico has an abundance of natural and human capital to develop a viable industry of cactus nurseries. That effort has been hindered by onerous or obscure government requirements and a lack of investment from the private sector. A scarcity of nurseries and lack of propagated material to meet foreign demand are likely to increase the incidence of illegal cactus collection and trade, which continue to threaten cactus populations in the Chihuahuan Desert. Growers should be offered incentives to propagate species for export markets because of commercial demand for cacti endemic or native to Mexico. In particular, propagation efforts should focus on rare, recently discovered, or recently described species for which demand is high but plants are lacking in the marketplace. Cactus propagation efforts under way at various universities throughout Mexico may have the capacity and technology to share with local growers and communities interested in growing cacti for domestic or export markets.

The limited but successful propagation of cactus species in Mexico over the past decade demonstrates the value of artificial propagation as an *ex situ* method for conserving endangered species (Martínez and Rubluo 1989, Malda et al. 1999, Martínez and Martínez 2002). As one example of this success, the Instituto Tecnólogico y de Estudios Superiores de Monterrey, Querétaro Campus (ITESM-CQ) has propagated 105 species, 62 of which are indigenous to Querétaro (Martínez and Martínez 2002). At least 31 species propagated by the institute were among those identified for sale on the international market, suggesting that a Mexican supply of propagated plants could meet some of the commercial international demand for those species.

The Mexican government permits the collection of wild specimens for commercial propagation under NOM-007-RECNAT-1997. However, the regulations and procedures for obtaining wild stock for propagation are issued

by a federal agency and may not be known to nursery operators or government employees at the state or local level. The federal agency (La Secretaría del Medio Ambiente y Recursos Naturales—SEMARNAT) responsible for implementing those regulations should consider making them easier for growers and government officials in other agencies to access and understand. In addition, the Mexican government should support the establishment of licensed nurseries and should identify measures to foster the sustainable production and artificial propagation of priority species. For instance, expanding the domestic market for cacti and removing burdensome government restrictions for exporting propagated plants are two actions that could stimulate production. Cactus growers indicate that domestic consumers are averse to paying higher prices for plants grown in a nursery partly because of indifference toward a group of plants that are perceived as commonplace. That bias deters growers from investing in propagation efforts. A public outreach campaign organized by governmental and nongovernmental organizations to publicize cacti as unique to Mexico may change public opinion and increase demand for propagated plants within Mexico.

Rural communities in the Chihuahuan Desert with access to wild plants and germplasm are good candidates for cultivating cactus species for commercial trade. Establishing nurseries in rural areas could empower local communities by creating employment and could also contribute to cactus conservation by decreasing the pressure of harvest on wild specimens. Community growers might find it beneficial to enlist or use the services of reputable botanical gardens or universities to help establish the first generation of cultivated seedlings from which daughter stock could be produced in local nurseries. The planning stage of a pilot program in Mexico, with assistance from the governments of the United States and Austria, to harvest a limited number of wild seeds and plants or both of representative cactus taxa for artificial propagation may evolve into a model for expanding commercial cultivation of high priority cactus taxa within the CDE of Mexico. Seized specimens are another potential source of nursery stock for establishing propagation centers.

Maintaining solvency is a significant barrier to the success of commercial nurseries in Mexico. Many nurseries simply do not possess the financial resources and technical expertise to sustain a profitable business. Nurseries not registered with the Mexican government undercut the legal production of plants by buying and selling plants collected illegally from wild populations. Some establishments expressed concern about excessive government paperwork requirements for operating a nursery or about prohibitively expensive export permits. Most growers interviewed by TRAFFIC stated that they could not afford to export cacti because the costs associated with bribes demanded by government officials for export permits or for inspections far outweighed any profits they might make. For instance, some growers generated a paltry US$60 for exporting up to 2,500 specimens over a three-year period. In addition, many growers are unaware of or do not fulfill government procedures and requirements for exporting cacti and, consequently, may be denied the necessary permits. The Mexican government should prepare and circulate a list of guidelines, requirements, and fees for exporting propagated plants to registered nurseries so as to clarify the responsibilities of exporters and prevent confusion or corruption among government officials.

Illegal Trade in Cactus Specimens

The seizure of thousands of CDE cactus specimens testifies to the scale and severity of illegal trade in cacti collected from natural populations in Mexico. The availability of illegally collected specimens of species identified in Mexican and international markets indicates that the source of the problem is internal. The Mexican government can address illegal domestic trade by increasing a law enforcement presence and random inspections at commercial outlets throughout the country, a practice that has been effective in reducing clandestine trade (Clayton et al. 2000). Moreover, resources for law enforcement should be directed at controlling trade in rare CDE cacti such as *Strombocactus disciformis* and *Cephalocereus senilis* rather than trade in lower-priority taxa like *Stenocereus marginatus*, which is widely cultivated throughout Mexico and, therefore, of less

conservation concern. Controlling international trade in cactus specimens collected illegally in Mexico is more challenging and will require domestic action as well as the support of the international community.

The illegal export of cactus specimens from Mexico is the regrettable outcome of several factors contributing to a practice that threatens some of Mexico's rarest and most endangered cactus species with extinction. Mexico prohibits the collection and export of plants collected from the wild and has strict regulations and numerous procedures for cultivation and exportation of propagated plants, in many cases eliminating incentives to grow plants for export markets. An additional barrier to trading cactus specimens was inclusion of seeds of native cacti gathered from wild populations in Mexico on CITES Appendix II in 1997, requiring CITES export permits for all cactus seeds leaving the country. Previous to the listing, cactus seeds were exempt from CITES controls and could be exported from the country without government approval or CITES export permits. At the time, the listing of seeds on CITES was a justifiable course of action to deter the illegal export of wild cactus seeds from the country. However, since the listing went into effect, Mexico's nurseries have not increased seed availability for international markets, in part because of strict export restrictions and an underdeveloped nursery industry with little incentive or investment to produce seeds for export. Compounding the problem is the tenacity of some private collectors, who continue to collect and export wild specimens in violation of Mexican and international (CITES) law. Moreover, enforcing the Appendix II listing for cactus seeds of Mexican origin is all but impossible considering the unlikely detection of such small specimens in personal belongings.

Commercial cultivation of CDE cactus taxa new to science or listed in Appendix I should be a priority for Mexican growers, because private collectors frequently target wild specimens of those taxa in the absence of cultivated material. The Mexican government should streamline restrictions for licensing nurseries in an effort to facilitate the propagation and exportation of rare, endangered, species of special concern. The main cactus markets, especially the United States, United Kingdom, and Germany, all of which have a long history of importing a wide variety of CDE cactus taxa, should be monitored for sales of newly described taxa, including *Ariocarpus bravoanus bravoanus*, *Aztekium hintonii*, *Geohintonia mexicana*, and *Turbinicarpus alonsoi*, and other rare species endemic to the Chihuahuan Desert of Mexico. Recent official inspections of private collections by German authorities led to the confiscation of 614 specimens of CITES Appendix I species, mainly of Mexican cacti of apparently wild origin (Thiede 2000). Other countries not identified as markets for CDE cacti in this review, but meriting closer scrutiny of commercial outlets owing to a history of incidents or seizures, are the Netherlands, Japan, China, and the Czech Republic. The government agencies in those countries that are responsible for implementing CITES (for example, CITES management authorities) should monitor the domestic availability of CDE cactus species susceptible to illegal trade.

High Priority Species and Localities

Cactus species occurring in the CDE were chosen for conservation attention if they were documented in very limited quantities in the marketplace (defined by a species availability index value of less than 0.33) or were included in at least two of the three lists designating species conservation or protection status: CITES Appendix I, Mexico's NOM list of legally protected plants, and the IUCN Red List of Threatened Species. Species meeting neither the criterion of low availability nor that of inclusion in two of three threatened status lists were added to the list of priority species if they were relatively new to science or subject to significant illegal trade (defined as total number of seized specimens exceeding 100 between 1996 and 2000). The extent to which specimens were endemic to the region and retail price of specimens were additional criteria used in the prioritization process.

TRAFFIC identified 39 cacti of the Chihuahuan Desert of Mexico whose conservation is at further risk if measures are not taken to limit or prevent the depletion of wild populations stemming from illegal or unsustainable collection (table 11). In the supporting text provided, the main reasons for

designating species a conservation priority are noted and specific *in situ* and *ex situ* actions are recommended to support the sustainable management of CDE cacti. Those recommendations include increasing commercial propagation for more than 30 rare, threatened, or vulnerable species of limited commercial availability as a precautionary measure to ensure that present and future demand is met with horticultural stock and not with specimens gathered illegally in the wild.

Many of the species considered a priority by TRAFFIC are in Mexican or foreign trade or both, though international markets account for the greatest availability of cactus species native to the Chihuahuan Desert of Mexico. One possible exception is the trade in skeletons of cylindrical *Opuntia* spp. (= *Cylindropuntia*), also known as *chollas*. The cholla crafts trade merits monitoring as any increase in harvest of live plant material of arboreal or shrubby species of *Opuntia* to supplement the gathering of dead wood could affect the stability of wild populations, whose inherent low rates of recruitment could be diminished further by harvest (Cody 2000).

Three regions inside the Chihuahuan Desert of Mexico are the highest priority for conservation: El Huizache in San Luis Potosí (square 600), Aramberri (square 379), and San Pedro de Las Colonias (square 281). Further three regions, Hipólito in Coahuila just north of Monterrey, Nuevo León, and Cuatro Ciénegas, are second-tier priorities (table 10; figure 13). The geographic areas designated "first priorities" were selected on the basis of the significant number of threatened and protected cactus taxa inhabiting these regions that were recorded in domestic or international trade or in both. The commercial availability and interest in cacti from these regions suggest that the regions supplied or continue to supply the trade with wild specimens and, as some of the last sources of germplasm, they should be the focus of cactus conservation efforts. The QHAZ, including eastern Guanajuato, is a known source for plant material for the international market, as is evident from the availability of endemic species such as *Turbinicarpus alonsoi* that are known to be restricted to this region. The QHAZ is a high priority area for conservation because its distinctive array of endemic taxa is concentrated in a relatively small area.

