INVENTORY AND POPULATION CHARACTERIZATION STUDY OF DESERT CYMOPTERUS ON EDWARDS AIR FORCE BASE, CALIFORNIA

FINAL

DECEMBER 1995

Prepared By:

Tetra Tech, Inc.
348 West Hospitality Lane, Suite 300
San Bernardino, California 92408

Prepared for:

Air Force Flight Test Center
Environmental Management Office
Edwards AFB, California 93523

INVENTORY AND POPULATION CHARACTERIZATION STUDY OF DESERT CYMOPTERUS ON EDWARDS AIR FORCE BASE, CALIFORNIA

Don Mitchell, Tetra Tech, Inc., 348 West Hospitality Lane, Suite 300, San Bernardino, CA 92408
Chris Surdzial, Tetra Tech, Inc., 348 West Hospitality Lane, Suite 300, San Bernardino, CA 92408
Claudia Pamiljans, Tetra Tech, Inc., 348 West Hospitality Lane, Suite 300, San Bernardino, CA 92408
Anne Surdzial, Tetra Tech, Inc., 348 West Hospitality Lane, Suite 300, San Bernardino, CA 92408

Abstract: Surveys were conducted for desert cymopterus (*Cymopterus deserticola*) in Spring 1995 on Edwards Air Force Base (AFB), California. Three detailed surveys, 17 population size surveys, and 125 potential habitat surveys were conducted of previously known populations and in areas of potential habitat to document the presence or absence of desert cymopterus on the base and to determine the numbers of individuals and population boundaries of the species on the base. These surveys detected 14,093 individuals of desert cymopterus, including many newly detected occurrences, in populations of up to 3,448 plants and population areas of up to 122.3 hectares. During the three observation periods the majority of individuals were in three distinct phenological stages, first in flower, then in flower and fruit, and finally in fruit and seed dispersal stages. Joshua tree woodland or ecotonal areas with Joshua tree woodland, occurred as the zonal habitat in 73 percent of desert cymopterus populations with creosote bush scrub and halophytic phase saltbush scrub as the other major zonal habitats. Dunes were the most common azonal habitat occurring in 88 percent of the populations. Sixty-four percent of the populations occurred in alluvial plain geomorphology and sandy soil texture was found in 97 percent of the populations. Populations occurred at elevations between 692 and 933 meters (m) above mean sea level (msl). The data indicates that the higher than average rainfall in the survey year may have resulted in extraordinary growth and vigor in the populations of desert cymopterus surveyed. Eight plant species identified as associated species in previous studies were also found in this study. Three additional species were found to be associates in this survey.

Desert cymoptems (*Cymopterus deserticola*) is a herbaceous perennial in the carrot family (Apiaceae) that flowers early in the spring. It has long, slender, deep tap roots with one or more leaves rising from a short, combined stem-root crown below ground. The leaves are highly dissected, grayish-green, and hairless. Purple flowers are clustered in a compact globe at the end of each leafless peduncle which rises above the leaves (Munz 1974). *Lomatium mohavense* is the only other member of the carrot family on Edwards AFB that might be confused with desert cymopterus. Illustrations and descriptions of desert cymopterus are found in Hickman (1993), Smithsonian Institution (1978a), and Abrams (1951). The desert cymoptems is a federal Category 1 candidate species and on the California Native Plant Society's (CNPS) List 1B (plants considered rare or endangered in California or elsewhere).

Desert cymoptems has been reported in widely scattered, highly dispersed, and generally small populations in the western Mojave Desert ranging from near Victorville north to Harper Dry Lake, northwest to near Fremont Peak, and west to Kramer Junction and Edwards AFB (CDFG 1994; Dames and Moore 1993; ENSR 1989; Moe 1988). Desert cymopterus occurs in tine to coarse, deep, loose, sandy soils of alluvial plains, often in swales or stabilized low dune areas (Charlton 1993a,b). This species typically exists in

elevations ranging from 700 to 1,300 m above msl. It is found in zonal habitats of creosote bush scrub, Joshua tree woodland, and both arid phase and halophytic phase saltbush scrub. Common associates growing with desert cymopterus include creosote bush (*Larrea tridentata*), Joshua tree (*Yucca brevifolia*), saltbush (*Atriplex polycarpa*), burro-weed (*Ambrosia dumosa*), box-thorn (*Lycium cooperi*), *Hymenoclea salsola*, croton (*Croton californicus* var. *mohavensis*), and ricegrass (*Oryzopsis hymenoides*). A wide diversity of annual species is also found in these sandy soil habitats. Desert cymopterus plants typically are widely scattered, usually growing in the openings between shrubs (Charlton 1993a,b).

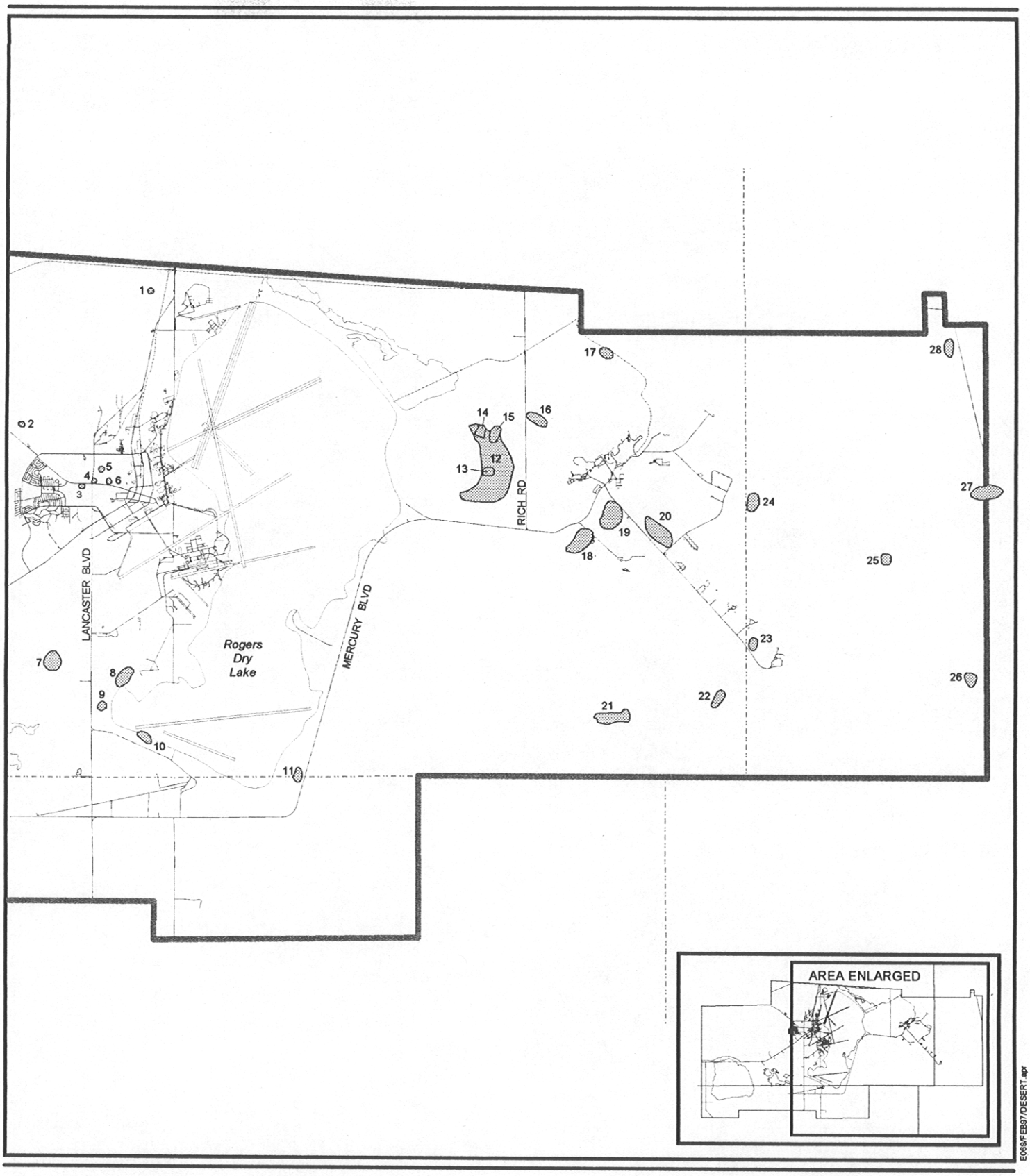
Twenty-nine populations of desert cymopterus have been previously reported in scattered populations in the central and eastern portions of Edwards AFB. Figure 1 shows the location of 28 previously reported populations. One population had insufficient locational data and therefore, does not appear on Figure 1. Most of the populations had fewer than 50 individuals. The largest reported population, number 19, had greater than 1,000 individuals (Figure 1).

The first species-specific surveys for desert cymopterus on Edwards AFB were conducted in 1977, the second year of a severe 2-year drought. Heckard and Moe located seven populations with fewer than 100 individuals, having limited access to the eastern portions and no access to the southeastern portion of the base (Heckard and Moe 1977; Smithsonian Institution 1978 a,b). Subsequent surveys on Edwards AFB for desert cymopterus were conducted between 1981 and 1994 (Moe 1981; Moe 1988; Charlton 1993b; Mitchell et al. 1993; Bagley and Eckert 1994).

The primary purpose of this survey was to determine the presence or absence of desert cymopterus on the base in 1995, to determine the number of plants in each population, and the boundaries of each population on Edwards AFB. This information will be used in the development of a management plan to protect the species with minimal impact to the Edwards AFB mission.

STUDY AREA

The study area is consistent with the boundaries of Edwards AFB, California. Within the study area, 145 survey areas were selected in consultation with the base biologist (Figures 2 and 3, Table 1), including 20 survey areas at previously known populations of desert cymopterus, which were divided into 3 detailed survey areas and 17 population size survey areas. One hundred and twenty-five survey areas were identified as areas of potential habitat for the species.



