

*tephrodes* (Algodones Dunes sunflower), *Croton wigginsii* (Wiggins' croton), *Palafoxia arida* ssp. *gigantea* (giant Spanish needle), *Pholisma* (as *Ammobroma*) *sonorae* (sand food), *Ephedra trifurca* (three-forked ephedra), and *Eriogonum deserticola* (desert eriogonum), are restricted desert psammophytic scrub taxa in the Algodones Dunes (Thorne 1982) while the same author included *Astragalus lentiginosus* var. *borreganus* (Borrego milk-vetch), *Dicorea canescens* (dune bugseed), *Petalonyx thurberi* (sandpaper plant), and *Tiquilia* species as more widely distributed species found off the dunes. Many of these taxa are also found in association with *A. m.* var. *peirsonii* in the Gran Desierto of Sonora, Mexico (Felger 2000). *Astragalus magdalenae* var. *peirsonii* is found on deep, active dunes generally under 20

degrees slope. Usually, one or more of the other psammophytic scrub taxa (Thorne 1982) are also found with *A. m.* var. *peirsonii*. Creosote bush scrub is rarely found in deep sand dunes, but may encroach in adjacent areas especially where the base soil is exposed.

The current known geographical range of *Astragalus magdalenae* var. *peirsonii* in the United States is limited to a narrow band in the central portion of the Algodones Dunes of Imperial County, California. This band runs parallel to the active, linear dunes on the western edge of the dune field in a northwest to southeast direction. The band is between these active linear dunes on the west and transverse ridge dunes to the east. The dunes in this band are composed of a series of transitional crescentic ridges (Muhs *et*

*al.* 1995). Historically *A. m.* var. *peirsonii* was found in Borrego Valley, San Diego County (Barneby 1964). In Mexico, *A. m.* var. *peirsonii* occurs in northeastern Estado de Baja California (Barneby 1959, 1964; Westec 1977; Spellenberg 1993), and in the Gran Desierto of Sonora (Felger 2000).

The Algodones Dunes are one of the largest dune fields in North America. The Algodones Dunes are often referred to as the Imperial Sand Dunes, a designation derived from their inclusion in the Imperial Sand Dunes Recreation Area (ISDRA) established by the BLM. Virtually all lands in the Algodones Dunes are managed by BLM. However, the State of California and private parties own some small inholdings in the dune area (see Table 1).

TABLE 1.—APPROXIMATE AREAS IN ACRES (AC) AND HECTARES (HA) OF PROPOSED CRITICAL HABITAT FOR *Astragalus magdalenae* VAR. *peirsonii* BY LAND OWNERSHIP.

| Unit                  | Federal                              | State                          | Private                          | Total                           |
|-----------------------|--------------------------------------|--------------------------------|----------------------------------|---------------------------------|
| Algodones Dunes ..... | 50,441 ac .....<br>(20,413 ha) ..... | 833 ac .....<br>(337 ha) ..... | 1,506 ac .....<br>(609 ha) ..... | 52,780 ac .....<br>(21,359 ha). |

The dunes extend about 40 miles (mi) (64 kilometers (km)), trending from northwest to southeast (Norris and Norris 1961). Winds from the northwest are prevalent in the winter, while in the summer the winds are from the southeast (Romspert and Burk 1979). This regime is likely responsible for the dune-building (Norris and Norris 1961) and fruit dispersal that result in the persistence of the plants in the dune system. The dunes are generally considered to have formed from sands from Lake Cahuilla that historically occupied the Cahuilla Basin. The western boundary of the dunes is marked by a series of parallel, longitudinal generally southeast trending ridges. The northern third of the dunes is narrow, about 2 mi (3 km) wide, and increases in elevation from 200 to 300 feet (ft) (60–91 meters (m)) in the northern portion to 300 to 400 ft (91 to 121 m) in the southern portion north of Highway 78. Areas in the central portion of the dunes reach an elevation 500 ft (152 m) south of State Highway 78, but reach elevations of only 200 ft (60 m) for most areas just north of Interstate 8. The central portion of the dunes is wider, about 5 mi (8 km), and is characterized by deep bowls (hollows among the dunes) and slip faces (areas so steep that the loose sand naturally cascades downward) that run transverse to the primary ridge line (Norris and Norris 1961). The area south

of Interstate 8 is generally characterized by lower elevation, under 300 ft (91 m), dunes.

The Algodones Dunes are one of the driest and hottest regions in the United States. Romspert and Burk (1979) reported average yearly precipitation between 1941–1970 was 2.6 in (67.8 mm). The rainfall is often described as scattered or patchy. Rainfall amounts differ from place to place and from year to year with areas to the northwest being generally dryer than those to the southeast (BLM 2001). A soil survey for the Imperial Valley area of Imperial County (Zimmerman 1981) did not include the areas east of the Coachella Canal but did depict a few adjacent portions of the Algodones Dunes as Rositas fine sand with 9 to 30 percent slopes. Rositas fine sand are described as deep, somewhat excessively drained, sloping soils formed in wind-blown sands of diverse origin. Dean (1978) describes the sand as quartz with a mean grain size of 0.006 in (0.17 mm). Norris and Norris (1961) report that the dunes contain 60 to 70 percent quartz and 30 to 40 percent feldspar sand. Further analysis of the sands of the Algodones Dunes found its source was likely sediment from the Colorado River that flowed into the Cahuilla Basin (Muhs *et al.* 1995).

Destruction of plants and modification of habitat associated with OHV activity is considered the primary

threat to *Astragalus magdalenae* var. *peirsonii*. Vehicles may have a direct impact on the plants by crushing and killing them or reducing their reproductive output. Vehicles can alter dune structure by altering hydrological traits of the dune, cover standing plants with encroaching sand, or expose standing plants by causing sand to fall away from the plants. Willoughby (BLM 2001), however, concluded that healthy populations of *A. m.* var. *peirsonii* persist in OHV “open areas” in the Algodones Dunes and that populations in both “open” and “closed” areas respond to precipitation patterns. This likely results from the observation that OHV use does not tend to encroach on habitat of the plants in more distant regions of the open area away from concentrated OHV staging sites (BLM 2001). Significant impacts from OHV use on *A. m.* var. *peirsonii* have been observed at and near OHV staging areas and have been previously documented (WESTEC 1977; ECOS 1990; BLM 2000). Since the species' listing, recreational use has steadily increased in the Algodones Dunes.

Another threat is herbivory by seed weevils, in the family Bruchidae, which contributes to the mortality of seeds and reduces seed crop for *Astragalus magdalenae* var. *peirsonii* (Romspert and Burk 1979). Fruits collected in April and stored in a bottle continued to release these seed weevils into