Table 11. Cactus Taxa Selected for *In situ* and *Ex situ* Conservation in Mexico

Taxon	Reasons for Conservation Concern	Recommended Action(s)
Ariocarpus agavoides	CITES App. I; endangered (NOM); endangered (IUCN); high retail price for specimens	Promote *in situ* conservation by protecting habitat; monitor international markets for specimens of high value
Ariocarpus bravoanus bravoanus	Low availability in trade; rare in Mexico; CITES App. I; rare (NOM); endangered (IUCN); newly described	Increase commercial propagation and protection of wild populations; monitor international markets for wild specimens
Ariocarpus kotschoubeyanus	CITES App. I; threatened (NOM); significant illegal trade; high retail price	Monitor international markets for wild specimens; increase commercial propagation
Ariocarpus scaphirostris	Low availability in trade; CITES App. I; endangered (NOM); vulnerable (IUCN)	Increase commercial propagation; promote *in situ* conservation through habitat restoration and protection
Astrophytum myriostigma	Threatened (NOM); vulnerable (IUCN); significant illegal trade; endemic	Promote *in situ* conservation through habitat restoration and protection; monitor international markets for wild specimens

Table 11. Cactus Taxa Selected for *In situ* and *Ex situ* Conservation in Mexico *(continued)*

Taxon	Reasons for Conservation Concern	Recommended Action(s)
Aztekium hintonii	Low availability in trade; newly described; rare (NOM); endemic	Consider uplisting to CITES App. I; increase commercial propagation and protection of wild populations; monitor international markets for wild specimens
Cephalocereus senilis	Threatened (NOM); vulnerable (IUCN); significant illegal trade; endemic	Consider uplisting to CITES App. I
Coryphantha durangensis	Low availability in trade; rare (NOM); rare (IUCN)	Increase commercial propagation
Coryphantha pseudechinus	Low availability in trade; rare (NOM); rare (IUCN)	Increase commercial propagation
Coryphantha pulleineana	Low availability in trade; threatened (NOM); vulnerable (IUCN)	Increase commercial propagation
Coryphantha ramillosa	Low availability in trade; threatened (NOM); vulnerable (IUCN)	Increase commercial propagation
Coryphantha werdermannii	Low availability in trade; CITES App. I; endangered (NOM); endangered (IUCN)	Increase commercial propagation
Echinocactus parryi	Low availability in trade; threatened (NOM); vulnerable (IUCN)	Increase commercial propagation
Echinocereus palmeri	Low availability in trade; endangered (NOM); endangered (IUCN)	Increase commercial propagation
Epithelantha bokei	Low availability in trade; threatened (NOM); vulnerable (IUCN)	Increase commercial propagation
Geohintonia mexicana	Low availability in trade; rare (NOM); newly described; endemic	Consider uplisting to CITES App. I; increase commercial propagation and protection of wild populations; monitor commercial availability in foreign countries
Lophophora diffusa	Low availability in trade; threatened (NOM); rare (IUCN); endemic	Increase commercial propagation; monitor international markets for wild specimens
Mammillaria albicoma	Low availability in trade; threatened (NOM); vulnerable (IUCN)	Increase commercial propagation
Mammillaria carmenae	Significant illegal trade; endangered (NOM); endangered (IUCN)	Consider uplisting to CITES App. I
Mammillaria grusonii	Low availability in trade; rare (NOM); rare (IUCN)	Increase commercial propagation
Mammillaria lindsayi	Low availability in trade; rare (NOM); rare (IUCN)	Increase commercial propagation
Mammillaria longiflora	Low availability in trade; rare (NOM); rare (IUCN)	Increase commercial propagation
Mammillaria mathildae	Low availability in trade; threatened (NOM); vulnerable (IUCN)	Increase commercial propagation
Mammillaria painteri	Low availability in trade; rare (NOM); rare (IUCN)	Increase commercial propagation
Mammillaria rettigiana	Low availability in trade; rare (NOM); rare (IUCN)	Increase commercial propagation
Mammillaria roseoalba	Low availability in trade; rare (NOM); rare (IUCN)	Increase commercial propagation
Mammillaria schwarzii	Low availability in trade; rare (NOM); rare (IUCN)	Increase commercial propagation

Table 11. Cactus Taxa Selected for *In situ* and *Ex situ* Conservation in Mexico *(continued)*

Taxon	Reasons for Conservation Concern	Recommended Action(s)
Mammillaria stella-de-tacubaya	Low availability in trade; rare (NOM); rare (IUCN)	Increase commercial propagation
Mammillaria weingartiana	Low availability in trade; threatened (NOM); vulnerable (IUCN)	Increase commercial propagation
Peniocereus greggi	Low availability in trade; rare (NOM); rare (IUCN)	Increase commercial propagation
Coryphantha durangensis	Low availability in trade; rare (NOM); rare (IUCN)	Increase commercial propagation
Sclerocactus erectocentrus	Low availability in trade; CITES App. I; endangered (NOM); rare (IUCN)	Increase commercial propagation
Sclerocactus mariposensis	Low availability in trade; CITES App. I; threatened (NOM); vulnerable (IUCN)	Increase commercial propagation
Sclerocactus mesae-verdae	Low availability in trade; CITES App. I; vulnerable (IUCN)	Increase commercial propagation
Sclerocactus wrightiae	Low availability in trade; CITES App. I; endangered (IUCN)	Increase commercial propagation
Strombocactus disciformis	Low availability in trade; CITES App. I; threatened (NOM)	Increase commercial propagation
Thelocactus heterochromus	Low availability in trade; threatened (NOM); rare (IUCN)	Increase commercial propagation
Turbinicarpus alonsoi	Newly described species; endemic	Increase commercial propagation
Turbinicarpus hoferi	Low availability in trade; CITES App. I; threatened (NOM); vulnerable (IUCN)	Increase commercial propagation
Turbinicarpus pseudomacrochele	CITES App. I; endangered (NOM); vulnerable (IUCN); endemic	Monitor international markets for wild specimens; promote *in situ* conservation
Turbinocarpus rioverdensis	Extremely limited in trade (only seeds available); potential for illegal trade is high	Increase commercial propagation

Specific Recommendations

Cactus Conservation Campaign

Conservationists should undertake, with sponsorship from private foundations or the Mexican government or both, a campaign to increase public awareness of cactus conservation in the CDE, publicizing the ecological characteristics, function, and status of cacti, as well as summarizing Mexico's laws concerning their collection and trade. This campaign should emphasize Mexico's incomparable wealth of cactus species, many of which are unique to the Chihuahuan Desert, and promote cacti as a symbol of that country's resilient environment, botanical beauty, and biological diversity. To this end, WWF should prepare and give written materials and talks to villages, schools, and community leaders within the Chihuahuan Desert to deliver its conservation messages. The Mexican government, with assistance from conservation organizations and universities, should prepare a code of conduct for collectors, who should pledge to protect wild cactus populations and adhere to government rules for collecting specimens.

Simplify and Explain Rules for Growing and Exporting Cacti

Nursery owners complain that existing rules and export procedures are confusing and expensive, undermining incentives to export propagated plants. The Mexican government should consolidate, clarify, and communicate government rules for licensing and operating nurseries and for exporting propagated cacti and other native plants. This would help reduce confusion among nursery owners and might deter government officials from manipulating the rules at the expense of exporters. In addition, nurseries should be informed about the purpose, requirements, and benefits of CITES so that there is greater understanding of and appreciation for the convention. Identification manuals and training courses are also needed to help government wildlife and customs officials identify the source (for example, wild or propagated) and species of cacti grown in nurseries or destined for export. Botanical institutions and universities may be able to provide technical and taxonomic assistance with the development of identification and training materials for government officials responsible for the inspection of nurseries and nursery stock.

Nursery Development and Certification and Germplasm Protection

Supporting the establishment and licensing of nurseries in rural communities within the Chihuahuan Desert to promote artificial propagation of those endemic and endangered species whose wild populations remain the target of illegal collectors should discourage poaching. The licensing process would involve inventorying, approving, and registering nursery operations that agree to periodic auditing and that implement production standards developed by qualified botanical gardens or universities in exchange for limited extraction of wild specimens. A system for registering nurseries propagating and exporting plant species listed in CITES Appendix I is already available to CITES parties and may be an appropriate model for Mexico's nurseries for two reasons: (1) many of the CDE cactus species identified as a conservation priority are listed in Appendix I and are strong candidates for artificial propagation; and (2) much of the information required for nursery registration under CITES would likely be mandatory under Mexican law (CITES Resolution Conference 9.19, 1994).

Conservationists should work with relevant government agencies and seek the technical input of botanical gardens or universities to assist community-based nurseries with the sustainable harvesting and sowing of seed stock, as well as the maintaining and marketing of nursery stock. Proponents of this scheme should seek to allow licensed nurseries to supplement their nursery stock by extracting a limited amount of germplasm from wild cactus populations, provided that the nurseries coordinate these activities with the relevant government agency and pledge to protect wild plants from illegal collection.

Establishment of Germplasm Reserves

Germplasm reserves are important for cactus conservation in the CDE of Mexico and will benefit the country's nursery industry by enabling growers to improve the quality of existing stock and ensure a competitive advantage in the marketplace.

Government and Community Interaction

WWF should help forge better communication between Mexico's federal and state environmental agencies and local communities, growers and exporters so that information on illegal collection or other threats to endangered cacti can be exchanged and reported. WWF should explain to local communities that illegal trade in native cacti undercuts the ability of local enterprises to produce and sell cactus plants and seeds in the marketplace, thereby undermining the community's economic welfare.

Illegal Trade

The Mexican government should increase resources for law enforcement devoted to detecting and deterring illegal trade in cacti. Specific activities for improving the detection of illegally acquired specimens might include the following: increase monitoring of nurseries, exchange information with governments of countries where CDE cacti of Mexico are or may be marketed, and identify or develop cost-effective molecular techniques such as DNA fingerprinting to help identify nursery-grown Mexican Cactaceae. Enhancing the ability of Mexican and international law enforcement agencies to determine with much greater certainty and accuracy the origin of plant material sold in trade could help expose and deter illegal traders. Molecular techniques have been used in the identification of different cultivars of *Chrysanthemum* and *Pelargonium* species to detect fraudulent trade in commercial stocks (Wolff et al. 1995; Becher et al. 2000).