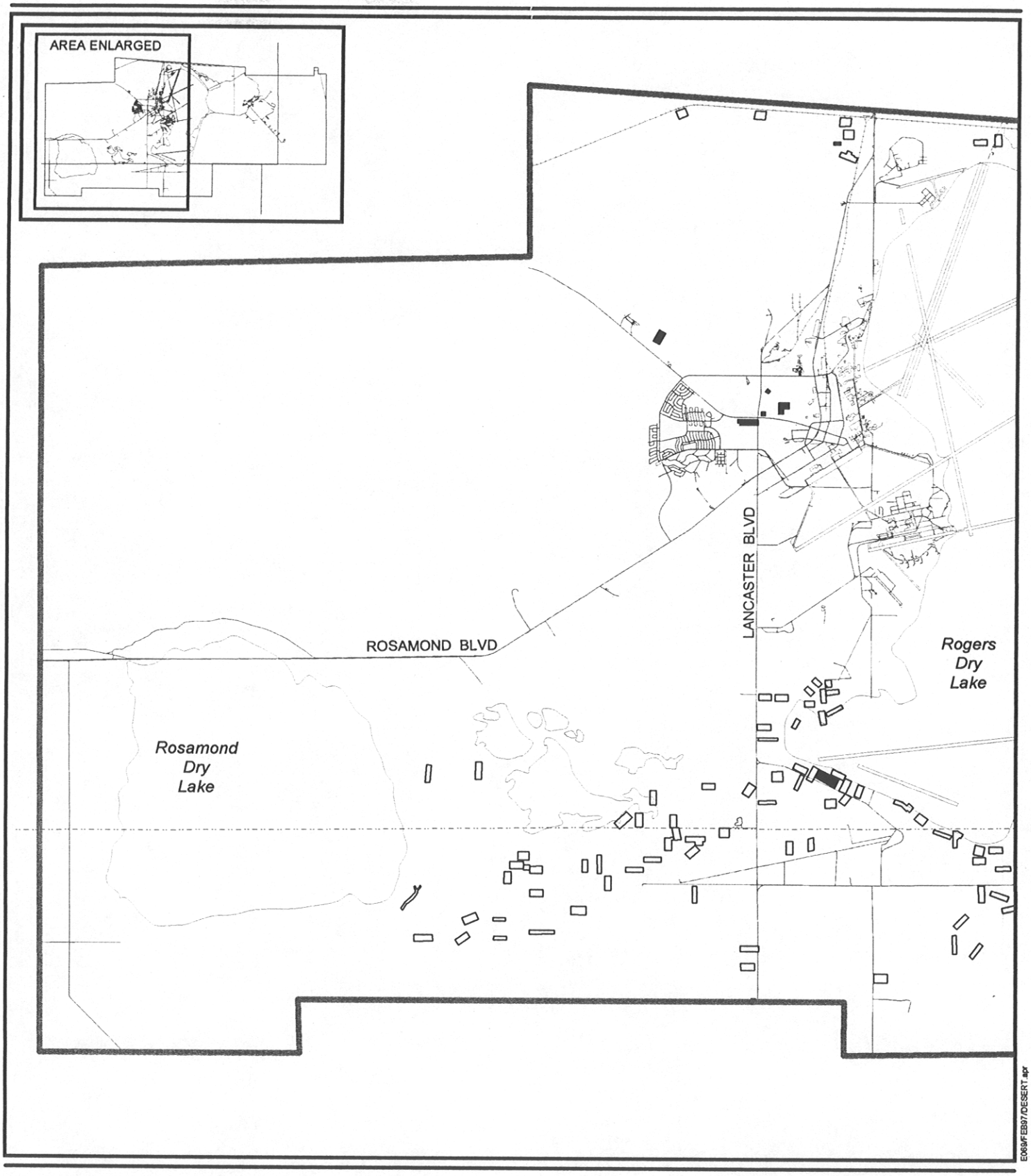
Base Boundary / Study Area Boundary

Population

10000 0 10000 Feet

Previously Reported Populations of Desert Cymopterus on Edwards Air Force Base

Figure 1



Base Boundary

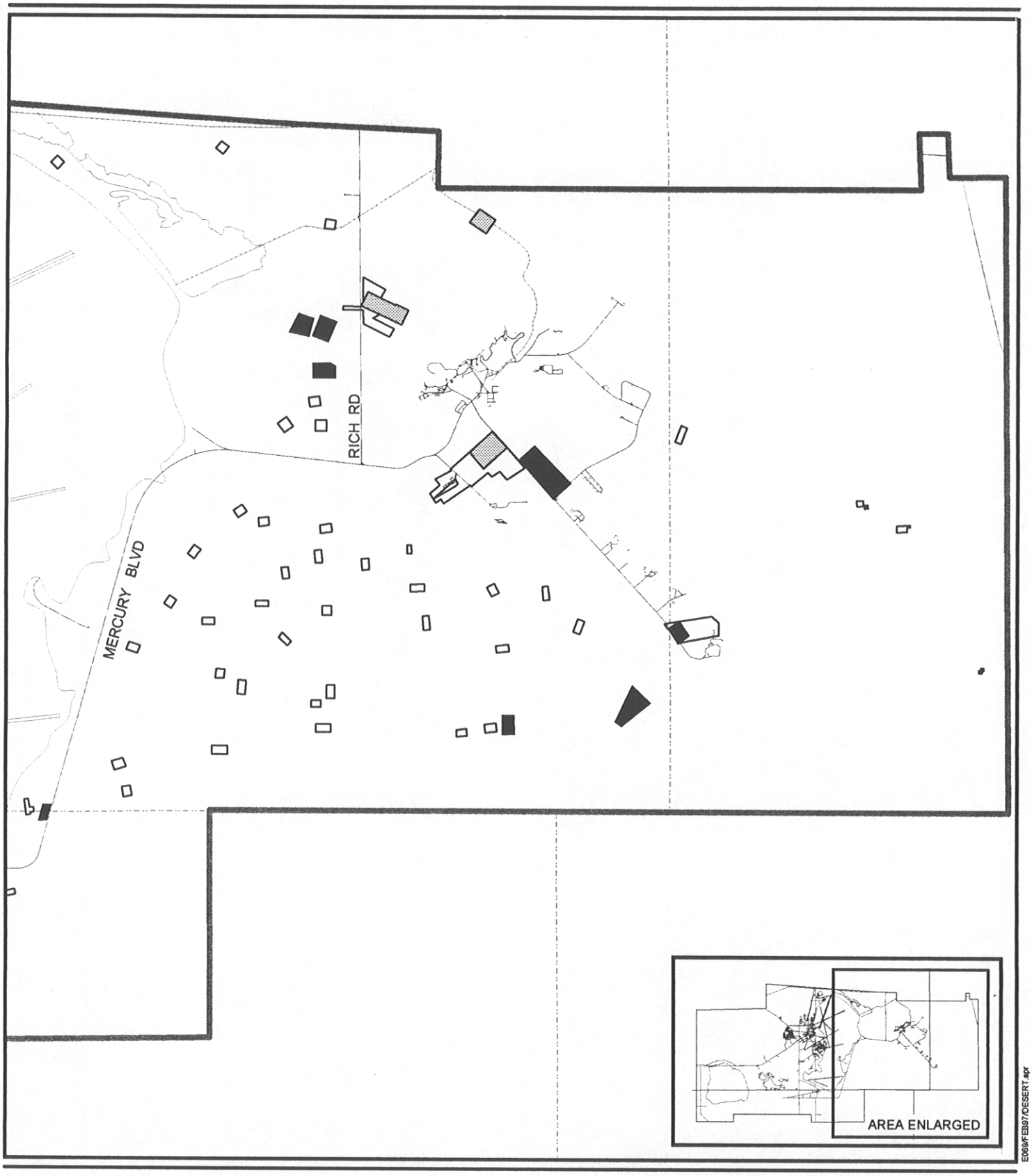
Population Size Survey Area

Potential Habitat Survey Area

5000 0 5000 10000 Feet

Desert Cymopterus Study Area and Survey Areas West Edwards AFB

Figure 2



Base Boundary
Detailed Survey Area
Population Size Survey Area
Potential Habitat Survey Area

5000 0 5000 10000 Feet

Desert Cymopterus Study Area and Survey Areas East Edwards AFB

Figure 3

Table 1

Locations of *Cymopterus deserticola* Survey Areas

Survey Area	1/4 Section	Section	Range	Township	USGS Quad
95RP001	NE	2	8W	9N	Leuhman Ridge
95RP001	NW	2	8W	9N	Leuhman Ridge
95RP001	SW	35	8W	10N	Leuhman Ridge
95RP001	SE	35	8W	10N	Leuhman Ridge
95RP001	NE	35	8W	10N	Leuhman Ridge
95RP001	SW	36	8W	10N	Leuhman Ridge
95RP001	NW	36	8W	10N	Leuhman Ridge
95RP002	NW	22	8W	10N	Leuhman Ridge
95RP002	NE	21	8W	10N	Leuhman Ridge
95RP002	SE	16	8W	10N	Leuhman Ridge
95RP003	SE	11	8W	10N	Leuhman Ridge
95RP003	NE	11	8W	10N	Leuhman Ridge
95RP005	NW	21	8W	10N	Leuhman Ridge
95RP005	SW	21	8W	10N	Leuhman Ridge
95RP005	NE	20	8W	10N	Leuhman Ridge
95RP005	SE	20	8W	10N	Leuhman Ridge
95RP006	NE	20	8W	10N	Leuhman Ridge
95RP006	SE	20	8W	10N	Leuhman Ridge
95RP006	SW	20	8W	10N	Leuhman Ridge
95RP006	NW	20	8W	10N	Leuhman Ridge
95RP007	SW	20	7W	9N	Jack Rabbit Hill
95RP007	SE	20	7W	9N	Jack Rabbit Hill
95RP007	NW	29	7W	9N	Jack Rabbit Hill
95RP007	NE	29	7W	9N	Jack Rabbit Hill
95RP008	NW	25	8W	9N	Jack Rabbit Hill
95RP009	NE	1	7W	10N	Kramer Junction
95RP009	NW	1	7W	10N	Kramer Junction
95RP009	SE	1	7W	10N	Kramer Junction
95RP009	SW	1	7W	10N	Kramer Junction
95RP010	NE	20	6W	9N	Red Buttes
95RP010	NW	20	6W	9N	Red Buttes
95RP011	SE	36	8W	10N	Leuhman Ridge
95RP011	SW	36	8W	10N	Leuhman Ridge
95RP011	SW	31	8W	10N	Leuhman Ridge
95RP011	NE	1	8W	9N	Leuhman Ridge
95RP011	NW	6	7W	9N	Leuhman Ridge

Survey Area	1/4 Section	Section	Range	Township	USGS Quad
95RP012	SE	16	7W	9N	Jack Rabbit Hill
95RP015	SW	36	10W	11N	Edwards
95RP017	SE	27	10W	10N	Edwards
95RP018A	SW	26	10W	10N	Edwards
95RP018B	SW	26	10W	10N	Edwards
95RP018C	NW	26	10W	10N	Edwards
95RP020	NW	36	10W	9N	Redman
95RP021	SW	34	9W	9N	Rogers Lake South
95RP021	NW	3	9W	8N	Rogers Lake South
95RP037	NW	28	8W	10N	Leuhman Ridge
95RP037	NE	29	8W	10N	Leuhman Ridge
95RP038	SW	16	7W	9N	Red Buttes
95RP038	SE	16	7W	9N	Red Buttes
95RP1002	SE	1	11W	8N	Redman
95RP1048	NW	33	7W	10N	Leuhman Ridge
95RP2001	NW	36	10W	9N	Redman
95RP2001	SW	25	10W	9N	Redman
95RP2002	SE	26	10W	9N	Redman
95RP2003	NE	35	10W	9N	Redman
95RP2004	NE	36	10W	9N	Redman
95RP3001	NW	1	7W	10N	Kramer Junction
95RP3002	SW	6	6W	10N	Kramer Junction
95RP3014	SE	5	10W	8N	Redman
95RP3015	SW	4	10W	8N	Redman
95RP3016	SW	5	10W	8N	Redman
95RP3016	SW	4	10W	8N	Redman
95RP3017	SE	6	10W	8N	Redman
95RP3017	SW	5	10W	8N	Redman
95RP3018	NE	7	10W	8N	Redman
95RP3019	SW	7	10W	8N	Redman
95RP3020	NW	7	10W	8N	Redman
95RP3021	SE	1	11W	8N	Redman
95RP3022	SE	33	10W	9N	Redman
95RP3023	NW	4	10W	8N	Redman
95RP3024	SE	32	10W	9N	Redman
95RP3025	SW	5	10W	8N	Redman
95RP3025	NW	8	10W	8N	Redman
95RP3026	SW	6	10W	8N	Redman
95RP3027	SE	1	11W	8N	Redman
95RP3028	SE	11	11W	8N	Rosamond Lake

Survey Area	1/4 Section	Section	Range	Township	USGS Quad
95RP3028	NE	14	11W	8N	Rosamond Lake
95RP3029	SE	11	11W	8N	Rosamond Lake
95RP3029	SW	12	11W	8N	Rosamond Lake
95RP3030	NE	10	11W	8N	Rosamond Lake
95RP3030	NW	11	11W	8N	Rosamond Lake
95RP3031	SW	11	11W	8N	Rosamond Lake
95RP3031	SE	10	11W	8N	Rosamond Lake
95RP3032	SW	12	11W	8N	Redman
95RP3032	SE	12	11W	8N	Redman
95RP3033	SW	12	11W	8N	Redman
95RP3033	SE	12	11W	8N	Redman
95RP3034	SE	32	10W	9N	Redman
95RP3040	NE	9	10W	8N	Redman
95RP4050	NE	15	10W	8N	Redman
95RP4051	NE	2	10W	8N	Redman
95RP4052	NE	2	10W	8N	Redman
95RP4053	SW	18	10W	8N	Redman
95RP4054	NE	34	10W	9N	Redman
95RP4055	NW	34	10W	9N	Redman
95RP4056	NE	4	10W	8N	Redman
95RP4057	NE	4	10W	8N	Redman
95RP4060	SW	36	10N	8W	Leuhman Ridge
95RP4060	SE	35	10N	8W	Leuhman Ridge
95RP4060	SW	35	10N	8W	Leuhman Ridge
95RP4060	NW	1	9N	8W	Leuhman Ridge
95RP4060	NE	2	9N	8W	Leuhman Ridge
95RP4060	NW	2	9N	8W	Leuhman Ridge
95RP4060	NE	3	9N	8W	Leuhman Ridge
95RP420	NW	10	8W	9N	Leuhman Ridge
95RP421	SE	9	8W	9N	Leuhman Ridge
95RP422	NE	8	8W	9N	Leuhman Ridge
95RP422	SE	8	8W	9N	Leuhman Ridge
95RP423	SW	8	8W	9N	Rogers Lake North
95RP424	NE	18	8W	9N	Rogers Lake North
95RP425	SW	17	8W	9N	Rogers Lake South
95RP426	SE	19	8W	9N	Rogers Lake South
95RP426	SW	19	8W	9N	Rogers Lake South
95RP427	SW	30	8W	9N	Rogers Lake South
95RP428	SW	18	8W	9N	Rogers Lake South
95RP434	SE	35	9W	9N	Rogers Lake South

Survey Area	1/4 Section	Section	Range	Township	USGS Quad
95RP435	NW	35	9W	9N	Rogers Lake South
95RP436	NE	14	8W	9N	Leuhman Ridge
95RP436	SE	11	8W	9N	Leuhman Ridge
95RP437	NE	17	8W	9N	Leuhman Ridge and Jack Rabbit Hill
95RP437	NW	16	8W	9N	Leuhman Ridge and Jack Rabbit Hill
95RP438	SE	29	8W	9N	Jack Rabbit Hill
95RP438	NE	29	8W	9N	Jack Rabbit Hill
95RP438	NW	28	8W	9N	Jack Rabbit Hill
95RP438	SW	28	8W	9N	Jack Rabbit Hill
95RP439	NE	29	8W	9N	Jack Rabbit Hill
95RP440	SW	21	8W	9N	Jack Rabbit Hill
95RP441	NE	26	8W	9N	Jack Rabbit Hill
95RP441	SE	26	8W	9N	Jack Rabbit Hill
95RP442	SW	26	8W	9N	Jack Rabbit Hill
95RP5006	NW	32	8W	10N	Rogers Lake North, Leuhman Ridge
95RP5007	SE	29	8W	10N	Leuhman Ridge
95RP5008	NE	32	8W	10N	Leuhman Ridge
95RP5009	SE	5	8W	9N	Leuhman Ridge
95RP5009	SW	4	8W	9N	Leuhman Ridge
95RP5009	NE	8	8W	9N	Leuhman Ridge
95RP5010	SE	6	8W	9N	Rogers Lake North
95RP5011	SW	6	8W	9N	Rogers Lake North
95RP5011	SE	6	8W	9N	Rogers Lake North
95RP5012	NE	12	9W	9N	Rogers Lake North
95RP5013	NW	13	9W	9N	Rogers Lake North
95RP5014	NE	23	9W	9N	Rogers Lake South
95RP5015	SW	19	9W	9N	Rogers Lake South
95RP5016	NW	21	10W	10N	Edwards
95RP5020	NE	21	8W	10N	Leuhman Ridge
95RP5020	SE	16	8W	10N	Leuhman Ridge
95RP5020	NW	22	8W	10N	Leuhman Ridge
95RP5020	SW	22	8W	10N	Leuhman Ridge
95RP5022	NE	36	10W	9N	Redman
95RP5023	NW	26	10W	9N	Redman
95RP5024	NW	26	10W	9N	Redman
95RP5025	SW	23	10W	9N	Redman
95RP5026	SW	23	10W	9N	Redman
95RP5026	SE	23	10W	9N	Redman
95RP5027	SE	23	10W	9N	Redman
95RP5028	NW	24	10W	9N	Redman

