

a portion of the soil seed bank. BLM did not survey every west-to-east transect across the dunes, however, interpolation of earlier survey data (WESTEC 1977) and census data (TOA 2001) confirms the presence of *Astragalus magdalenae* var. *peirsonii* and the continuity of the northwest-to-southeast habitat. These data sustain our inclusion of these areas in the proposed critical habitat. These areas are not likely any bigger than naturally occurring gaps in the spatial distribution. As a result, these intervening areas, where standing plants may not have been documented are determined to be essential to the conservation of *A. m. var. peirsonii* because they contain the primary constituent elements and will accommodate the natural fluctuations and movement of populations as well as connectivity across the plants' range. Surveys need not have identified standing plants for an area to be considered occupied because a species may still be present at a site as part of the seed bank (Given 1994) or unspouted root crowns.

The most extensive survey of the Algodones Dunes was conducted in 1977 (Westec 1977). This survey used 66 transects that ran across the dunes from west to east. Along the transects they recorded presence and relative abundance of standing plants of *Astragalus magdalenae* var. *peirsonii* and four other rare psammophytic scrub species. In 1998 the BLM began surveying for rare plants in the dunes repeating the methodology used by Westec in their 1977 survey; however, the BLM surveyed only 34 of the original 66 transects and employed a different abundance measure. The BLM conducted these surveys for 5 consecutive years (1998, 1999, 2000, 2001, and 2002) recording the presence and abundance of the rare plant taxa along the transects.

To determine the general range of *Astragalus magdalenae* var. *peirsonii* in the Algodones Dunes, we used survey information from published and unpublished documents and maps including Westec (1977), BLM (2000, 2001), and TOA (2001). Westec (1977) devised a grid system overlay for the Algodones Dunes. Each quadrant of the grid was approximately 0.45 mi (0.72 km) on a side. BLM reproduced this grid system to present data from their subsequent annual surveys from 1998 to 2002 (BLM 2000, 2001). Both Westec and BLM considered a grid square occupied if *A. m. var. peirsonii* was encountered anywhere within that grid square. For comparison, we also superimposed census data included by TOA (2001) on this same grid system.

We produced maps based on Westec (1977), BLM (2000, 2001), and TOA (2001) data. Because of the differences in survey methodologies and abundance classes used by these surveys, we considered each of these records to represent presence or absence only. Due to fluctuations in both the presence and abundance of *A. m. var. peirsonii* from year to year, we combined the data from multiple years of survey data. Also the various surveys recorded standing plants as the only measure of occupancy, not taking into account a dormant soil seed bank or root crowns.

The survey efforts, discussed above, provided us with the data necessary to construct a model showing which regions of the Algodones Dunes represent essential habitat for the *Astragalus magdalenae* var. *peirsonii*. The model that we created used the data collected by the BLM from 1998 to 2002 as the input data and the data collected by Westec 1977 and TOA 2001 as a means of verifying the information generated by the model. The BLM data was used as the input data source for the model because it was more current, covered multiple years, and used the same methodology each year. Time and resources precluded us from conducting independent surveys. Outlier occurrences evidenced only by Westec 1977 were not included because of the age of the report and the lack of substantiation by more recent BLM surveys.

In order to create this model we used the BLM data to extrapolate the values for four variables: (1) The presence or absence of standing plants of *A. m. var. peirsonii*; (2) the abundance of *A. m. var. peirsonii*; (3) the frequency of occurrence of *A. m. var. peirsonii*; and (4) the number of associated rare psammophytic plant taxa present. These variables were scored, then standardized, and finally compiled. We grouped the data into five categories and created a map depicting the distribution of the model's output. This map showed a strong band of high values that ran from the Northeast to the Southwest of the dune field. The portion of the dunes that corresponded to the top three categories represented the portion of the Algodones Dunes that is essential to the conservation of this species.

Analysis of four variables depicted on GIS-based maps provided us with information necessary for determining which areas of the Algodones Dunes are essential for the conservation of the species and contain the primary constituent elements. The first variable was that of the presence or absence of standing plants. This indicated localities where *Astragalus magdalenae*

var. *peirsonii* had been found in each of the five survey years either as seedlings or as older plants. The second variable gave us information about the relative abundance of *A. m. var. peirsonii* in each of the five survey years. The highest abundance class value recorded for each grid cell during the five survey years was used as the cell's value for this variable. This provided us with information to depict areas that seem to have higher plant densities, and thus presence of primary constituent elements. The third variable provided us with information about the frequency with which *A. m. var. peirsonii* occurred from year to year. This variable was calculated based on the number of times *A. m. var. peirsonii* was reported in a grid cell throughout the 5-year survey period. This was important in determining areas that continued to function as good habitat for *A. m. var. peirsonii* and were most likely to contain the primary constituent elements. Finally, we used the presence and absence data for the other rare psammophytic scrub taxa that occur in the Algodones dunes and are often found with *A. m. var. peirsonii* as the fourth variable. These plants included *Croton wigginsii*, *Helianthus niveus* ssp. *tephrodes*, *Palafoxia arida* var. *gigantea*, and *Pholisma sonora*. For each grid cell, scores were assigned based on the number of these associated plants that were found over the course of the 5 years of surveys. Higher scores may indicate a greater abundance and persistence of *A. m. var. peirsonii* and/or the diversity of associated psammophytic scrub species. Therefore, by this measure higher scores indicate the presence of higher quality psammophytic scrub habitat, and thus the presence of primary constituent elements.

Intrinsic to the creation of the essential habitat model for *Astragalus magdalenae* var. *peirsonii* was the application of several assumptions related to the (1) BLM study design (Willoughby 2000 and Willoughby 2001), (2) habitat and weather variability across the entire dune system, (3) paved roads as barriers to dispersal, (4) occurrences of plants and seeds in grid cells over different survey periods, and (5) model protocol. These assumptions are described to allow the reviewer to understand the potential strengths and limitations of the results of the habitat modeling. Based on the BLM study design, a consistent survey methodology was used for the plant surveys conducted in 1998, 1999, and 2000 (Willoughby 2000 and Willoughby 2001). Vegetation maps (BLM 2003),