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APPENDICES
PART II

Appendix 1
Questionnaire for Nursery Managers and Cactus Producers

CURRENT STATUS OF EXPLOITATION AND TRADE OF
CHIHUAHUAN DESERT CACTUS SPECIES

Name: _____

Nursery name: _____ No._____

Address: _____

Working hours: _____

Telephone: _____ Fax: _____

E-mail: _____ Web address: _____

Diversity

Do you have a catalogue or price list of the species you have for sale? ❑ yes ❑ no

Propagation

1. Where did you originally obtain the germplasm of these species?

   ❑ wild ❑ another nursery ❑ another source

Please specify _____

2. What kind of reproduction do you use to propagate your species?

   ❑ seed ❑ asexual

Please specify _____

Production

3. What is the average sale time of plants propagated by seed? (average of the slowest species and of the fastest species) _____

4. Do you have an estimate of how many plants and species you sell every year? _____

   _____

5. Could you compete against the foreign nurseries in terms of the following:

   ❑ plants produced per year ❑ quality of the product

   ❑ price ❑ processes of production

Appendix 1 *(continued)*

Sales

6. Are professional collectors interested in artificially propagated plants? ❑ yes ❑ no
7. Is there any annual variation in sales through the year? _____
   What are the best months for sale? _____
8. Do you have any explanation for this difference? ❑ offer ❑ demand ❑ other
   Please specify _____
9. How do you advertise your product?
   ❑ verbally ❑ Internet ❑ science journal ❑ price list ❑ other
   Please specify _____
10. Do you think the national market is good in terms of sales? ❑ yes ❑ no

Exportation

11. Do you export cacti? ❑ yes ❑ no
12. Which are the most sought-after species in the international market?
    _____
13. Which are the best markets for exportation? (America, Europe, Asia, Australia, Africa)
    _____
14. Do you have an estimate of how many plants and species you export to various countries?
    Please specify _____
15. What is the better market for sales? ❑ national ❑ international

Appendix 2
List of Taxa from the Chihuahuan Desert Ecoregion Found in Mexican Trade

Ariocarpus agavoides
Ariocarpus bravoanus var. *bravoanus*
Ariocarpus bravoanus var. *hintonii*
Ariocarpus kotschoubeyanus
Ariocarpus retusus
Astrophytum asterias
Astrophytum capricorne
Astrophytum myriostigma
Astrophytum ornatum
Aztekium hintonii
Aztekium ritteri
Cephalocereus senilis
Coryphantha bumamma
Coryphantha cornifera
Coryphantha erecta
Coryphantha delaetiana
Coryphantha radians
Echinocactus grusonii
Echinocactus platyacanthus
Echinocactus texensis
Echinocereus cinerascens
Echinocereus pectinatus
Echinocereus poselgeri
Echinocereus schmollii
Epithelantha micromeris
Ferocactus echidne var. *echidne*
Ferocactus echidne var. *victoriensis*
Ferocactus glaucescens
Ferocactus histrix
Ferocactus latispinus
Ferocactus macrodiscus
Ferocactus pilosus
Ferocactus sp. *(hybrid)*
Geohintonia mexicana
Isolatocereus dumortieri
Leuchtenbergia principis
Lophophora difussa
Mammillaria aureilanata
Mammillaria bocasana
Mammillaria bombycina
Mammillaria camptotricha
Mammillaria candida
Mammillaria carmenae
Mammillaria compressa
Mammillaria crinita var. scheinvariana
Mammillaria elongata
Mammillaria geminispina
Mammillaria gigantea
Mammillaria glassii
Mammillaria hahniana
Mammillaria herrerae
Mammillaria longimamma
Mammillaria luethyi
Mammillaria magnimamma
Mammillaria mathildae
Mammillaria multihamata
Mammillaria nana
Mammillaria painteri
Mammillaria parkinsonii
Mammillaria perbella
Mammillaria pilispina
Mammillaria plumosa
Mammillaria polythele
Mammillaria poselgeri
Mammillaria pringlei
Mammillaria prolifera
Mammillaria schiedeana
Mammillaria senilis
Mammillaria surculosa
Mammillaria uncinata
Mammillaria wildii
Myrtillocactus geometrizans
Neolloydia conoidea
Opuntia microdasys
Opuntia microdasys var. albispina
Pelecyphora aselliformis
Pelecyphora strobiliformis
Sclerocactus scheeri
Sclerocactus uncinatus
Stenocactus crispatus
Stenocactus ochoterenanus
Stenocereus griseus
Strombocactus disciformis
Thelocactus bicolor
Thelocactus hastifer
Thelocactus hexaedrophorus
Turbinicarpus alonsoi
Turbinicarpus gielsdorfianus
Turbinicarpus horripilus
Turbinicarpus laui
Turbinicarpus lophophoroides
Turbinicarpus schmiedickeanus
Turbinicarpus valdezianus
Turbinicarpus ysabelae

Appendix 3
Taxa Identified in Mexican and International Trade

Taxon	Conservation Status	Countries Trading	Wild-Collected Specimens in Mexican Trade?	Number of Countries	Number of Nurseries	Availability by Country	Availability by Nursery	SAI
Ariocarpus agavoides	CITES App. I; endangered (IUCN); in danger (NOM)	Germany, Italy, Mexico, Spain, Sweden, United Kingdom, United States	No	7	17	high	high	0.69
Ariocarpus bravoanus ssp. *bravoanus*	CITES App. I; endangered (IUCN); rare (NOM)	Mexico	No	1	2	low	low	0.09
Ariocarpus bravoanus ssp. *hintonii*	CITES App. I; vulnerable (IUCN)	Italy, Mexico, United Kingdom, United States	No	4	6	medium	low	0.29
Ariocarpus fissuratus	CITES App. I; vulnerable (IUCN); threatened (NOM)	Germany, Italy, Sweden, United Kingdom, United States	No	5	15	high	medium	0.57
Ariocarpus kotschoubeyanus	CITES App. I; threatened (NOM)	Germany, Italy, Mexico, Spain, Sweden, United Kingdom, United States	No	7	18	high	high	0.71
Ariocarpus retusus	CITES App. I	Germany, Italy, Mexico, United Kingdom, United States	Yes	5	17	high	high	0.63
Ariocarpus scaphirostris	CITES App. I; vulnerable (IUCN); in danger (NOM)	United States	No	1	3	low	low	0.11
Astrophytum asterias	CITES App. I; endangered (IUCN); in danger (NOM)	Germany, Italy, Mexico, Spain, Sweden, United Kingdom, United States	No	7	20	high	high	0.77
Astrophytum capricorne	Vulnerable (IUCN); threatened (NOM)	Germany, Italy, Mexico, Sweden, United Kingdom, United States	No	6	20	high	high	0.74
Astrophytum myriostigma	Vulnerable (IUCN); threatened (NOM)	Germany, Italy, Mexico, Spain, Sweden, United Kingdom, United States	Yes	7	24	high	high	0.89
Astrophytum ornatum	Indeterminate (IUCN); threatened (NOM)	Germany, Italy, Mexico, Spain, Sweden, United Kingdom, United States	No	7	24	high	high	0.89
Aztekium hintonii	Rare (NOM)	Mexico, United Kingdom, United States	No	3	6	medium	low	0.26
Aztekium ritteri	CITES App. I; rare (IUCN); threatened (NOM)	Italy, Mexico, Sweden, United Kingdom, United States	No	5	8	high	low	0.37
Cephalocereus senilis	Vulnerable (IUCN); threatened (NOM)	Germany, Italy, Mexico, Spain, United Kingdom, United States	Yes	6	21	high	high	0.77
Coryphantha bumamma		Italy, Mexico, United Kingdom, United States	Yes	4	4	medium	low	0.23
Coryphantha clava		United States	No	1	1	low	low	0.06
Coryphantha clavata		United States	No	1	1	low	low	0.06
Coryphantha compacta		United Kingdom, United States	No	2	4	low	low	0.17
Coryphantha cornifera		Germany, Mexico, Spain, United Kingdom, United States	Yes	5	13	high	medium	0.51
Coryphantha delaetiana		Germany, Mexico, Spain, United Kingdom, United States	No	5	6	high	low	0.31
Coryphantha difficilis		Italy, Sweden, United Kingdom, United States	No	4	4	medium	low	0.23
Coryphantha durangensis	Rare (IUCN); rare (NOM)	United Kingdom, United States	No	2	2	low	low	0.11

Appendix 3
Taxa Identified in Mexican and International Trade *(continued)*

Taxon	Conservation Status	Countries Trading	Wild-Collected Specimens in Mexican Trade?	Number of Countries	Number of Nurseries	Availability by Country	Availability by Nursery	SAI
Coryphantha echinoidea		United Kingdom, United States	No	2	3	low	low	0.14
Coryphantha echinus		Spain, United Kingdom, United States	No	3	8	medium	low	0.31
Coryphantha elephantidens	Vulnerable (IUCN); threatened (NOM)	Germany, Italy, Spain, United Kingdom, United States	Yes	5	11	high	medium	0.46
Coryphantha erecta		Germany, Italy, Mexico, United States	Yes	4	6	medium	low	0.29
Coryphantha georgii		Germany, United Kingdom, United States	No	3	3	medium	low	0.17
Coryphantha glanduligera	Vulnerable (IUCN); threatened (NOM)	Germany, Sweden, United Kingdom, United States	No	4	7	medium	low	0.31
Coryphantha guerkeana		Germany, United States	No	2	2	low	low	0.11
Coryphantha jaumavei		Germany, United Kingdom, United States	No	3	4	medium	low	0.20
Coryphantha longicornis	Indeterminate (IUCN)	Italy, United Kingdom, United States	No	3	4	medium	low	0.20
Coryphantha macromeris		Germany, Italy, Sweden, United States	No	4	12	medium	medium	0.46
Coryphantha maiz-tablasensis	Rare (IUCN)	Germany, Spain, United States	No	3	6	medium	low	0.26
Coryphantha nickelsiae		United States	No	1	2	low	low	0.09
Coryphantha odorata	Rare (IUCN); rare (NOM)	Germany, Sweden, United Kingdom, United States	No	4	4	medium	low	0.23
Coryphantha ottonis		Spain, United Kingdom, United States	No	3	4	medium	low	0.20
Coryphantha poselgeriana	Vulnerable (IUCN); threatened (NOM)	Sweden, United Kingdom, United States	No	3	6	medium	low	0.26
Coryphantha potosiana		United States	No	1	1	low	low	0.06
Coryphantha pseudechinus	Rare (IUCN); rare (NOM)	United States	No	1	2	low	low	0.09
Coryphantha pulleineana	Vulnerable (IUCN); threatened (NOM)	United States	No	1	1	low	low	0.06
Coryphantha pusilliflora		United States	No	1	1	low	low	0.06
Coryphantha radians	Rare (IUCN)	Germany, Mexico, Sweden, United Kingdom, United States	Yes	5	8	high	low	0.37
Coryphantha ramillosa	Vulnerable (IUCN); threatened (NOM)	United States	No	1	2	low	low	0.09
Coryphantha salinensis		Spain, United Kingdom, United States	No	3	3	medium	low	0.17
Coryphantha sulcata	Threatened (NOM)	Germany, Spain, United Kingdom, United States	No	4	7	medium	low	0.31
Coryphantha sulcolanata		Spain, United Kingdom, United States	No	3	3	medium	low	0.17
Coryphantha tripugionacantha		Germany	No	1	1	low	low	0.06
Coryphantha unicornis		United Kingdom	No	1	1	low	low	0.06