Survey Area	1/4 Section	Section	Range	Township	USGS Quad
95RP5028	NE	23	10W	9N	Redman
95RP5029	SE	23	10W	9N	Redman
95RP5030	SW	24	10W	9N	Redman
95RP5030	SE	24	10W	9N	Redman
95RP5030	NW	25	10W	9N	Redman
95RP5031	SW	24	10W	9N	Redman
95RP5032	NE	26	10W	9N	Redman
95RP5033	SW	24	10W	9N	Redman
95RP5034	SW	24	10W	9N	Redman
95RP5035	NW	24	10W	9N	Redman
95RP5036	NE	1	10W	10N	Edwards
95RP5036	NW	1	10W	10N	Edwards
95RP5036	NE	1	10W	10N	Edwards
95RP5040	SW	18	7W	9N	Jack Rabbit Hill
95RP5040	SE	18	7W	9N	Jack Rabbit Hill
95RP5041	NW	24	8W	9N	Jack Rabbit Hill
95RP5042	SE	15	8W	9N	Jack Rabbit Hill
95RP5043	SE	10	8W	10N	Leuhman Ridge
95RP5043	NE	15	8W	10N	Leuhman Ridge
95RP5044	NE	13	8W	9N	Leuhman Ridge
95RP5045	SE	32	9W	11N	North Edwards and Rogers Lake North
95RP5046	SW	33	9W	11N	North Edwards and Rogers Lake North
95RP5047	NE	33	10W	11N	California City South
95RP5047	SE	33	10W	11N	California City South
95RP5048	NE	34	10W	11N	California City South
95RP5048	SE	34	10W	11N	California City South
95RP5048	NW	35	10W	11N	California City South
95RP5048	SW	35	10W	11N	California City South
95RP5049	SW	36	10W	11N	California City South
95RP5049	SE	36	10W	11N	California City South
95RP5050	SW	36	10W	11N	California City South
95RP5050	SE	36	10W	11N	California City South
95RP5051	SW	3	10W	10N	Rogers Lake North
95RP5052	SW	9	8W	10N	Leuhman Ridge
95RP5052	SE	8	8W	10N	Leuhman Ridge
95RP5053	NW	6	8W	10N	Rogers Lake North
95RP5068	NE	1	11W	8N	Redman
95RP5068	SE	1	11W	8N	Redman
95RP5070	NW	9	9W	8N	Rogers Lake South
95RP5070	NE	9	9W	8N	Rogers Lake South

Survey Area	1/4 Section	Section	Range	Township	USGS Quad
95RP5071	NE	17	9W	8N	Rogers Lake South
95RP5072	NW	17	9W	8N	Rogers Lake South
95RP5072	SW	8	9W	8N	Rogers Lake South
95RP5073	SE	8	9W	8N	Rogers Lake South
95RP5074	NE	8	9W	8N	Rogers Lake South
95RP5075	NW	9	9W	8N	Rogers Lake South
95RP5076	SE	5	9W	8N	Rogers Lake South
95RP5077	NW	4	9W	8N	Rogers Lake South
95RP5078	NE	5	9W	8N	Rogers Lake South
95RP5080	NW	5	9W	8N	Rogers Lake South
95RP5080	NE	5	9W	8N	Rogers Lake South
95RP5081	SE	31	9W	9N	Rogers Lake South
95RP5082	NW	36	10W	9N	Redman
95RP5082	SW	36	10W	9N	Redman
95RP5083	NW	36	10W	9N	Redman
95RP5083	NE	36	10W	9N	Redman
95RP5083	SW	36	10W	9N	Redman
95RP5083	SE	36	10W	9N	Redman
95RP5084	NW	35	10W	9N	Redman
95RP5085	NE	35	10W	9N	Redman
95RP5086	SW	35	10W	9N	Redman
95RP5087	NW	3	9W	8N	Redman
95RP5088	NW	3	10W	8N	Redman
95RP5088	NE	4	10W	8N	Redman
95RP5089	NW	33	10W	9N	Redman
95RP5089	SW	33	10W	9N	Redman
95RP5090	NE	15	10W	8N	Redman
95RP5091	NW	35	11W	9N	Rosamond Lake
95RP5091	SW	26	11W	9N	Rosamond Lake
95RP5092	NW	36	11W	9N	Rosamond Lake
95RP5092	SW	25	11W	9N	Rosamond Lake
95RP5093	SW	31	9W	9N	Rogers Lake South
95RP5093	SE	31	9W	9N	Rogers Lake South
95RP5094	NW	5	9W	8N	Rogers Lake South
95RP5095	SW	4	9W	8N	Rogers Lake South
95RP5095	SE	33	9W	9N	Rogers Lake South
95RP5096	NE	4	9W	8N	Rogers Lake South
95RP5114	NW	23	12W	10N	Soledad Mountain

METHODS

Desert cymopterus surveys were originally scheduled to be conducted during Spring 1994; however, reconnaissance surveys revealed little or no germination of *Cymopterus deserticola* at known population sites, probably due to below average rainfall. After consultation with the base biologist, the surveys were postponed until the 1995 growing season. Field investigations were conducted between March 7 and May 12, 1995, when desert cymopterus was evident and identifiable. This timeframe also coincided with known flowering and fruiting periods.

Surveys were conducted in 20 known desert cymopterus populations and in 125 areas of potential habitat. Three types of surveys were conducted: 3 detailed surveys, 17 population size surveys, and 125 potential habitat surveys. The detailed surveys were conducted within known populations to record the size and location of the population and to collect individual plant data that would characterize aspects of plant growth and distribution. Population size surveys were conducted to record the area and number of individuals within known populations and to delineate population boundaries using global positioning systems (GPS) technology. Potential habitat surveys were conducted to determine the presence or absence as well as the number of individuals of desert cymopterus in selected areas of the base.

Trimble GeoExplorer™ GPS receivers were used to delineate and record the location of each survey area boundary. For populations larger than 50 square meters, the population boundary was recorded as a polygon. For populations smaller than 50 square meters, a single point near the center of the population was recorded. For populations that were linear, such as those found in a drainage, the population was recorded as a line. Using a base station and post-processing procedures, the positions recorded in the field were corrected to a 10m degree of accuracy.

Table 2 summarizes the types of data collected for the detailed, population size, and potential habitat surveys, along with the method used in the collection of those data. Data requirements for these surveys were collected in accordance with the Edwards AFB Geographic Information System (GIS) data dictionary. Survey areas were located with the assistance of botanist David Charlton using United States Geological Survey (USGS) maps. Field forms developed by the California Native Plant Society (CNPS) were filled out for each survey area to record all field data. In addition, all survey areas and populations found were recorded on USGS 7.5-minute quad maps as a paper back-up to the GPS records.

Table 2

Data Requirements and Methods for Surveys Conducted for *Cymopterus deserticola*

Data Requirements	Detailed Surveys	Population Size Surveys	Potential Habitat Surveys	Methods and Units
Observation date	*	*	*	Actual date
Start and end time of each survey period	*	*	*	By 24-hour clock
Surveyor(s) initials	*	*	*	First and last initial
Survey Area identifier (ID)	*	*	*	A 7-or 8-digit alphanumeric, including year of survey, "RP" for rare plant, and unique numeric identifiers for each population
Transect ID	*	*	*	A 7-or 8-digit alphanumeric including year of survey, "CD" for *Cymopterus deserticola*, and unique numeric identifiers for each population
Number of individuals	*	*	*	Counted in the field up to 500 using hand held tally counters or estimated if over 500
Plant ID	*			A 3-digit number assigned in chronological order (001, 002, etc.)
Blade length of largest leaf	*			Measured from the point of attachment to the petiole to the tip of the leaf blade
Blade width of largest leaf	*			Widest portion of leaf blade measured
Petiole length of largest leaf	*			Measured from ground to point of attachment to the leaf blade
Number of inflorescences	*			Included both mature and immature inflorescences
Length of longest inflorescence	*			Measured from the ground to end of inflorescence
Distance to nearest plant, same species	*			Measured to the nearest centimeter (cm) with a tape measure
Number of leaves	*			Counted in the field
Evidence of browsing	*			Visually determined in field
Phenological stage	*	*	*	CNPS definitions (percent in each class)
Habitat description for each survey area:				
Zonal habitat and azonal habitat	*	*	*	Zonal habitat read from vegetation maps of the base (Mitchell *et. al.* 1993) or visually determined in the field; azonal habitat visually determined in the field
Associated plant species	*	*	*	Visually determined in field
Incidental sensitive species at site	*	*	*	Visually determined in field
Geomorphology	*	*	*	Visually determined in field using GIS domain table

Data Requirements	Detailed Surveys	Population Size Surveys	Potential Habitat Surveys	Methods and Units
Soil texture	*	*	*	Visually determined in field using GIS domain table
Slope	*	*	*	Measured in percentage with clinometer or estimated in the field
Aspect	*	*	*	Measured in degrees with compass
Weather conditions for each survey period:				
Maximum and minimum daily temperature	*	*	*	Measured in Celsius with standard scientific thermometer
Maximum daily wind speed	*	*	*	Estimated in the field
Wind direction	*	*	*	Estimated in the field
Maximum percent cloud cover	*	*	*	Estimated in the field
Location:				
County	*	*	*	County name
USGS quadrangle	*	*	*	USGS quad name
Township, range, and section	*	*	*	Read from USGS quad
Elevation	*	*	*	Read from USGS quad or determined from GPS data
GPS survey area boundary	*	*	*	Field measurement
Population area	*	*	*	Field measured and calculated

Surveys of Known Populations

Two types of surveys, detailed surveys and population size surveys, were conducted at known populations selected in consultation with the base biologist. Survey areas were consistent with the previously reported boundary of the desert cymopterus population. The surveys were conducted by systematically walking parallel transects 6 meters apart across the entire area and recording population data observed. Plant data were observed for 3 meters on either side of each transect. Alignment of the transects to the survey area (eg. north to south, east to west, etc.) was irrelevant as long as all transect lines were aligned with each other, equally spaced, and the entire survey area was covered. Transect orientation was established and maintained by use of a compass and flagging tape. The flagging tape from previous transects was used to help align subsequent transects until the entire survey area had been covered. The end of the transect was marked when no individuals were observed 75m from the last observed individual. Otherwise, the transect

boundary was extended and observations continued until no individuals were observed within 75m of the last observation. When this lengthening of transect revealed locations where desert cymopterus occurred outside the survey area boundaries, they were not incorporated into the known population survey data, but were used in determining new population boundaries.

Detailed Surveys

Detailed survey areas for desert cymopterus were located within three previously known populations. These survey areas are referred to as the Mars Boulevard detailed survey area, Tortoise Pens detailed survey area, and Railroad detailed survey area (Figure 3). Detailed surveys were conducted in 3 observation periods during the growing season. Observation Period A was conducted between March 7 and 9 and March 13 and 18 at the Mars Boulevard detailed survey area, March 14 and 17 at the Tortoise Pens detailed survey area, and March 14 and 15 at the Railroad detailed survey area. Observation Period B was conducted between April 8 and 10 at the Mars Boulevard detailed survey area, April 10 and 12 at the Tortoise Pens detailed survey area, and on April 9 at the Railroad detailed survey area. Observation Period C was conducted between May 10 and 12 at the Mars Boulevard detailed survey area, May 6 and 8 at the Tortoise Pens detailed survey area, and on May 5 at the Railroad detailed survey area. The primary objectives of this survey were to record the size and location of the populations and to collect individual plant data that would characterize some aspects of plant growth and population distribution over time.

Because of an overlap in surveyor observation areas encountered during Observation Period A, and after consultation with the base biologist; transect spacing, initially at 3m, was increased to 6m, with transect width remaining at 6m, for Observation Periods B and C. Data requirements listed on Table 2 were collected for all plants at populations containing less than 500 plants. At populations exceeding 500 plants, data were collected for 500 plants during each observation period. GPS data included survey area boundaries and plant population boundaries, and was collected only once, during Observation Period A.

The number of plants in each population were counted directly. Each individual was marked with a pin flag and their phenological stage was recorded. The pin flags were numbered sequentially as the data were collected. This number represented the plant identification (ID) number that would be tracked throughout

the survey period. Unmarked plants located during Observation Periods B and C were flagged and their phenological stage was recorded. All pin flags were removed after the final observation period for each population.

Individual plant data were collected on all plants in populations with 500 or fewer individuals. To determine which plants would have individual plant data collected in populations larger than 500, the following procedure was employed:

1. Using the pin flags, which were placed during the direct population count and phenological stage data collection, numbered sequentially to assign plant ID numbers to all plants in the population (example: a population of 720 plants);

2. Five hundred was divided by the total number of plants in the population and this number was rounded up to the nearest tenths place digit (example: 500 divided by 720 = .694 rounded up to .7);

3. The number generated in step two was multiplied by 10 to give the number of plants in each group of 10 to be surveyed (.7 multiplied by 10 = 7); and;

4. The total poulation was split into groups of ten based on their pin flag plant ID number. Individual plant data was collected in each group of ten sequentially until the number that was calculated under step 3 was reached, the rest of the plants in that group of 10 were skipped and the next group of 10 was surveyed (Example: Individual plant data was collected for: plants one through seven in the first group of 10, plants 11 through 17 in the second group of 10, etc.);

5. Individual plant data collection stopped when 500 plants had been surveyed. (Example: The final plant which individual plant data was gathered in a population of 720 would be plant number 713. Seventy-one groups of seven plants plus plants 711, 712, and 713 for a total of 500 plants).

Population Size Surveys

Population size surveys were conducted at 17 known populations of desert cymopterus (Figures 2 and 3). The primary objectives were to record the size of each population (both the area and the number of individuals) and to record the population boundary using GPS technology. Population size surveys were conducted once for each population at the estimated peak of the flowering period to maximize detection.

Transects were determined and marked for population size surveys using the same methods as for the detailed surveys, including the 6m transect spacing and 6m transect width. The number of individuals in each population and the phenological stage of each were recorded while transects were walked. No individual plant data were collected. Direct counts were obtained using handheld tally counters. To avoid double counting, or miscounting, individuals near the margins of a transect were marked with flagging or pin flags. Field data were recorded on CNPS field sheets and USGS quad maps, and GPS recordings were made for each survey area.

Potential Habitat Surveys

One hundred and twenty five survey areas of approximately 8 ha each, totalling 1,209 ha of potential habitat for desert cymopterus, were selected in coordination with the base biologist and based on observations made during known population surveys (Figures 2 and 3). The primary objective of these surveys was to determine the presence or absence of desert cymopterus.