Appendix 3
Taxa Identified in Mexican and International Trade *(continued)*

Taxon	Conservation Status	Countries Trading	Wild-Collected Specimens in Mexican Trade?	Number of Countries	Number of Nurseries	Availability by Country	Availability by Nursery	SAI
Coryphantha vaupeliana		United States	No	1	1	low	low	0.06
Coryphantha vogtherriana		Spain	No	1	1	low	low	0.06
Coryphantha werdermannii	CITES App. I; endangered (IUCN); in danger (NOM)	United States	No	1	2	low	low	0.09
Echinocactus grusonii	Endangered (IUCN); in danger (NOM)	Germany, Italy, Mexico, Spain, Sweden, United Kingdom, United States	No	7	28	high	high	1.00
Echinocactus horizonthalonius	Vulnerable (IUCN)	Germany, Italy, United Kingdom, United States	No	4	8	medium	low	0.34
Echinocactus parryi	Vulnerable (IUCN); threatened (NOM)	United States	No	1	1	low	low	0.06
Echinocactus platyacanthus	Vulnerable (IUCN); special protection (NOM)	Germany, Italy, Mexico, Sweden, United Kingdom, United States	Yes	6	15	high	medium	0.60
Echinocactus texensis		Germany, Italy, Mexico, Sweden, United Kingdom, United States	Yes	6	15	high	medium	0.60
Echinocereus adustus	Vulnerable (IUCN); threatened (NOM)	Germany, Sweden, United Kingdom, United States	No	4	5	medium	low	0.26
Echinocereus berlandieri		Sweden, United Kingdom, United States	No	3	3	medium	low	0.17
Echinocereus chisoensis	Vulnerable (IUCN)	Germany, United Kingdom, United States	No	3	5	medium	low	0.23
Echinocereus cinerascens		Mexico, Spain, Sweden, United States	Yes	4	5	medium	low	0.26
Echinocereus coccineus	Vulnerable (IUCN)	Germany, Sweden, United Kingdom, United States	No	4	11	medium	medium	0.43
Echinocereus dasyacanthus		Germany, United States	No	2	5	low	low	0.20
Echinocereus enneacanthus		Germany, Italy, Sweden, United Kingdom, United States	No	5	11	high	medium	0.46
Echinocereus knippelianus	Vulnerable (IUCN); threatened (NOM)	Germany, Italy, Spain, Sweden, United Kingdom, United States	No	6	11	high	medium	0.49
Echinocereus mojavensis		Germany, United Kingdom, United States	No	3	6	medium	low	0.26
Echinocereus nicholii	Vulnerable (IUCN)	Germany, United Kingdom, United States	No	3	5	medium	low	0.23
Echinocereus nivosus	Rare (IUCN); rare (NOM)	Germany, Spain, United Kingdom, United States	No	4	6	medium	low	0.29
Echinocereus palmeri	Endangered (IUCN); in danger (NOM)	Germany, United States	No	2	3	low	low	0.14
Echinocereus pamanesiorum	Indeterminate (IUCN)	Sweden, United Kingdom, United States	No	3	3	medium	low	0.17
Echinocereus papillosus	Rare (IUCN)	Germany, Sweden, United Kingdom, United States	No	4	5	medium	low	0.26
Echinocereus parkeri		Germany, United Kingdom, United States	No	3	4	medium	low	0.20
Echinocereus pectinatus		Germany, Italy, Mexico, Spain, Sweden, United Kingdom, United States	Yes	7	16	high	medium	0.66

Appendix 3
Taxa Identified in Mexican and International Trade *(continued)*

Taxon	Conservation Status	Countries Trading	Wild-Collected Specimens in Mexican Trade?	Number of Countries	Number of Nurseries	Availability by Country	Availability by Nursery	SAI
Coryphantha vaupeliana		United States	No	1	1	low	low	0.06
Echinocereus pentalophus		Canada, Germany, Italy, Sweden, United Kingdom, United States	Yes	6	13	high	medium	0.54
Echinocereus polyacanthus		Germany, Sweden, United Kingdom, United States	No	4	7	medium	low	0.31
Echinocereus poselgeri	In danger (NOM)	Italy, Mexico, Spain, Sweden, United Kingdom, United States	No	6	11	high	medium	0.49
Echinocereus primolanatus		Sweden, United Kingdom, United States	No	3	3	medium	low	0.17
Echinocereus pseudopectinatus		United States	No	1	1	low	low	0.06
Echinocereus pulchellus	Endangered (IUCN); threatened (NOM)	Germany, United Kingdom, United States	No	3	7	medium	low	0.29
Echinocereus rayonesensis	Rare (IUCN)	United Kingdom, United States	No	2	2	low	low	0.11
Echinocereus reichenbachii	Rare (IUCN); threatened (NOM)	Germany, Italy, Sweden, United Kingdom, United States	No	5	15	high	medium	0.57
Echinocereus rigidissimus		Germany, Sweden, United Kingdom, United States	No	4	12	medium	medium	0.46
Echinocereus russanthus		Germany, Sweden, United States	No	3	7	medium	low	0.29
Echinocereus scheeri		Germany, Sweden, United Kingdom, United States	No	4	7	medium	low	0.31
Echinocereus schmollii	CITES App. I; endangered (IUCN); in danger (NOM)	Italy, Mexico, Sweden, United States	No	4	12	medium	medium	0.46
Echinocereus spinigemmatus		Germany, United Kingdom, United States	No	3	3	medium	low	0.17
Echinocereus stramineus		Germany, United States	No	2	7	low	low	0.26
Echinocereus triglochidiatus	Indeterminate (IUCN)	Germany, Sweden, United Kingdom, United States	No	4	11	medium	medium	0.43
Echinocereus viereckii	Vulnerable (IUCN)	Germany, Spain, United Kingdom, United States	No	4	8	medium	low	0.34
Echinocereus viridiflorus	Endangered (IUCN)	Germany, Spain, Sweden, United Kingdom, United States	No	5	16	high	medium	0.60
Echinocereus waldeisii		Spain, United States	No	2	3	low	low	0.14
Epithelantha bokei	Vulnerable (IUCN); threatened (NOM)	United Kingdom, United States	No	2	4	low	low	0.17
Epithelantha micromeris	Endangered (IUCN); rare (NOM)	Germany, Italy, Mexico, Spain, Sweden, United Kingdom, United States	No	7	13	high	medium	0.57
Escobaria aguirreana	Rare (IUCN); rare (NOM)	Germany, Sweden, United Kingdom, United States	No	4	5	medium	low	0.26
Escobaria albicolumnaria	Vulnerable (IUCN)	Germany, Spain, Sweden, United Kingdom	No	4	4	medium	low	0.23
Escobaria chihuahuensis		Germany, Italy, Mexico, United States	No	4	9	medium	medium	0.37

Appendix 3
Taxa Identified in Mexican and International Trade *(continued)*

Taxon	Conservation Status	Countries Trading	Wild-Collected Specimens in Mexican Trade?	Number of Countries	Number of Nurseries	Availability by Country	Availability by Nursery	SAI
Escobaria cubensis	Endangered (IUCN)	United States	No	1	1	low	low	0.06
Escobaria dasyacantha	Indeterminate (IUCN)	Sweden, United Kingdom, United States	No	3	6	medium	low	0.26
Escobaria duncanii		Sweden, United Kingdom, United States	No	3	5	medium	low	0.23
Escobaria emskoetteriana		Germany, Spain, Sweden, United Kingdom, United States	No	5	6	high	low	0.31
Escobaria guadalupensis	Endangered (IUCN)	Spain, United States	No	2	2	low	low	0.11
Escobaria hesteri		Germany, United Kingdom, United States	No	3	7	medium	low	0.29
Escobaria laredoi Rare	(IUCN); rare (NOM)	Italy, Spain, United Kingdom, United States	No	4	6	medium	low	0.29
Escobaria lloydii		United Kingdom, United States	No	2	2	low	low	0.11
Escobaria minima	CITES App. I; endangered (IUCN)	Germany, Spain, Sweden, United Kingdom, United States	No	5	7	high	low	0.34
Escobaria missouriensis	Threatened (NOM)	Germany, Sweden, United Kingdom, United States	No	4	5	medium	low	0.26
Escobaria orcuttii	Rare (IUCN)	Germany, Italy, Sweden, United States	No	4	4	medium	low	0.23
Escobaria organensis	Vulnerable (IUCN)	United States	No	1	1	low	low	0.06
Escobaria robbinsorum	Endangered (IUCN)	United States	No	1	2	low	low	0.09
Escobaria roseana	Rare (IUCN); rare (NOM)	Germany, United Kingdom, United States	No	3	5	medium	low	0.23
Escobaria sandbergii	Vulnerable (IUCN)	United Kingdom, United States	No	2	2	low	low	0.11
Escobaria sneedii	CITES App. I; vulnerable (IUCN)	Germany, Spain, Sweden, United Kingdom, United States	No	5	8	high	low	0.37
Escobaria tuberculosa		Spain, Sweden, United Kingdom, United States	No	4	7	medium	low	0.31
Escobaria villardii	Vulnerable (IUCN)	United Kingdom, United States	No	2	2	low	low	0.11
Escobaria vivipara	Rare (IUCN)	Germany, Italy, Spain, Sweden, United States	No	5	16	high	medium	0.60
Escobaria zilziana		Sweden, United Kingdom, United States	No	3	4	medium	low	0.20
Ferocactus echidne		Germany, Mexico, Sweden, United Kingdom, United States	No	5	10	high	medium	0.43
Ferocactus glaucescens		Germany, Mexico, Spain, United Kingdom, United States	No	5 1	3	high	medium	0.51
Ferocactus hamatacanthus		Germany, Spain, Sweden, United Kingdom, United States	No	5	11	high	medium	0.46
Ferocactus histrix		Italy, Mexico, United Kingdom, United States	No	4	7	medium	low	0.31
Ferocactus latispinus		Germany, Italy, Mexico, Spain, Sweden, United Kingdom, United States	Yes	7	24	high	high	0.89