All potential habitat surveys were conducted by systematically walking transects spaced at 25-meter intervals across the area and recording data as previously described for the population size surveys. All plants in population under 500 individuals were directly counted. Population exceeding 500 individuals had the population size estimated. The same transect protocol was followed as noted for the known population surveys, with the exception of transect width and spacing. If individuals of desert cymopterus were discovered, transect width and spacing were decreased to 6 m until a boundary could be determined for that population.

The population boundaries were established when no individuals could be found within 75m of the last observed individual. This boundary was flagged and the next transect started. This process continued until the boundaries of the whole population had been determined. Once the boundaries of a population were established, the transect width and spacing were increased back to 25m until the remainder of the potential habitat survey area had been surveyed, or until another population within the survey area caused the spacing to decrease to 6m again.

Incidental Detections

Incidental detections of desert cymopterus made during Spring 1995 surveys for sensitive plant species were recorded with the results presented in this report. For all incidental detections, the number of individuals and population size was estimated.

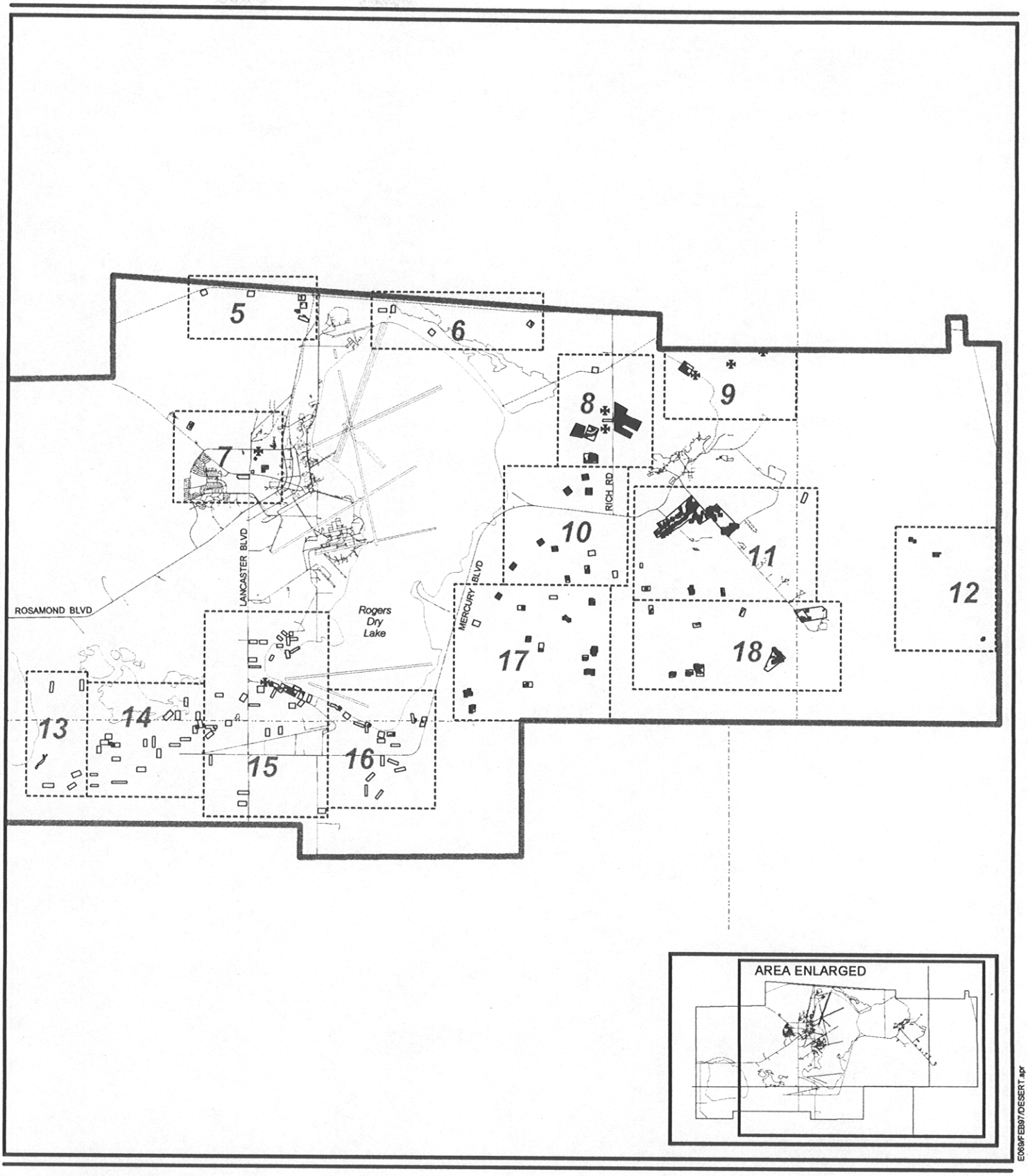
RESULTS

Figure 4 shows the survey area locations across the base for desert cymopterus and serves as the key map for Figures 5 through 18, which show more detailed views of the survey areas, desert cymopterus populations, and incidental detections of desert cymopterus. A total of 14,093 desert cymopterus plants were counted or estimated in 592.7 ha throughout the survey areas (Table 3), and approximately 200 individuals were observed by incidental detection at seven sites. The species was found in 67 of the 145 survey areas. Fifty-six new population locations were discovered.

Table 3

Summary of Survey Data for *Cymopterus deserticola* on Edwards AFB, March Through May 1995

Survey Type	Number of Individuals	Number of Populations	Population Area (hectares)	Number of Survey Areas
Detailed	4,398	3	105.6	3
Population Size	4,914	15	165.3	17
Potential Suitable Habitat	4,781	49	321.8	125
Total:	**14,093**	**67**	**592.7**	**145**



Base Boundary

6 Detailed Population Map
(Number Indicates Figure Number)

Survey Area Boundary

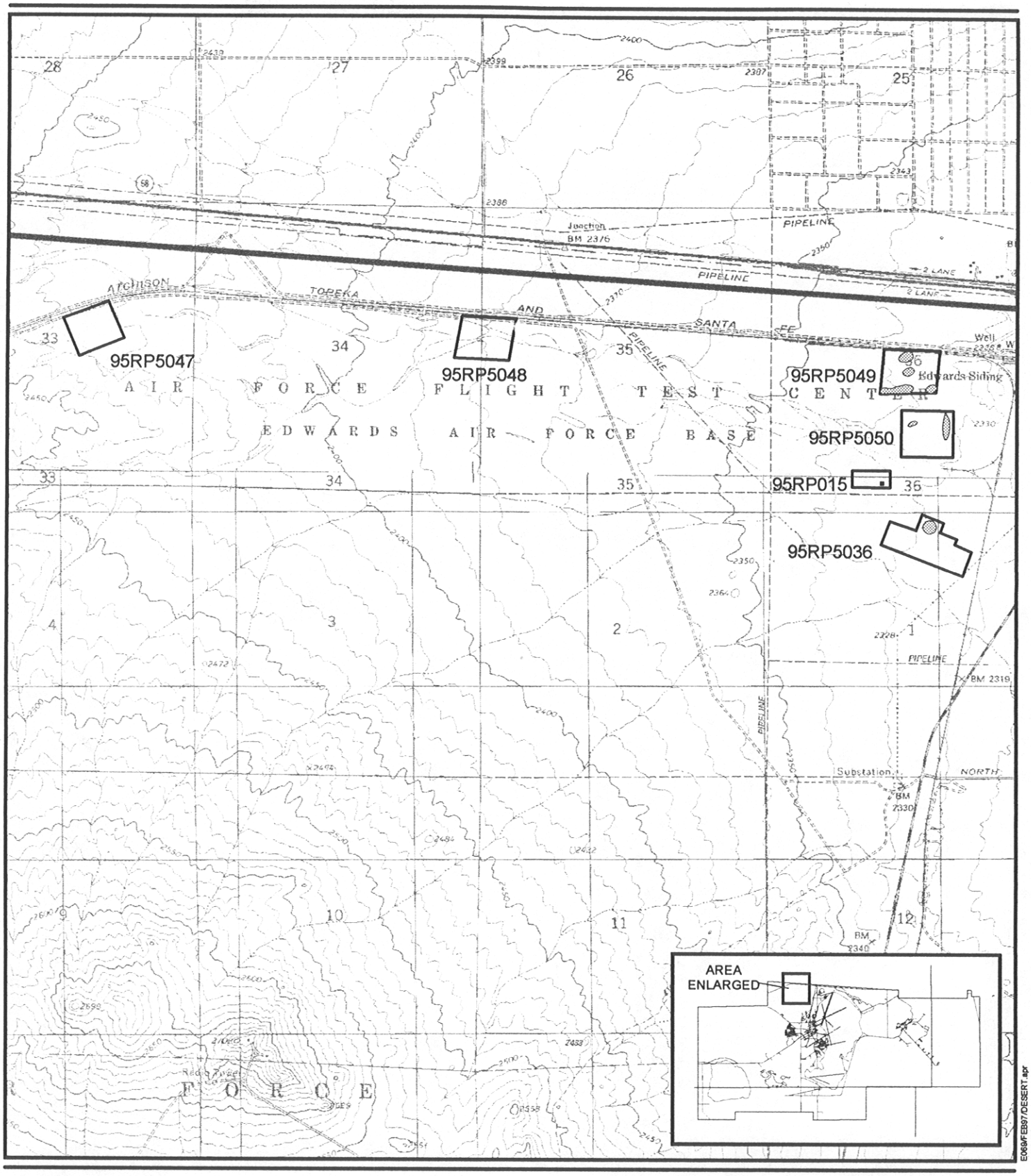
Population

Incidental

10000 0 10000 Feet

Populations of Desert Cymopterus Edwards AFB

Figure 4



Base Boundary

Survey Area Boundary

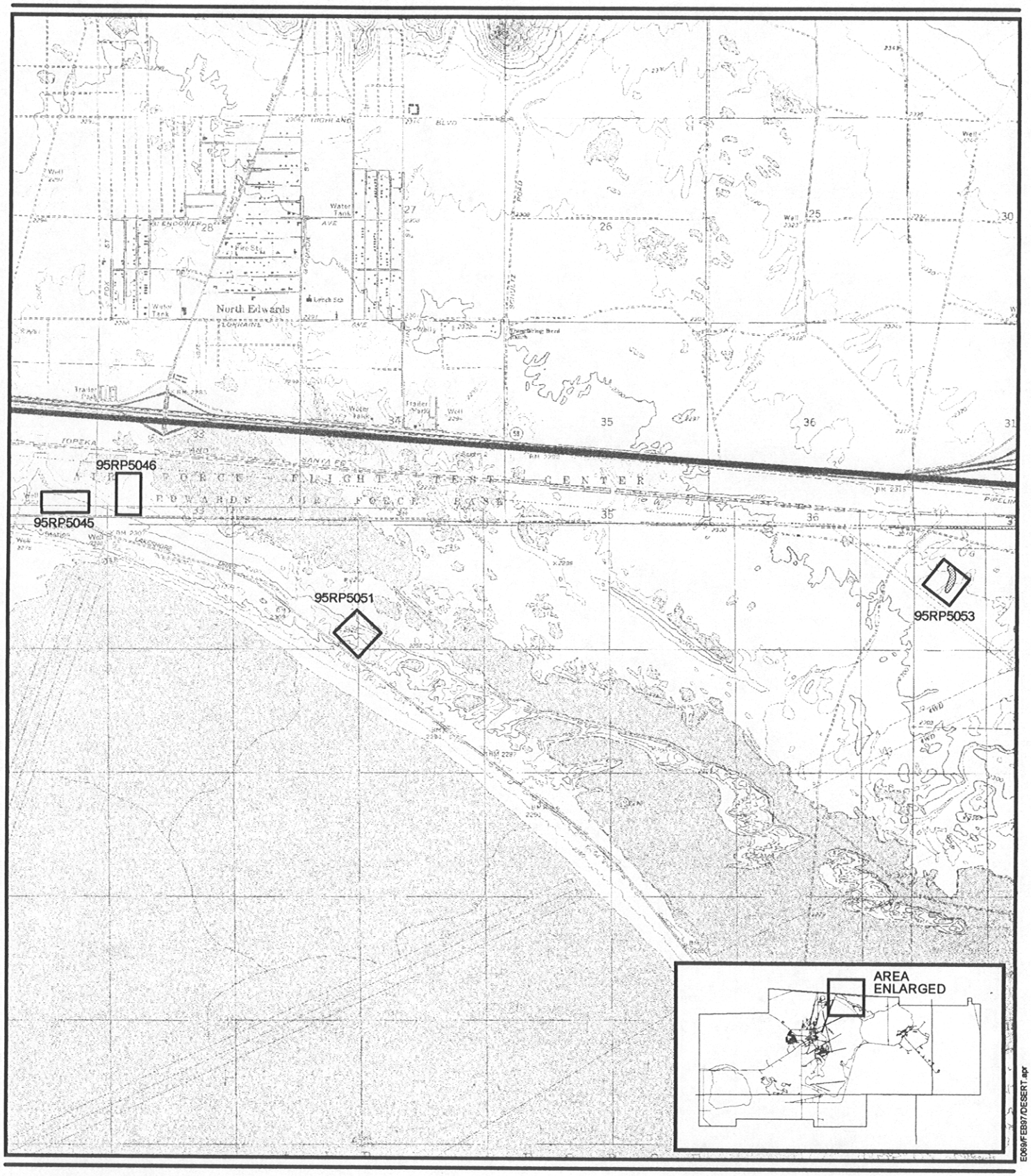
Population > 50 Square Meters

Population ≤ 50 Square Meters

900 0 900 1800 Feet

Survey Areas, Populations and Incidental Detections of Desert Cymopterus on Edwards AFB

Figure 5



Base Boundary

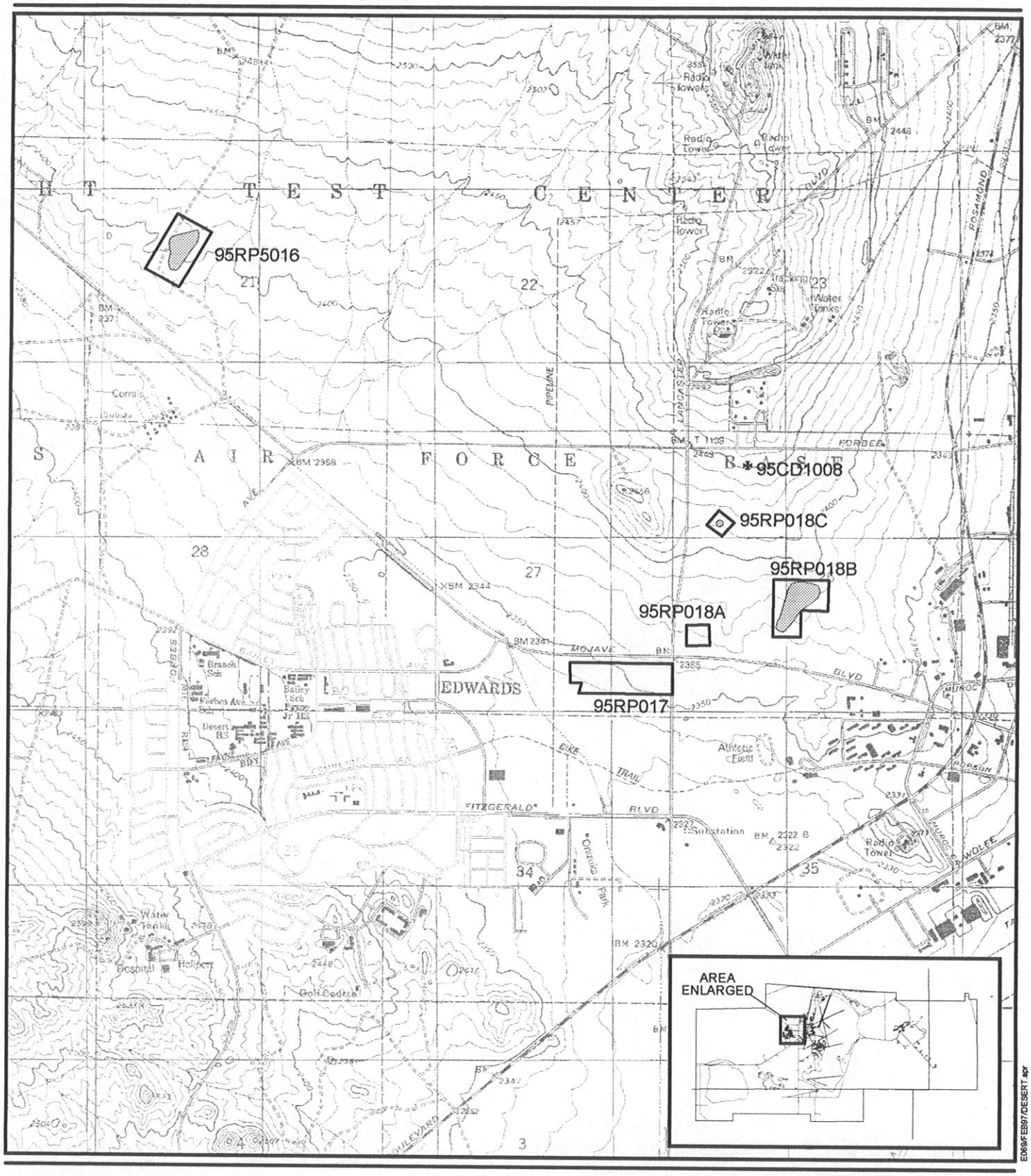
Survey Area Boundary

Population > 50 Square Meters

1000 0 1000 2000 3000 Feet

Survey Areas, Populations and Incidental Detections of Desert Cymopterus on Edwards AFB

Figure 6



Base Boundary

Survey Area Boundary

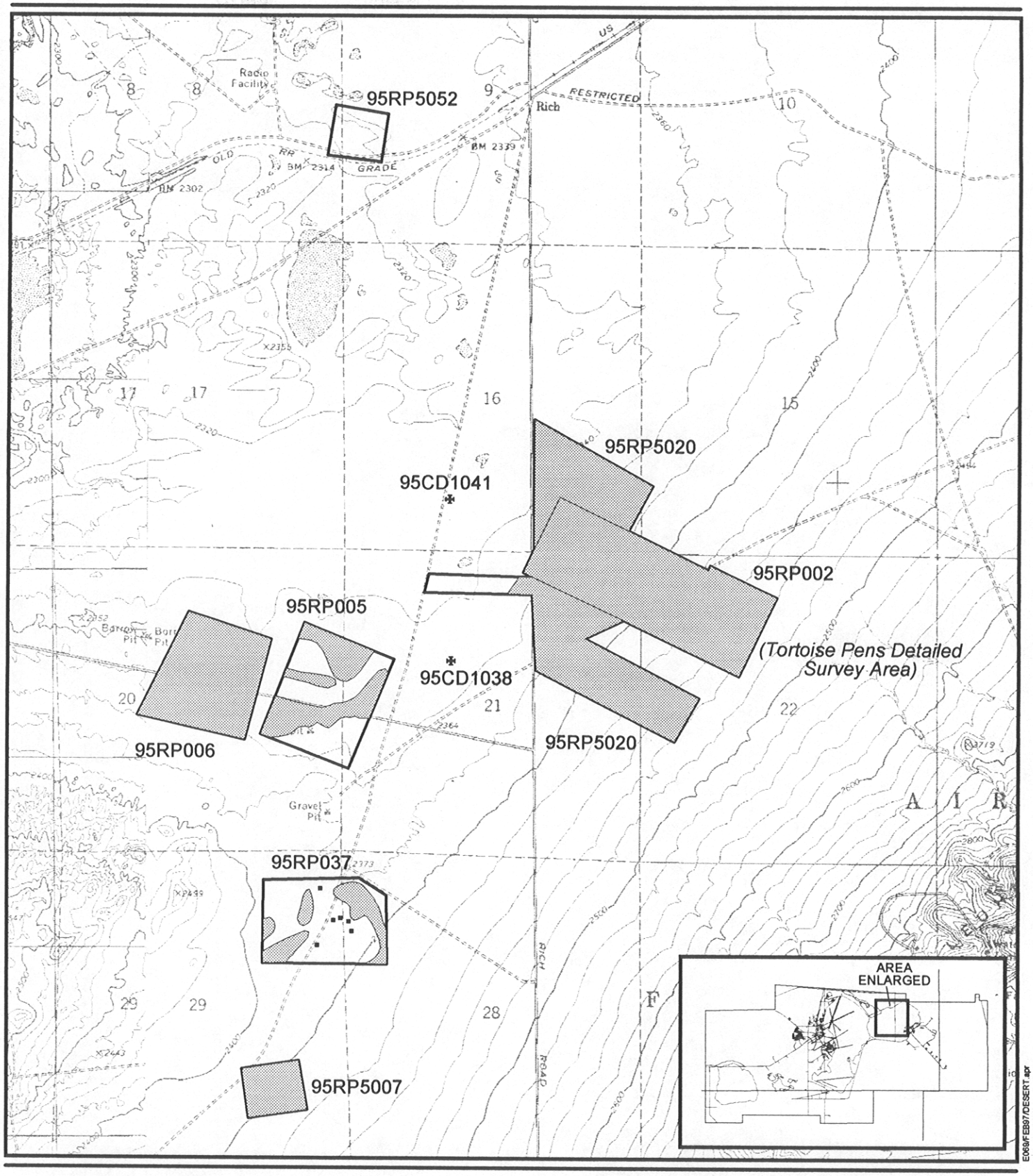
Population > 50 Square Meters

Incidental Detection

1000 0 1000 2000 Feet

Survey Areas, Populations and Incidental Detections of Desert Cymopterus on Edwards AFB

Figure 7



Base Boundary

Survey Area Boundary

Population > 50 Square Meters

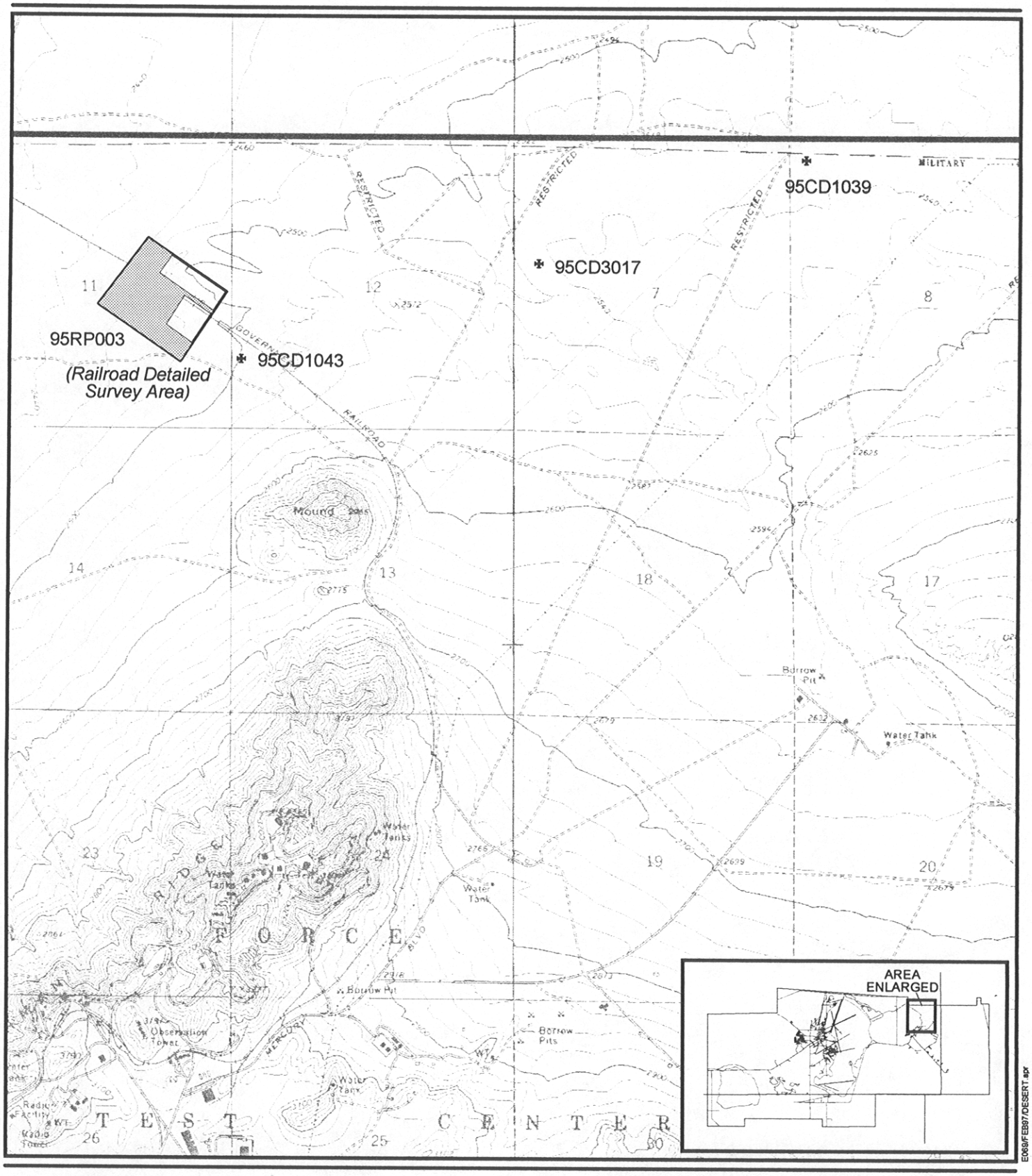
Population ≤ 50 Square Meters

Incidental Detection

1000 0 1000 2000 Feet

Survey Areas, Populations and Incidental Detections of Desert Cymopterus on Edwards AFB

Figure 8



Base Boundary

Survey Area Boundary

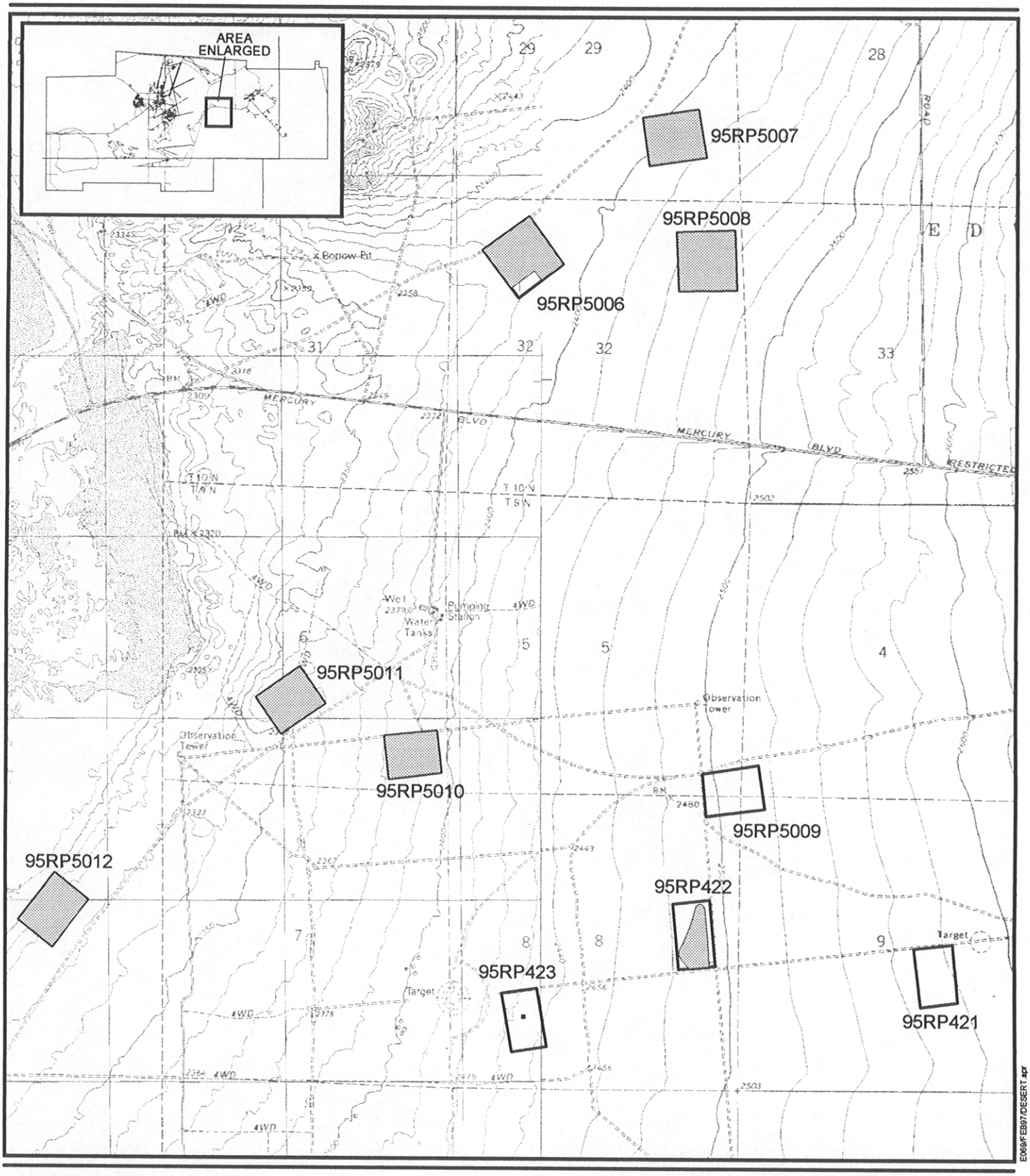
Population > 50 Square Meters

Incidental Detection

1000 0 1000 2000 Feet

Survey Areas, Populations and Incidental Detections of Desert Cymopterus on Edwards AFB