Appendix 3
Taxa Identified in Mexican and International Trade *(continued)*

Taxon	Conservation Status	Countries Trading	Wild-Collected Specimens in Mexican Trade?	Number of Countries	Number of Nurseries	Availability by Country	Availability by Nursery	SAI
Ferocactus macrodiscus		Germany, Mexico, Spain, Sweden, United Kingdom, United States	No	6	14	high	medium	0.57
Ferocactus pilosus	Vulnerable (IUCN); threatened (NOM)	Germany, Mexico, Spain, Sweden, United Kingdom, United States	Yes	6	15	high	medium	0.60
Geohintoniia mexicana	Rare (NOM)	Mexico, United Kingdom	No	2	4	low	low	0.17
Hamatocactus crassihamatus	Threatened (NOM)	Germany, Italy, United Kingdom, United States	No	4	5	medium	low	0.26
Isolatocereus dumortieri		Germany, Mexico, United States	No	3	5	medium	low	0.23
Leuchtenbergia principis	Rare (IUCN); threatened (NOM)	Germany, Italy, Mexico, Spain, Sweden, United Kingdom, United States	No	7	20	high	high	0.77
Lophophora diffusa	Rare (IUCN); threatened (NOM)	Mexico	No	1	1	low	low	0.06
Lophophora williamsii	Special protection (NOM)	Germany, Italy, Mexico, Spain, Sweden, United Kingdom, United States	No	7	9	high	medium	0.46
Mammillaria albata		Germany	No	1	1	low	low	0.06
Mammillaria albicoma	Vulnerable (IUCN); threatened (NOM)	Germany, United States	No	2	6	low	low	0.23
Mammillaria aureilanata	Vulnerable (IUCN); threatened (NOM)	Germany, Mexico, Sweden, United States	No	4	5	medium	low	0.26
Mammillaria barbata		Germany, Spain, United States	No	3	4	medium	low	0.20
Mammillaria baumii	Rare (IUCN); rare (NOM)	Germany, United Kingdom, United States	No	3	6	medium	low	0.26
Mammillaria bocasana	Vulnerable (IUCN); threatened (NOM)	Germany, Mexico, Spain, Sweden, United Kingdom, United States	No	6	17	high	high	0.66
Mammillaria bombycina	Rare (IUCN); rare (NOM)	Germany, Mexico, Spain, United Kingdom, United States	No	5	10	high	medium	0.43
Mammillaria camptotricha		Germany, Mexico, Spain, Sweden, United Kingdom, United States	No	6	16	high	medium	0.63
Mammillaria candida	Indeterminate (IUCN); threatened (NOM)	Germany, Mexico, Sweden, United Kingdom, United States	Yes	5	13	high	medium	0.51
Mammillaria carmenae	Endangered (IUCN); in danger (NOM)	Germany, Mexico, Spain, United Kingdom, United States	No	5	10	high	medium	0.43
Mammillaria carretii	Vulnerable (IUCN); rare (NOM)	Germany, United Kingdom, United States	No	3	5	medium	low	0.23
Mammillaria coahuilensis	Vulnerable (IUCN); threatened (NOM)	Germany, Sweden, United Kingdom, United States	No	4	7	medium	low	0.31
Mammillaria compressa		Mexico, United Kingdom, United States	No	3	9	medium	medium	0.34
Mammillaria craigii		Germany, Spain	No	2	2	low	low	0.11
Mammillaria crinita		Mexico, United States	No	2	3	low	low	0.14
Mammillaria decipiens		Germany, Spain, United Kingdom, United States	No	4	4	medium	low	0.23

Appendix 3
Taxa Identified in Mexican and International Trade *(continued)*

Taxon	Conservation Status	Countries Trading	Wild-Collected Specimens in Mexican Trade?	Number of Countries	Number of Nurseries	Availability by Country	Availability by Nursery	SAI
Mammillaria densispina		Germany, Sweden, United Kingdom, United States	Yes	4	5	medium	low	0.26
Mammillaria elongata		Canada, Germany, Mexico, Spain, United Kingdom, United States	Yes	6	20	high	high	0.74
Mammillaria erythrosperma		United Kingdom, United States	No	2	2	low	low	0.11
Mammillaria formosa		Germany, Sweden, United Kingdom, United States	No	4	9	medium	medium	0.37
Mammillaria geminispina		Germany, Italy, Mexico, Spain, United Kingdom, United States	Yes	6	16	high	medium	0.63
Mammillaria gigantea		Germany, United Kingdom, United States	No	3	5	medium	low	0.23
Mammillaria gilensis		Sweden, United States	No	2	5	low	low	0.20
Mammillaria glassii	Rare (IUCN)	Germany, Mexico, Spain, Sweden, United Kingdom, United States	No	6	10	high	medium	0.46
Mammillaria grahamii		Germany, United Kingdom	No	2	5	low	low	0.20
Mammillaria grusonii	Rare (IUCN); rare (NOM)	United States	No	1	4	low	low	0.14
Mammillaria guelzowiana	Vulnerable (IUCN); threatened (NOM)	Germany, Sweden, United States	No	3	8	medium	low	0.31
Mammillaria guillauminiana		Germany, United States	No	2	2	low	low	0.11
Mammillaria herrerae	Vulnerable (IUCN); in danger (NOM)	Germany, Mexico, United States	No	3	7	medium	low	0.29
Mammillaria heyderi		Germany, Spain, United Kingdom, United States	No	4	11	medium	medium	0.43
Mammillaria humboldtii	Vulnerable (IUCN); threatened (NOM)	Germany, Italy, United Kingdom, United States	No	4	7	medium	low	0.31
Mammillaria klissingiana	Vulnerable (IUCN); threatened (NOM)	Germany, Spain, United Kingdom, United States	No	4	5	medium	low	0.26
Mammillaria lasiacantha		Germany, United Kingdom, United States	No	3	11	medium	medium	0.40
Mammillaria laui	Indeterminate (IUCN); in danger (NOM)	Germany, United Kingdom, United States	No	3	7	medium	low	0.29
Mammillaria lenta	Vulnerable (IUCN); threatened (NOM)	Germany, United Kingdom, United States	No	3	11	medium	medium	0.40
Mammillaria leucantha		United States	No	1	1	low	low	0.06
Mammillaria lindsayi	Rare (IUCN); rare (NOM)	Germany, United States	No	2	2	low	low	0.11
Mammillaria longicoma		United Kingdom	No	1	1	low	low	0.06
Mammillaria longiflora	Vulnerable (IUCN); threatened (NOM)	Germany, United States	No	2	5	low	low	0.20
Mammillaria longimamma	Threatened (NOM)	Germany, Mexico, Spain, United Kingdom, United States	Yes	5	12	high	medium	0.49
Mammillaria luethyi		Mexico	No	1	3	low	low	0.11
Mammillaria magallanii		Germany, United States	No	2	5	low	low	0.20

Appendix 3
Taxa Identified in Mexican and International Trade *(continued)*

Taxon	Conservation Status	Countries Trading	Wild-Collected Specimens in Mexican Trade?	Number of Countries	Number of Nurseries	Availability by Country	Availability by Nursery	SAI
Mammillaria magnimmama		Italy, Mexico, Spain, Sweden, United Kingdom, United States	Yes	6	19	high	high	0.71
Mammillaria mathildae	Vulnerable (IUCN); threatened (NOM)	Mexico, United States	No	2	3	low	low	0.14
Mammillaria meiacantha		Spain, Sweden, United Kingdom, United States	No	4	5	medium	low	0.26
Mammillaria melaleuca	Vulnerable (IUCN); threatened (NOM)	Germany, United Kingdom, United States	No	3	6	medium	low	0.26
Mammillaria melanocentra		United Kingdom, United States	No	2	6	low l	ow	0.23
Mammillaria microhelia	Rare (IUCN); rare (NOM)	Germany, Spain, Sweden, United States	No	4	5	medium	low	0.26
Mammillaria microthele		Germany, United Kingdom, United States	No	3	8	medium	low	0.31
Mammillaria moelleriana	Rare (IUCN); rare (NOM)	Germany, United Kingdom, United States	No	3	6	medium	low	0.26
Mammillaria mollendorffiana		Spain, United States	No	2	2	low	low	0.11
Mammillaria morricalii		Sweden, United Kingdom, United States	No	3	3	medium	low	0.17
Mammillaria muehlenpfordtii		United Kingdom, United States	No	2	4	low	low	0.17
Mammillaria nana	Rare (IUCN); rare (NOM)	Germany, Mexico, Spain, Sweden, United Kingdom, United States	No	6	11	high	medium	0.49
Mammillaria painteri	Rare (IUCN); rare (NOM)	Mexico, United States	No	2	2	low	low	0.11
Mammillaria parkinsonii	Rare (IUCN); rare (NOM)	Germany, Mexico, Spain, Sweden, United Kingdom, United States	No	6	11	high	medium	0.49
Mammillaria pennispinosa	Rare (IUCN); rare (NOM)	Germany, United Kingdom, United States	No	3	5	medium	low	0.23
Mammillaria perbella		Germany, Italy, Mexico, Spain, United Kingdom, United States	No	6	8	high	low	0.40
Mammillaria petterssonii		Germany, United Kingdom, United States	No	3	7	medium	low	0.29
Mammillaria picta		United States	No	1	2	low	low	0.09
Mammillaria pilispina	Rare (IUCN); rare (NOM)	Mexico, United Kingdom, United States	No	3	3	medium	low	0.17
Mammillaria plumosa	Indeterminate (IUCN); threatened (NOM)	Germany, Italy, Mexico, Spain, Sweden, United Kingdom, United States	No	7	16	high	medium	0.66
Mammillaria polythele		Germany, Mexico, United Kingdom, United States	Yes	4	8	medium	low	0.34
Mammillaria pottsii		United Kingdom, United States	No	2	6	low	low	0.23
Mammillaria pringlei	Rare (IUCN); rare (NOM)	Mexico, Spain, United States	No	3	3	medium	low	0.17
Mammillaria prolifera		Canada, Germany, Mexico, Spain, United Kingdom, United States	No	6	13	high	medium	0.54
Mammillaria pygmaea		United States	No	1	2	low	low	0.09