Figure 9



Base Boundary

Survey Area Boundary

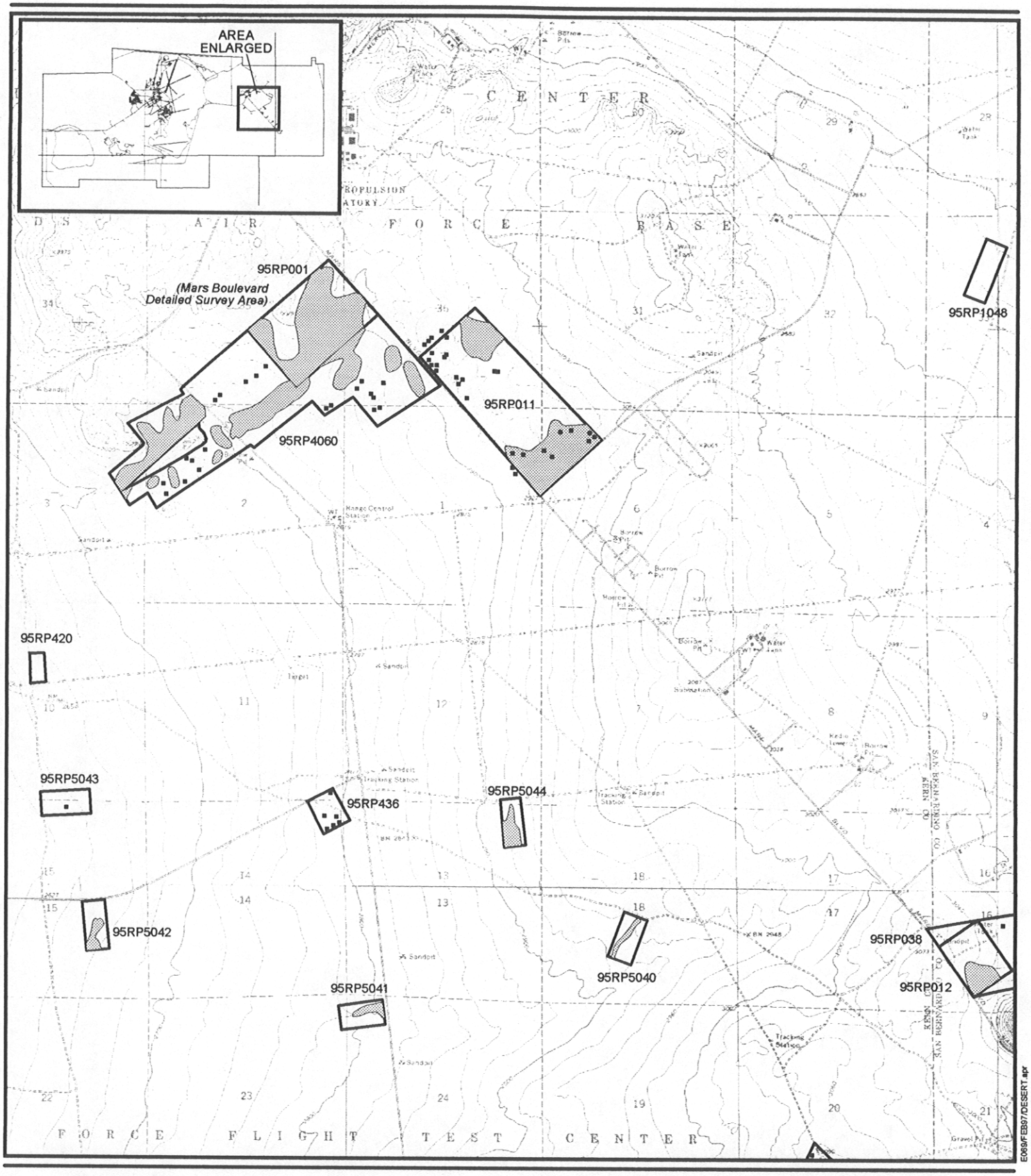
Population > 50 Square Meters

Population ≤ 50 Square Meters

1000 0 1000 2000 Feet

Survey Areas, Populations and Incidental Detections of Desert Cymopterus on Edwards AFB

Figure 10



Base Boundary

Survey Area Boundary

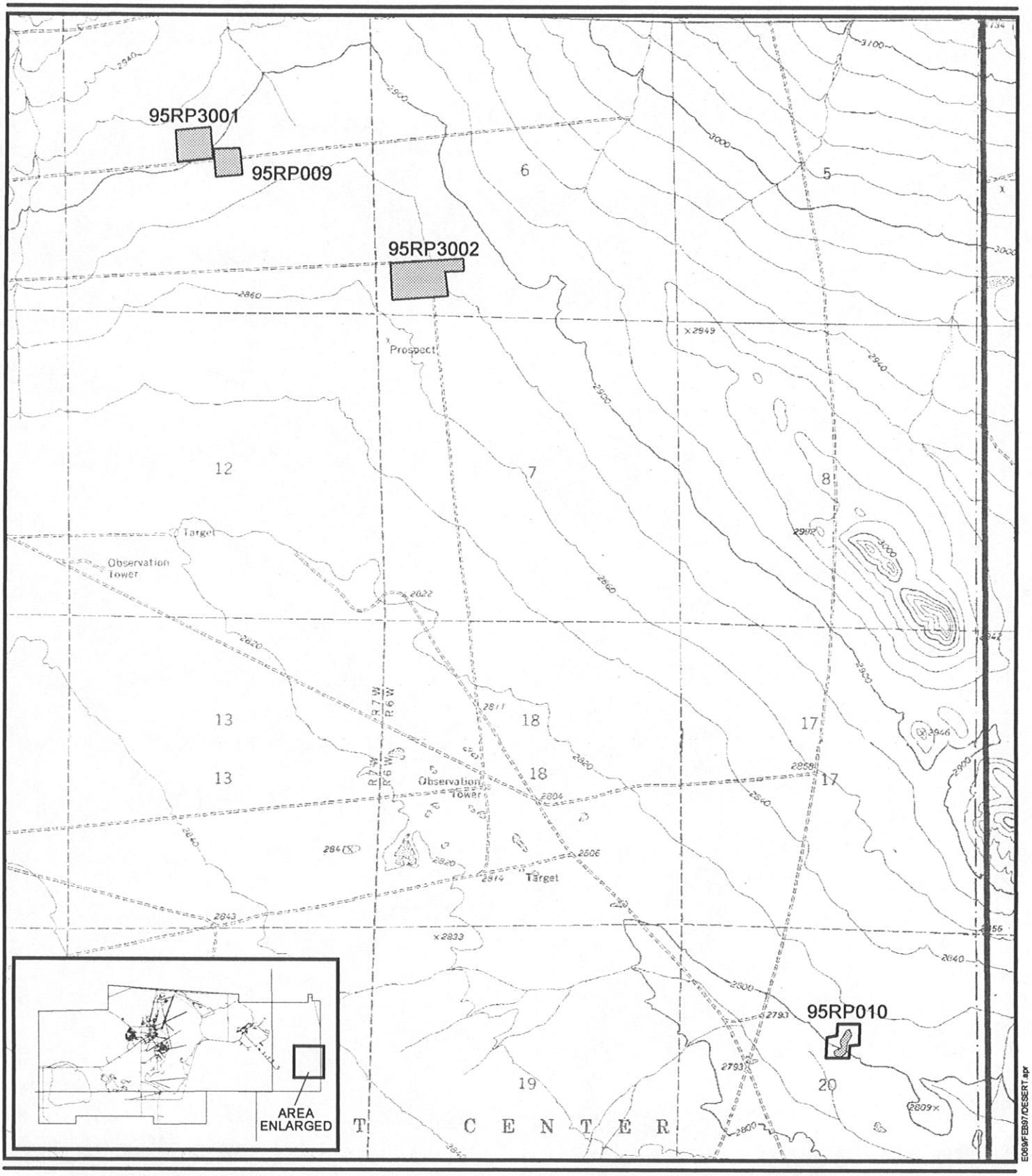
Population > 50 Square Meters

Population ≤ 50 Square Meters

1000 0 1000 2000 3000 Feet

Survey Areas, Populations and Incidental Detections of Desert Cymopterus on Edwards AFB

Figure 11



Base Boundary

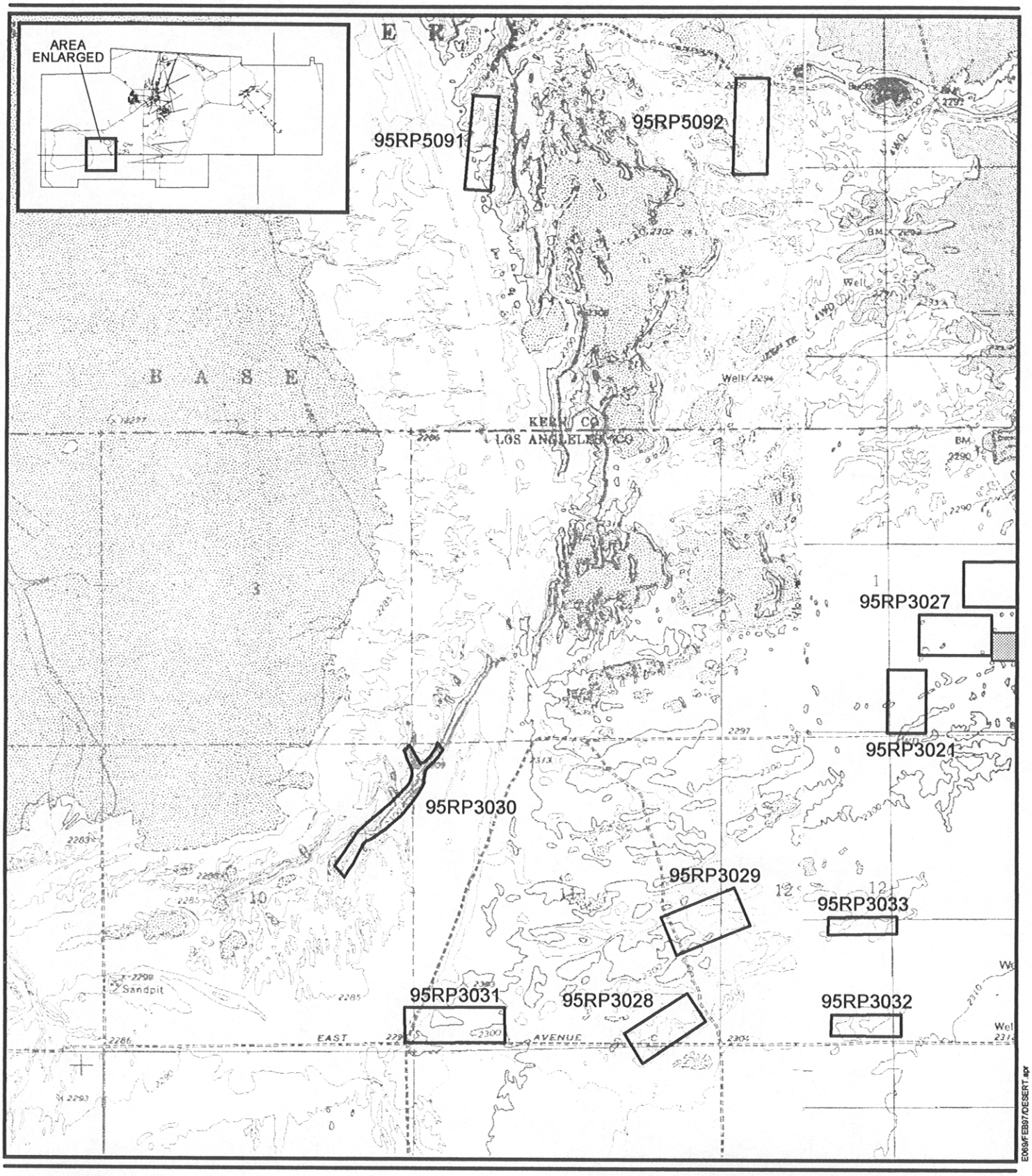
Survey Area Boundary

Population > 50 Square Meters

1000 0 1000 2000 Feet

Survey Areas, Populations and Incidental Detections of Desert Cymopterus on Edwards AFB