Appendix 3
Taxa Identified in Mexican and International Trade *(continued)*

Taxon	Conservation Status	Countries Trading	Wild-Collected Specimens in Mexican Trade?	Number of Countries	Number of Nurseries	Availability by Country	Availability by Nursery	SAI
Mammillaria rettigiana	Rare (IUCN); rare (NOM)	United States	No	1	1	low	low	0.06
Mammillaria rhodantha		Germany, Spain, Sweden, United States	No	4	13	medium	medium	0.49
Mammillaria ritteriana		United States	No	1	1	low	low	0.06
Mammillaria roseoalba	Rare (IUCN); rare (NOM)	Germany, United States	No	2	2	low	low	0.11
Mammillaria roseocentra		Germany, United States	No	2	4	low	low	0.17
Mammillaria rubrograndis	Rare (IUCN); rare (NOM)	United States	No	1	3	low	low	0.11
Mammillaria saboae	Vulnerable (IUCN); threatened (NOM)	Canada, Germany, Italy, United Kingdom, United States	No	5	8	high	low	0.37
Mammillaria saetigera		United States	No	1	2	low	low	0.09
Mammillaria schiedeana	Vulnerable (IUCN); threatened (NOM)	Germany, Mexico, United Kingdom, United States	No	4	8	medium	low	0.34
Mammillaria schwarzii	Rare (IUCN); rare (NOM)	Germany, United States	No	2	6	low	low	0.23
Mammillaria sempervivi		United Kingdom, United States	No	2	4	low	low	0.17
Mammillaria senilis	Vulnerable (IUCN); threatened (NOM)	Canada, Mexico, United Kingdom, United States	No	4	8	medium	low	0.34
Mammillaria sinistrohamata		Sweden, United Kingdom, United States	No	3	3	medium	low	0.17
Mammillaria sphaerica		Germany, Sweden, United Kingdom, United States	No	4	8	medium	low	0.34
Mammillaria stella-de-tacubaya	Rare (IUCN); rare (NOM)	Germany, United States	No	2	4	low	low	0.17
Mammillaria surculosa	Rare (IUCN); rare (NOM)	Germany, Mexico, Spain, United States	No	4	7	medium	low	0.31
Mammillaria theresae	Vulnerable (IUCN); threatened (NOM)	Germany, Italy, United Kingdom, United States	No	4	4	medium	low	0.23
Mammillaria uncinata		Mexico, United States	Yes	2	5	low	low	0.20
Mammillaria vagaspina		Germany	No	1	1	low	low	0.06
Mammillaria wagneriana		Germany, United States	No	2	4	low	low	0.17
Mammillaria weingartiana	Vulnerable (IUCN); threatened (NOM)	United States	No	1	1	low	low	0.06
Mammillaria wildii		Mexico, United States	No	2	5	low	low	0.20
Mammillaria wintrerae		Germany, United Kingdom, United States	No	3	5	medium	low	0.23
Mammillaria wrightii	Rare (IUCN)	Germany, Sweden, United Kingdom, United States	No	4	7	medium	low	0.31
Mammillaria zacatecasensis		United States	No	1	2	low	low	0.09
Mammillaria zephyranthoides	Vulnerable (IUCN); threatened (NOM)	Germany, Italy, United States	No	3	7	medium	low	0.29
Myrtillocactus geometrizans		Germany, Italy, Mexico, Spain, Sweden, United Kingdom, United States	No	7	19	high	high	0.74

Appendix 3
Taxa Identified in Mexican and International Trade *(continued)*

Taxon	Conservation Status	Countries Trading	Wild-Collected Specimens in Mexican Trade?	Number of Countries	Number of Nurseries	Availability by Country	Availability by Nursery	SAI
Neolloydia conoidea		Mexico, United Kingdom, United States	No	3	7	medium	low	0.29
Obregonia denegrii	CITES App. I; rare (IUCN); threatened (NOM)	Germany, Italy, Mexico, Spain, Sweden, United Kingdom, United States	No	7	16	high	medium	0.66
Opuntia aciculata		United States	No	1	1	low	low	0.06
Opuntia atrispina		Sweden, United States	No	2	2	low	low	0.11
Opuntia aureispina	Endangered (IUCN)	United States	No	1	1	low	low	0.06
Opuntia brachyarthra		Germany, United States	No	2	2	low	low	0.11
Opuntia bradtiana		Germany, United States	No	2	3	low	low	0.14
Opuntia bulbispina		Spain, United States	No	2	2	low	low	0.11
Opuntia camanchica		Sweden, United States	No	2	2	low	low	0.11
Opuntia chaffeyi	Rare (IUCN)	United States	No	1	1	low	low	0.06
Opuntia chisosensis		Sweden, United States	No	2	2	low	low	0.11
Opuntia chlorotica		United States	No	1	2	low	low	0.09
Opuntia clavata	Rare (IUCN)	United Kingdom, United States	No	2	4	low	low	0.17
Opuntia corrugata		United States	No	1	1	low	low	0.06
Opuntia cymochila		Sweden, United States	No	2	3	low	low	0.14
Opuntia davisii		United States	No	1	1	low	low	0.06
Opuntia durangensis		United States	No	1	1	low	low	0.06
Opuntia emoryi		United States	No	1	1	low	low	0.06
Opuntia engelmannii		Germany, Sweden, United Kingdom, United States	No	4	8	medium	low	0.34
Opuntia erinacea		Germany, Sweden, United Kingdom, United States	No	4	7	medium	low	0.31
Opuntia grahamii		United States	No	1	1	low	low	0.06
Opuntia imbricata		Germany, Sweden, United States	No	3	9	medium	medium	0.34
Opuntia kleiniae		United States	No	1	2	low	low	0.09
Opuntia laevis		Sweden, United States	No	2	3	low	low	0.14
Opuntia leptocaulis		Germany, Italy, United States	No	3	6	medium	low	0.26
Opuntia leucotricha		United States	No	1	1	low	low	0.06
Opuntia lindheimeri		United States	No	1	1	low	low	0.06

Appendix 3
Taxa Identified in Mexican and International Trade *(continued)*

Taxon	Conservation Status	Countries Trading	Wild-Collected Specimens in Mexican Trade?	Number of Countries	Number of Nurseries	Availability by Country	Availability by Nursery	SAI
Opuntia linguiformis	Extinct (IUCN)	United States	No	1	3	low	low	0.11
Opuntia macrocentra		United Kingdom, United States	No	2	10	low	medium	0.34
Opuntia macrorhiza		Germany, Sweden, United States	No	3	7	medium	low	0.29
Opuntia microdasys	Rare (IUCN)	Germany, Mexico, United Kingdom, United States	Yes	4	17	medium	high	0.60
Opuntia parishii		United States	No	1	1	low	low	0.06
Opuntia phaeacantha		Germany, Italy, Sweden, United Kingdom, United States	No	5	12	high	medium	0.49
Opuntia pubescens		United States	No	1	1	low	low	0.06
Opuntia pulchella		United States	No	1	1	low	low	0.06
Opuntia robusta		United Kingdom, United States	No	2	5	low	low	0.20
Opuntia rufida		United States	No	1	2	low	low	0.09
Opuntia rutila		Germany, United States	No	2	2	low	low	0.11
Opuntia santa-rita	Vulnerable (IUCN)	United States	No	1	2	low	low	0.09
Opuntia schottii		United States	No	1	1	low	low	0.06
Opuntia sphaerocarpa		Germany	No	1	1	low	low	0.06
Opuntia spinosior		Germany, United States	No	2	3	low	low	0.14
Opuntia stenopetala		Germany, United States	No	2	2	low	low	0.11
Opuntia tomentosa		United States	No	1	2	low	low	0.09
Opuntia trichophora		United States	No	1	2	low	low	0.09
Opuntia tunicata		Italy, United States	No	2	3	low	low	0.14
Pelecyphora aselliformis	CITES App. I; rare (IUCN); threatened (NOM)	Italy, Mexico, Spain, United States	No	4	5	medium	low	0.26
Pelecyphora strobiliformis	CITES App. I; vulnerable (IUCN); in danger (NOM)	Italy, Mexico, United Kingdom, United States	No	4	8	medium	low	0.34
Peniocereus greggii	Rare (IUCN); rare (NOM)	United Kingdom, United States	No	2	4	low	low	0.17
Sclerocactus brevihamatus	CITES App. I	Italy, Spain, United States	No	3	5	medium	low	0.23
Sclerocactus brevispinus		United States	No	1	1	low	low	0.06
Sclerocactus erectocentrus	CITES App. I; rare (IUCN); in danger (NOM)	Germany, United States	No	2	2	low	low	0.11
Sclerocactus glaucus	CITES App. I; rare (IUCN)	Sweden, United Kingdom, United States	No	3	3	medium	low	0.17
Sclerocactus intertextus	Threatened (NOM)	Germany, Italy, Sweden, United Kingdom, United States	No	5	9	high	medium	0.40