Figure 12



Base Boundary

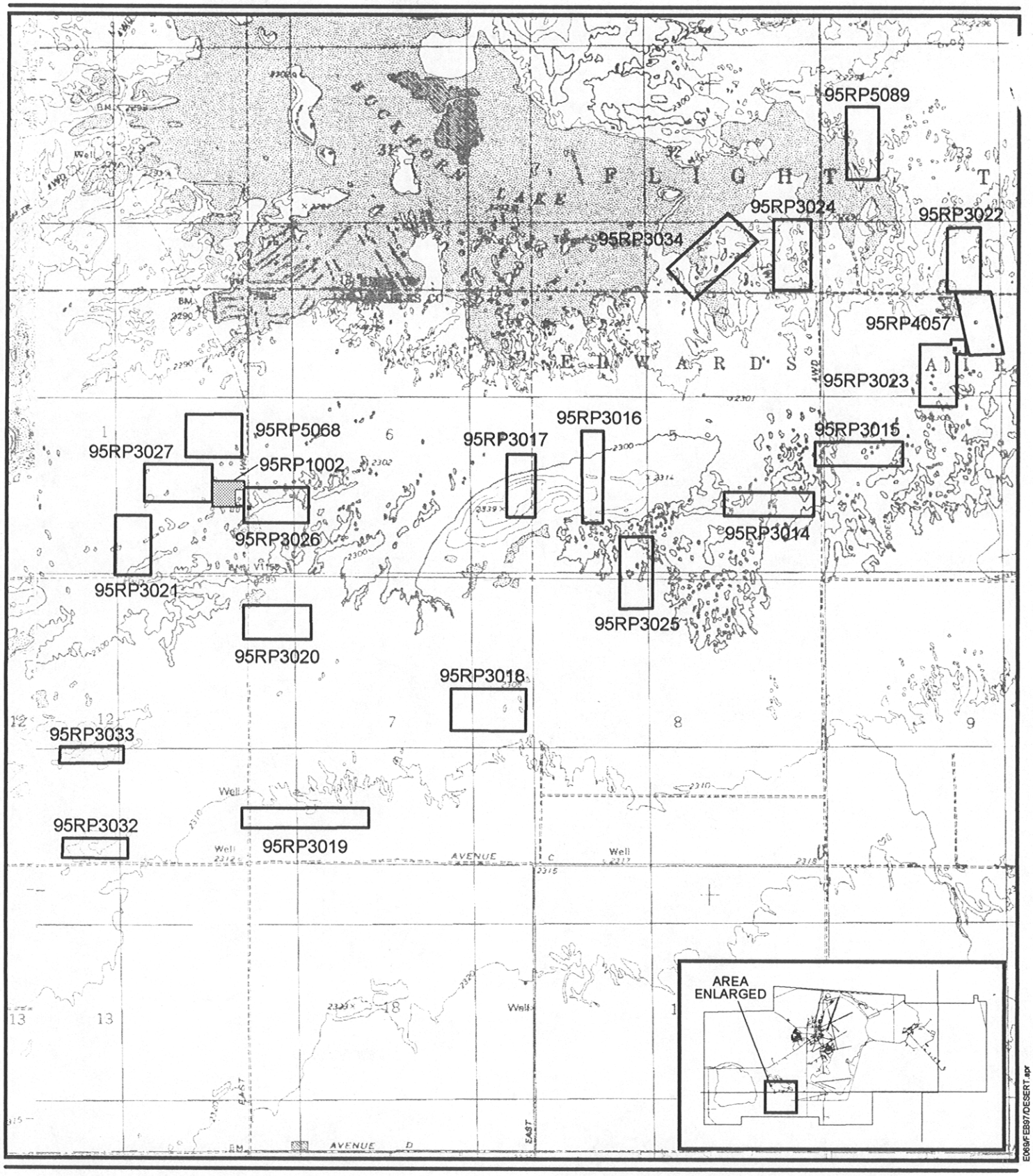
Survey Area Boundary

Population > 50 Square Meters

1000 0 1000 2000 Feet

Survey Areas, Populations and Incidental Detections of Desert Cymopterus on Edwards AFB

Figure 13



Base Boundary

Survey Area Boundary

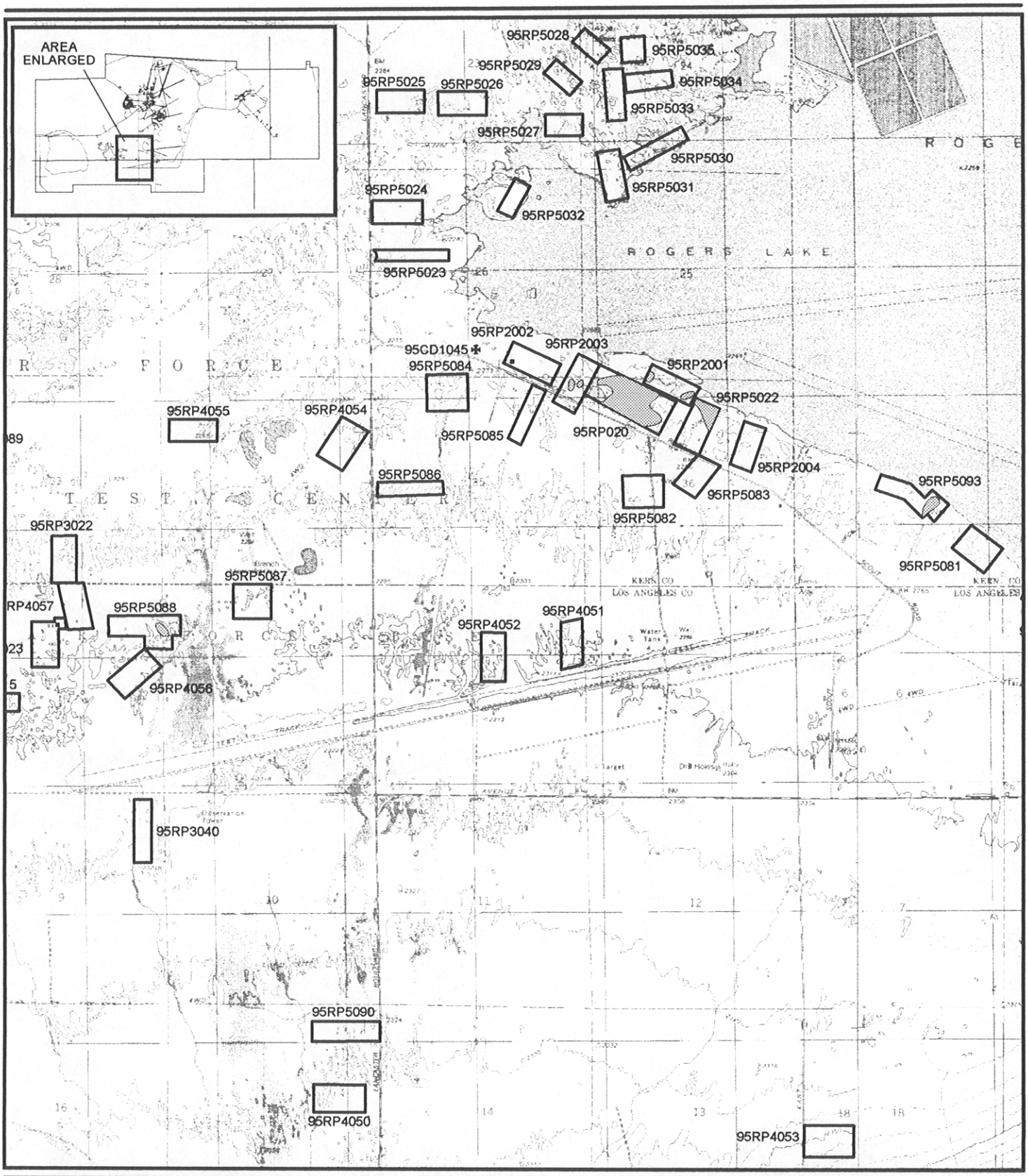
Population > 50 Square Meters

Population ≤ 50 Square Meters

1000 0 1000 2000 Feet

Survey Areas, Populations and Incidental Detections of Desert Cymopterus on Edwards AFB

Figure 14



Base Boundary

Survey Area Boundary

Population > 50 Square Meters

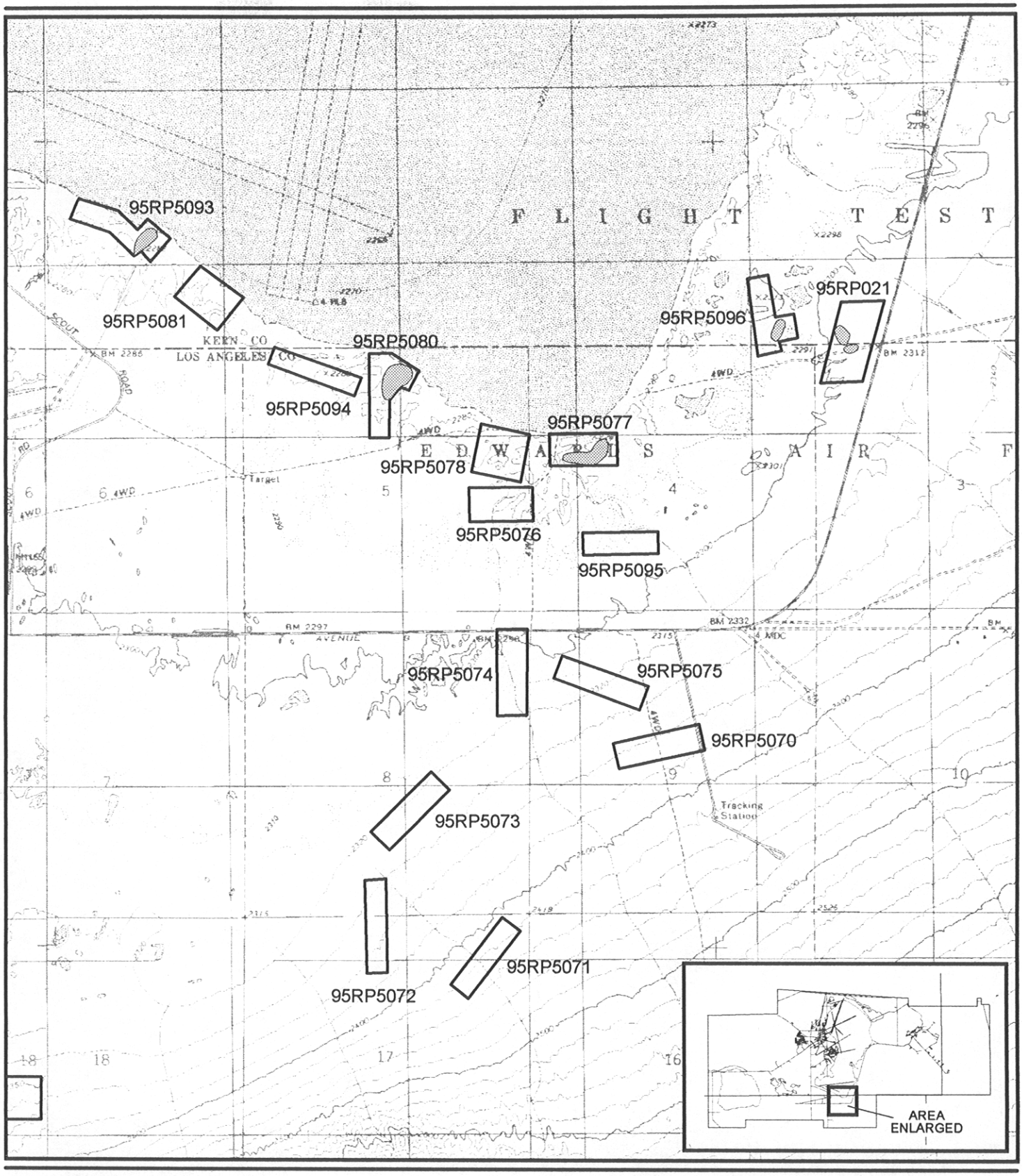
■ Population ≤ Square Meters

✠ Incidental Detection

1000 0 1000 2000 Feet

Survey Areas, Populations and Incidental Detections of Desert Cymopterus on Edwards AFB

Figure 15



Base Boundary

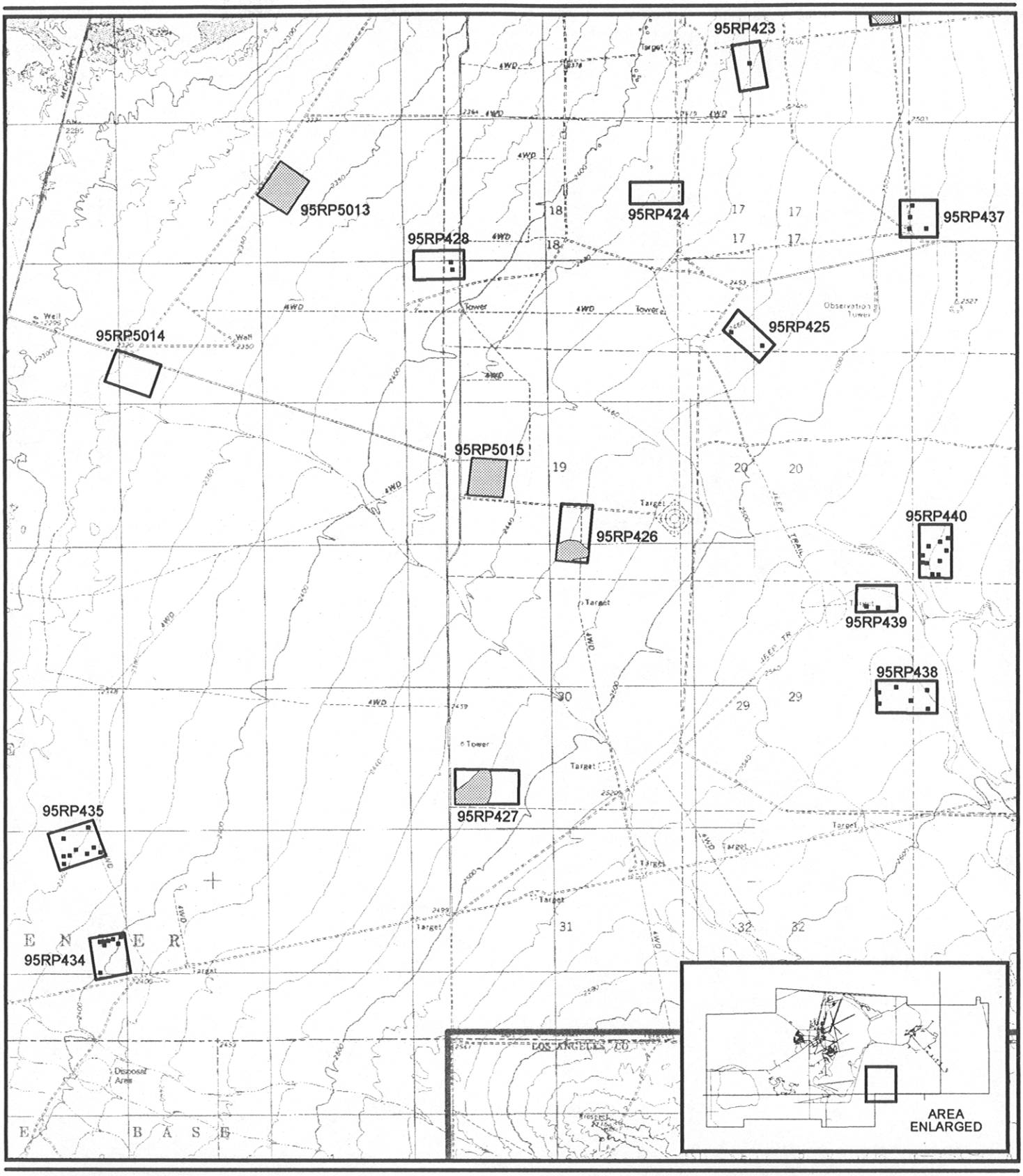
Survey Area Boundary

Population > 50 Square Meters

1000 0 1000 2000 Feet

Survey Areas, Populations and Incidental Detections of Desert Cymopterus on Edwards AFB