Appendix 3
Taxa Identified in Mexican and International Trade *(continued)*

Taxon	Conservation Status	Countries Trading	Wild-Collected Specimens in Mexican Trade?	Number of Countries	Number of Nurseries	Availability by Country	Availability by Nursery	SAI
Sclerocactus johnsonii		Italy, United States	No	2	3	low	low	0.14
Sclerocactus mariposensis	CITES App. I; vulnerable (IUCN); threatened (NOM)	United States	No	1	1	low	low	0.06
Sclerocactus mesae-verdae	CITES App. I; vulnerable (IUCN)	Sweden, United States	No	2	2	low	low	0.11
Sclerocactus nyensis		United States	No	1	1	low	low	0.06
Sclerocactus parviflorus	Rare (IUCN)	United Kingdom, United States	No	2	2	low	low	0.11
Sclerocactus polyancistrus		Sweden, United States	No	2	2	low	low	0.11
Sclerocactus pubispinus	CITES App. I	United States	No	1	1	low	low	0.06
Sclerocactus scheeri		Germany, Italy, Mexico, United Kingdom, United States	No	5	11	high	medium	0.46
Sclerocactus spinosior	Vulnerable (IUCN)	Italy, United Kingdom, United States	No	3	3	medium	low	0.17
Sclerocactus uncinatus	Threatened (NOM)	Italy, Mexico, Spain, Sweden, United States	Yes	5	9	high	medium	0.40
Sclerocactus unguispinus	Rare (IUCN); rare (NOM)	Germany, Italy, United States	No	3	3	medium	low	0.17
Sclerocactus warnockii	Rare (NOM)	United States	No	1	3	low	low	0.11
Sclerocactus whipplei		Sweden, United Kingdom, United States	No	3	4	medium	low	0.20
Sclerocactus wrightiae	CITES App. I; endangered (IUCN)	United States	No	1	1	low	low	0.06
Stenocactus coptonogonus	Rare (IUCN); rare (NOM)	Germany, Italy, Sweden, United Kingdom, United States	No	5	9	high	medium	0.40
Stenocactus crispatus		Germany, Mexico, Sweden, United Kingdom, United States	No	5	6	high	low	0.31
Stenocactus multicostatus		Germany, Italy, Spain, Sweden, United Kingdom, United States	No	6	12	high	medium	0.51
Stenocactus obvallatus		Italy, Sweden, United Kingdom, United States	No	4	6	medium	low	0.29
Stenocactus ochoterenanus		Germany, Mexico, United Kingdom, United States	No	4	5	medium	low	0.26
Stenocactus phyllacanthus		Germany, Sweden, United Kingdom, United States	No	4	5	medium	low	0.26
Stenocactus vaupelianus		Germany, Sweden, United Kingdom, United States	No	4	6	medium	low	0.29
Stenocereus griseus		Mexico, United States	Yes	2	4	low	low	0.17
Stenocereus marginatus		Italy, United Kingdom, United States	No	3	6	medium	low	0.26
Stenocereus pruinosus		United States	No	1	4	low	low	0.14
Strombocactus disciformis	CITES App. I; threatened (NOM)	Germany, Italy, Mexico, Sweden, United States	Yes	5	13	high	medium	0.51

Appendix 3
Taxa Identified in Mexican and International Trade *(continued)*

Taxon	Conservation Status	Countries Trading	Wild-Collected Specimens in Mexican Trade?	Number of Countries	Number of Nurseries	Availability by Country	Availability by Nursery	SAI
Thelocactus bicolor	Vulnerable (IUCN); threatened (NOM)	Germany, Italy, Mexico, Spain, Sweden, United Kingdom, United States	Yes	7	17	high	high	0.69
Thelocactus conothelos	Vulnerable (IUCN)	Germany, Spain, Sweden, United Kingdom, United States	No	5	8	high	low	0.37
Thelocactus hastifer	Vulnerable (IUCN); rare (NOM)	Mexico, Spain, United States	No	3	8	medium	low	0.31
Thelocactus heterochromus	Rare (IUCN); threatened (NOM)	Germany, United States	No	2	4	low	low	0.17
Thelocactus hexadrophorus		Germany, Italy, Mexico, United Kingdom, United States	No	5	13	high	medium	0.51
Thelocactus lausseri		Germany, United States	No	2	4	low	low	0.17
Thelocactus leucacanthus	Rare (NOM)	Germany, Sweden, United States	No	3	5	medium	low	0.23
Thelocactus macdowellii	Vulnerable (IUCN); threatened (NOM)	Germany, United Kingdom, United States	No	3	8	medium	low	0.31
Thelocactus rinconensis	Rare (IUCN); threatened (NOM)	Germany, Italy, Sweden, United Kingdom, United States	No	5	10	high	medium	0.43
Thelocactus setispinus		Germany, Spain, Sweden, United Kingdom, United States	No	5	12	high	medium	0.49
Thelocactus tulensis	Vulnerable (IUCN); threatened (NOM)	Germany, Italy, United Kingdom, United States	No	4	7	medium	low	0.31
Turbinicarpus alonsoi	CITES App. I	Mexico, United Kingdom, United States	No	3	3	medium	low	0.17
Turbinicarpus beguinii	CITES App. I	Germany, Italy, United Kingdom, United States	No	4	6	medium	low	0.29
Turbinicarpus bonatzii	CITES App. I	United Kingdom, United States	No	2	3	low	low	0.14
Turbinicarpus gielsdorfianus	CITES App. I; vulnerable (IUCN); threatened (NOM)	Germany, Italy, Mexico, Spain, Sweden, United Kingdom, United States	No	7	9	high	medium	0.46
Turbinicarpus hoferi	CITES App. I; vulnerable (IUCN); threatened (NOM)	United Kingdom, United States	No	2	3	low	low	0.14
Turbinicarpus horripilus	CITES App. I	Germany, Mexico, Spain, Sweden, United Kingdom, United States	No	6	8	high	low	0.40
Turbinicarpus jauernigii	CITES App. I	Germany, United Kingdom, United States	No	3	4	medium	low	0.20
Turbinicarpus knuthianus	CITES App. I; rare (IUCN)	Germany, United Kingdom, United States	No	3	6	medium	low	0.26
Turbinicarpus laui	CITES App. I; vulnerable (IUCN); threatened (NOM)	Italy, Mexico, Sweden, United Kingdom, United States	No	5	6	high	low	0.31
Turbinicarpus lophophoroides	CITES App. I; vulnerable (IUCN); threatened (NOM)	Germany, Italy, Mexico, Spain, Sweden, United Kingdom, United States	No	7	10	high	medium	0.49
Turbinicarpus pseudo-macrochele	CITES App. I; vulnerable (IUCN); in danger (NOM)	Germany, Italy, Mexico, Spain, United Kingdom, United States	No	6	12	high	medium	0.51
Turbinicarpus pseudo-pectinatus	CITES App. I; rare (NOM)	Germany, Italy, Spain, Sweden, United Kingdom, United States	No	6	11	high	medium	0.49

Appendix 3
Taxa Identified in Mexican and International Trade *(continued)*

Taxon	Conservation Status	Countries Trading	Wild-Collected Specimens in Mexican Trade?	Number of Countries	Number of Nurseries	Availability by Country	Availability by Nursery	SAI
Turbinicarpus rioverdensis	CITES App. I	United Kingdom	No	1	1	low	low	0.06
Turbinicarpus saueri	CITES App. I; indeterminate (IUCN); threatened (NOM)	Italy, United Kingdom, United States	No	3	4	medium	low	0.20
Turbinicarpus schmie-dickeanus	CITES App. I; vulnerable (IUCN); threatened (NOM)	Germany, Italy, Mexico, Spain, Sweden, United Kingdom, United States	No	7	17	high	high	0.69
Turbinicarpus subterraneus	CITES App. I; vulnerable (IUCN); threatened (NOM)	Germany, Italy, Sweden, United States	No	4	5	medium	low	0.26
Turbinicarpus swobodae	CITES App. I; vulnerable (IUCN); threatened (NOM)	Germany, Spain, Sweden, United Kingdom, United States	No	5	8	high	low	0.37
Turbinicarpus valdezianus	CITES App. I; threatened (NOM)	Germany, Italy, Mexico, Spain, Sweden, United Kingdom, United States	No	7	16	high	medium	0.66
Turbinicarpus viereckii	CITES App. I; threatened (NOM)	Germany, United Kingdom, United States	No	3	6	medium	low	0.26
Turbinicarpus ysabelae	CITES App. I; vulnerable (IUCN); threatened (NOM)	Germany, Italy, Mexico, Spain, United States	No	5	6	high	low	0.31

Appendix 4
Nondetermined Species Names, Doubtful Species Names, Hybrid Species, and Related Cactaceae Products Found in International Trade

Nondetermined Species Names

Coryphantha aff. *radians*
Coryphantha glanduligera/schwarziana
Coryphantha sp.
Echinocereus aff. *russanthus*
Echinocereus sp.
Escobaria sp. *nova*
Escobaria sp.
Ferocactus sp.
Lophophora sp.
Mammillaria aff. *brauneana*
Mammillaria aff. *goodridgii*
Mammillaria aff. *hutchisoniana*
Mammillaria aff. *multiseta*
Mammillaria aff. *petterssonii*
Mammillaria cluster
Mammillaria mme. Marnier
Mammillaria sp.
Mammillaria sp. *n.*
Mammillaria sp. *nova*
Myrtillocactus sp.
Opuntia "lenguitas"
Opuntia "pinecone"
Opuntia aff. *laevis*
Opuntia aff. *tunicata*
Opuntia nova
Opuntia nova "kaibabensis"
Opuntia nova "sandiana"
Opuntia sp. aff. *cymochila*
Opuntia sp.
Opuntia variegated
Opuntia yellow
Sclerocactus sp.
Sclerocactus "busekii"
Sclerocactus "gradyi"
Sclerocactus sp.
Stenocactus aff. *phyllacanthus*
Stenocactus sp.
Stenocactus sp. *n.*
Thelocactus sp.
Turbinicarpus sp.
Turbinicarpus sp. *nova*

Doubtful Species Names

Coryphantha bisbeeana
Coryphantha compressa
Coryphantha hesteri
Coryphantha strobiliformus
Echinocereus cucumis
Echinocereus finii
Echinocereus hidalgensis
Echinocereus kohresii
Echinocereus lloydii
Echinocereus octacanthus
Echinocereus oklahomensis
Echinocereus pailanus
Echinocereus plomosus
Echinocereus plumosus
Echinocereus sharpii
Echinocereus spinabarbis
Echinocereus viridiflorus/montanus
Epithelantha neomexicana
Escobaria aningaense
Escobaria chariocantha
Escobaria chisoensis
Escobaria denudatum
Escobaria fossulatus
Escobaria lagunillasense
Escobaria marstonii
Escobaria moelleriana
Escobaria mucidum
Escobaria neuhuberi
Escobaria oenanthemum
Escobaria onychacanthum
Escobaria prolifera
Escobaria riojense
Escobaria spegazzinii
Escobaria wissmannii
Ferocactus gigantea
Ferocactus ingens
Ferocactus sinuatus
Lophophora decipiens

Mammillaria anniae
Mammillaria bachmannii
Mammillaria berkiana
Mammillaria bieselii
Mammillaria boelderliana
Mammillaria dolichotele
Mammillaria ginsa-maru
Mammillaria graessneriana
Mammillaria heliopsis
Mammillaria hirsuta
Mammillaria kladiway
Mammillaria krainziana
Mammillaria lanigera
Mammillaria lents
Mammillaria leptacantha
Mammillaria lloydii
Mammillaria melacantha
Mammillaria microheliopsis
Mammillaria monticola
Mammillaria morganiana
Mammillaria mundtii
Mammillaria nazasensis
Mammillaria obscura
Mammillaria pachycylindrica
Mammillaria pennispina
Mammillaria phaeacantha
Mammillaria pilcomayensis
Mammillaria pink nymph
Mammillaria pitcayensis
Mammillaria priessnitzii
Mammillaria pseudoperbella
Mammillaria pseudosuperbella
Mammillaria rayonensis
Mammillaria rioverdense
Mammillaria saxicola
Mammillaria scheinvariana
Mammillaria seitziana
Mammillaria supraflumen
Mammillaria tlalocii
Mammillaria trichacantha
Mammillaria verticealba
Mammillaria wohlschlageri
Opuntia alta
Opuntia barboana
Opuntia burbankii
Opuntia canada
Opuntia cattispegazzini
Opuntia claude
Opuntia cyclodes
Opuntia diademata
Opuntia dulcis
Opuntia ellisiana
Opuntia fusca
Opuntia gilvescens
Opuntia greenburst
Opuntia gregoriana
Opuntia horstii
Opuntia inarmata
Opuntia inermis
Opuntia lanceolata
Opuntia nopalea
Opuntia perita
Opuntia pharcantha
Opuntia pollaedii
Opuntia pringleii
Opuntia pyrocarpa
Opuntia retrospina
Opuntia rugosa
Opuntia sandiana
Opuntia sanguinicula
Opuntia stenochila
Opuntia strobiliformis
Opuntia sublata
Opuntia tortispina
Opuntia toumeyi
Opuntia ursina
Opuntia valida
Opuntia white
Opuntia xanthostemma
Sclerocactus gradii
Sclerocactus heilii
Stenocactus albidas
Stenocactus bicolor
Stenocactus hookeri
Stenocactus longispinus
Stenocactus parksianus
Stenocactus robustus
Stenocactus schwarzii
Stenocactus tricuspidatus
Stenocactus xiphacanthus
Stenocereus victoriensis
Thelocactus bolaensis
Turbinicarpus lilinkeuiduus
Turbinicarpus macdowelli
Turbinicarpus miquinhana
Turbinicarpus salamanca

Hybrid Species

Ariocarpus agavoides x *A. kotschoubeyanus*
Astrophytum CAPAS
Astrophytum capricorne x *senile*
Astrophytum hybrids
Astrophytum myriostigma x *A. asterias*
Astrophytum myriostigma x ornatun
Astrophytum x *Copiapoa*
Astrophytum x *MYR*
Astrophytum x *MYR-OR*
Astrophytum x *SEN-AS*
Echinocereus hybrid
Echinocereus x *lloydii*
Echinocereus x *roetteri*
Ferocactus hamatacanthus x
Leuchtenbergia principis
Mammillaria carmenae x *laui*
Mammillaria glassii x *laui*
Opuntia fragilis x *polyacantha*
Opuntia pottsii x *phaeacantha*
Opuntia rhodantha x *utahensis*
Opuntia vaseyi
Opuntia viridiflora
Opuntia x *rutilins*
Turbinicarpus hybride
Turbinicarpus roseiflorus
Turbinicarpus x *roseiflorus*

Related Products

Astrophytum mixture
Cactus collection
Collection #15
Coryphantha mixture
Choicer cactus
Echinocereus mix rainbows
Globular cactus
Grand cactus mix
Hamatocactus sp. mix
Mammillaria assortment
Mammillaria mix
Opuntia skeletons

Appendix 5
Mexican Legislation and Regulations Relevant to Cactus Collection and Trade

Presidential Decree (Diario Oficial de la Federación, August 29, 1940)

This presidential decree declares that the conservation of wild orchids and cacti is of public interest. It establishes that export of orchids and cactus species will be authorized only to persons who cultivate and propagate them within licensed establishments. The decree declares wild orchids and cacti as forest resources of public interest, in effect prohibiting export of noncultivated specimens, but provides for permits for collection and propagation of wild specimens. The decree also requires proof of inventories for export authorization.

Presidential Decree (Diario Oficial de la Federación, March 6, 1992)

This presidential decree declares Mexico's accession to the Convention on International Trade in Endangered Species of Wild Fauna and Flora.

Ley Federal de Sanidad Vegetal (Diario Oficial de la Federación, January 5, 1994)

This federal law establishes phytosanitary (plant health) requirements for plant species and material leaving or entering Mexico.

Norma Oficial Mexicana (NOM)-059-ECOL-2001 (Diario Oficial de la Federación, March 6, 2002)

These are regulations prohibiting the commercial extraction of species from the wild that are listed as in danger, threatened, rare or subject to special protection. These regulations, implemented by La Secretaría del Medio Ambiente y Recursos Naturales (SEMARNAT), supersede NOM-059-ECOL 1994. Legal harvest is permissible for scientific purposes or for propagation, provided that valid permits have been obtained. Propagated descendants of the original wild stock may be traded commercially with the approval of the government.

Manual de Procedimientos para Importación y Exportación de Especies de Flora y Fauna Silvestre y Acuática, sus Productos y Subproductos, así como para la Importación de Productos Forestales, Sujetos a Regulación por Parte de la Secretaría de Medio Ambiente, Recursos Naturales y Pesca (Diario Oficial de la Federación, July 31, 1996)

This manual operationalizes and outlines the procedures for importing or exporting species regulated by CITES or listed in the NOM-059-ECOL-2001.

Ley Forestal (Diario Oficial de la Federación, May 20, 1997)

This law regulates the use of nontimber forest products defined as seeds, resins, fibers, gums, waxes, roots, leaves or fleshy leaves, and stems of forest vegetation. Forest vegetation is any plant species characterized as arboreal, shrubby, or xeric growing naturally in temperate or tropical forests.

Norma Oficial Mexicana (NOM)-005-RECNAT-1997 (Diario Oficial de la Federación, May 20, 1997)

These regulations cover the commercial collection and movement of nontimber forest products, including cactus bark, stems, and whole plants. Under this regulation, a technical study conducted by a "registered forest technician," is required before collecting cacti or other nontimber forest products. The study, which is valid for up to five years, should include a detailed population study of the species to be collected. The regulations outline criteria that must be followed for harvesting cactus taxa (*Echinocactus* and *Ferocactus*) used for candy production and ornamental purposes. Cactus species listed in the NOM-059-ECOL-2001 may be harvested for commercial use if authorization is obtained from the federal government.

Norma Oficial Mexicana (NOM)-007-RECNAT-1997 (Diario Oficial de la Federación, May 30, 1997)

These regulations cover the commercial collection of plant parts (branches, leaves, fleshy leaves, flowers, fruits, and seeds) from *Opuntia* species and other cactus taxa for artificial propagation. The regulations outline specific criteria that must be met before wild plant specimens can be collected. For instance, a permit approved by a "registered forest technician" and valid for up to five years is required before harvest and only wild and healthy plants are to be collected for specimens. Harvest is limited to mature individuals, of which 20 percent of the species in question must be left undisturbed and uniformly distributed throughout the area affected by harvest. Specimens from species listed in the NOM-059-ECOL-2001 may be harvested for commercial use if prior authorization is obtained.

Reglamento de la Ley Forestal (Diario Oficial de la Federación, September 25, 1998)

These regulations cover the use of nontimber products and provide rules for "forest technicians."

Norma Oficial Mexicana (NOM)-007-FITO-1995 (Diario Oficial de la Federación, November 30, 1998)

These regulations establish phytosanitary requirements for the importation of propagative plant material. The regulations specify 56 cactus species imported into Mexico from the United States that must be free of the following pathogens: *Henderinia cerei*, *Poria carnegiana*, *Diplotheca tunae*, and *Opogona sacchari*.

Ley General de Vida Silvestre (Diario Oficial de la Federación, July 3, 2000)

This law deals with the sustainable use and conservation of wildlife species and their habitat in Mexico. The law specifies that timber products are to be regulated by the Forestry Law. It covers all plant species, timber or nontimber, listed in the NOM-059-ECOL-2001.

Acuerdo que establece la clasificación y codificación de mercancías cuya importación y exportación esta sujeta a regulación por parte de la Secretaría de Medio Ambiente Recursos Naturales y Pesca (Diario Oficial de la Federación, November 30, 2000)

This accord describes the requirements for importing or exporting regulated merchandise, including CITES species for which authorization and export or import permits are needed from the General Directorate of Wildlife (Dirección General de Vida Silvestre—[DGVS]). Export permits are required from the General Directorate of Wildlife before shipping cacti out of Mexico.

Norma Oficial Mexicana (NOM)-126-ECOL-2000 (Diario Oficial de la Federación, March 20, 2001)

These regulations establish procedures and requirements for collecting wild flora and fauna and other biological resources for scientific purposes.

Decreto que reforma el articulo 7 de la Ley Forestal (Diario Oficial de la Federación, December 31, 2001)

This decree authorizes state, federal, and municipal governments to process applications and permits for nontimber forest products, such as those required by NOM-007-RECNAT-1997.

Decreto por el que se reforman diversas disposiciones de la Ley General de Vida Silvestre (Diario Oficial de la Federación, January 10, 2001)

This decree specifies that all nontimber products, except those included in the NOM-059-ECOL-2001, are regulated by the Forestry Law.

Acuerdo por el que se dan a conocer los formatos y el Manual de Procedimientos para obtener el certificado fitosanitario de los productos y subproductos forestales, cuya importación está sujeta a regulación por parte de la Secretaría de Medio Ambiente y Recursos Naturales. (Diario Oficial de la Federación, January 10, 2001)

This accord outlines the procedures for obtaining phytosanitary certificates for timber and nontimber products.

IUCN
The World Conservation Union

The TRAFFIC Network is the world's largest wildlife trade monitoring program with offices covering most parts of the world. TRAFFIC is a program of WWF-World Wildlife Fund and IUCN-The World Conservation Union, established to monitor trade in wild plants and animals. It works in close cooperation with the Secretariat of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES).

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