Figure 16



Base Boundary

Survey Area Boundary

Population > 50 Square Meters

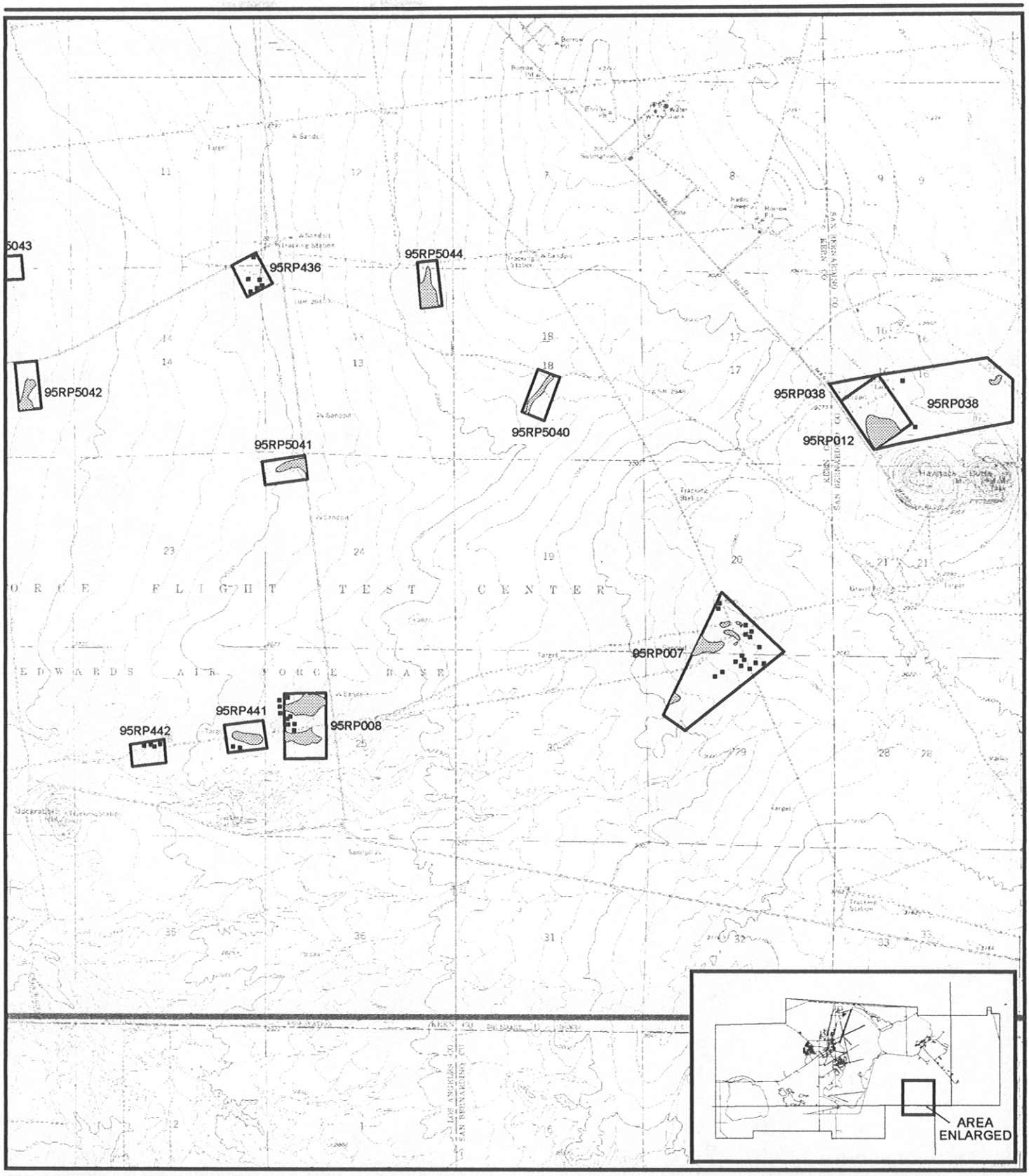
Population ≤ 50 Square Meters

1500 0 1500 3000 Feet

Survey Areas, Populations and Incidental Detections of Desert Cymopterus on Edwards AFB

Figure 17

E069/FEB97/DESERT.apr



Base Boundary

Survey Area Boundary

Population > 50 Square Meters

Population ≤ 50 Square Meters

2000 0 2000 4000 Feet

Survey Areas, Populations and Incidental Detections of Desert Cymopterus on Edwards AFB

Figure 18

Population sizes ranged from one to 3,448 individuals (Survey Area 95RP4060 on Figure 11). Population areas ranged from 1 square meter to 122.3 ha. Fifty-one percent of the populations were less than 2 ha and 33 percent were less than 0.25 ha. Eight populations (11%) were greater than 10 ha.

The majority of the desert cymopterus identified during this study was concentrated in two areas of the base accounted for in five survey areas. Sixty-one percent of the desert cymopterus observed during this study (8,605 plants) occurred in the following three survey areas: the Mars Boulevard detailed survey area (95RP001 on Figure 11; 3,228 individuals); the population size survey area 95RP011, which was located north of the Mars Boulevard detailed survey area (Figure 11; 1,929 individuals); and potential habitat survey area 95RP4060, which was located south of the Mars Boulevard detailed survey area (Figure 11; 3,448 individuals). These survey areas accounted for 33 percent (197.3 ha) of the total desert cymopterus population area found in this study. The Tortoise Pens detailed survey area and an adjacent survey area (95RP002 and 95RP5020 on Figure 8; 1,075 individuals, and 538 individuals, respectively) accounted for 1,613 plants (11% of the total) in 106.45 ha (18% of the total) of the population area observed in this study.

Joshua tree woodland occurred as the zonal habitat at 49 of 67 (73%) desert cymopterus populations. Eleven of the 67 populations of desert cymopterus (16.5%) had creosote bush scrub as the zonal habitat. Halophytic phase saltbush scrub was recorded as the zonal habitat in 4 of the 67 populations (6%) of desert cymopterus observed. Arid phase saltbush scrub was recorded as the zonal habitat in 3 of the 67 populations (4.5%) of desert cymopterus. The most common azonal habitat recorded was dunes, recorded in 88 percent of those survey areas with recorded azonal habitats. Thirty-two percent of these areas with dunes azonal habitat also had clay pans azonal habitat which was the second most prevalent azonal habitat recorded. Other azonal habitats recorded were desert wash with mesquite woodlands, and desert wash without mesquite woodlands.

Sixty-four percent of the desert cymopterus populations (43 of 67 populations) were found to occur in alluvial plain geomorphology. Other geomorphological types included dune (19%), slope (10%), alluvial fan (5%), and hill (2%). The dominant soil texture in the desert cymopterus populations was sand, reported as the only soil texture in 82 percent of the populations, and reported in 15 percent of the poulations as a mixture of sand soil texture with clay, clay loam, gravel, silt, silty clay, sandy clay, or sandy loam soil textures. Two of the populations (3%) contained sandy clay as their dominant soil texture.

The slope aspect in the population areas were distributed with 20 percent of the populations each oriented north, west, and southwest. The remaining 40 percent of the populations were generally equally divided among the other compass headings with an average of 8 percent of the populations each. Slopes were generally flat, ranging from 0 to 10 degrees, with a mean of 2.7 degrees. Populations occurred at elevations between 692 and 933 meters above msl.

Eight plant species were found as common associates of desert cymopterus in a previous study (Charlton 1993b). These species were also found in the current study. Creosote bush was found in 47 of the 67 populations (70%). Joshua tree was found in 54 of these populations (81%). *Atriplex polycarpa* was found in 6 of these populations (9%). Burro-weed was found in 49 of these populations (73%). Box-thorn was found in 27 of these populations (40%). *Hymenoclea salsola* was found in 60 of these populations (90%). Croton was found in 18 of these populations (27%). Ricegrass was found in 24 of these populations (36%).

In addition to these species, three other species were often associated with desert cymopterus in this study. Goldenhead (*Acamptopappus sphaerocephalus*) was found in 40 of the 67 populations (60%). Another saltbush species (*A. canescens*) was found in 27 of these populations (40%). *Eurotia lanata* was found in 29 of these populations (43%).

Weather data for these surveys are provided in Table 4, and show that minimum temperatures ranged from 8 to 29 degrees Celsius (C) with a mean of 17.75 degrees C, while maximum temperatures ranged from 10 to 34 degrees C with a mean of 21.77 degrees C. Wind speed ranged from 0 to 60 kilometers per hour (kph) with a mean of 15.38 kph. Cloud cover ranged from 0 to 100 percent with a mean of 34.77 percent.

Table 4

Temperature, Wind Speed, Wind Direction, and Cloud Cover at *Cymopterus deserticola* Survey Areas on Edwards AFB, Spring 1995

Date	Survey Area ID	Start Time	End Time	Max Temp (Celsius)	Min Temp (Celsius)	Max Wind Speed (kph)	Wind Direction	Cloud Cover (%)
3/7/95	95RP001(A)	1350	1745	26	15	5	NE	95
3/7/95	95RP4060	1350	1745	26	15	5	NE	95
3/8/95	95RP001(A)	1200	1700	24	18	10	W	50
3/8/95	95RP4060	1200	1700	24	18	10	W	50
3/9/95	95RP001(A)	930	1700	22	15	30	S	100
3/9/95	95RP4060	930	1700	22	15	30	S	100

Date	Survey Area ID	Start Time	End Time	Max Temp (Celsius)	Min Temp (Celsius)	Max Wind Speed (kph)	Wind Direction	Cloud Cover (%)
3/13/95	95RP001(A)	800	1700	26	14	10	SW	65
3/13/95	95RP4060	800	1700	26	14	10	SW	65
3/14/95	95RP001(A)	900	1600	26	16	10	W	20
3/14/95	95RP002(A)	1000	1645	24	17	10	W	35
3/14/95	95RP003(A)	1200	1715	27	22	5	SW	60
3/14/95	95RP4060	900	1045	26	16	10	W	20
3/15/95	95RP001(A)	800	1545	33	15	16	W	75
3/15/95	95RP002(A)	815	1630	29	15	20	SW	65
3/15/95	95RP003(A)	900	1100	26	21	5	SW	15
3/16/95	95RP001(A)	830	1730	28	18	10	SW	50
3/16/95	95RP002(A)	830	1645	30	15	5	SW	75
3/17/95	95RP001(A)	800	1730	20	16	5	SE	25
3/17/95	95RP002(A)	1000	1645	34	14	5	NW	70
3/18/95	95RP001(A)	740	1035	19	15	7	W	90
3/18/95	95RP007	1100	1645	26	20	60	W	80
3/19/95	95RP007	815	1700	31	14	30	W	70
3/20/95	95RP007	815	1130	18	15	40	W	85
3/26/95	95RP005	1630	1730	24	12	3	NW	1
3/27/95	95RP005	1030	1730	29	15	30	NE	10
3/27/95	95RP007	830	945	14	12	20	NE	0
3/27/95	95RP011	1400	1730	22	18	10	NE	2
3/28/95	95RP005	800	1000	18.5	15.5	5	NE	10
3/28/95	95RP006	1000	1700	22	15	5	NE	70
3/28/95	95RP011	800	1615	24	11	5	NE	50
3/28/95	95RP012	800	1300	22	12	10	NE	2
3/29/95	95RP006	815	1130	17	13	5	NE	5
3/29/95	95RP011	830	1630	20	14	5	NE	5
3/29/95	95RP020	1330	1700	27	17	5	NNE	10
3/29/95	95RP037	1300	1630	31	24	2	NW	5
3/30/95	95RP017	1315	1415	22.5	21	5	NE	5
3/30/95	95RP018A	830	930	19	15	20	NE	5
3/30/95	95RP008	830	1200	21	11	20	E	5
3/30/95	95RP015	1430	1630	28	21	10	NE	10
3/30/95	95RP018B	930	1130	19	15	20	NE	5
3/30/95	95RP018C	1130	1300	19	18	20	NE	5
3/30/95	95RP018D	1230	1300	19	18	20	NE	5
3/30/95	95RP037	1330	1715	23	17	10	E	10
3/30/95	95RP5036	1630	1700	28	21	10	NE	10
3/31/95	95RP008	900	1030	19	17	3	NW	5
3/31/95	95RP010	945	1230	25	20	2	NE	2
3/31/95	95RP018B	1400	1700	22	18	0	NA	45

Date	Survey Area ID	Start Time	End Time	Max Temp (Celsius)	Min Temp (Celsius)	Max Wind Speed (kph)	Wind Direction	Cloud Cover (%)
3/31/95	95RP021	800	1815	24	22	2	NE	10
3/31/95	95RP3002	1330	1415	23	22	2	NE	2
4/4/95	95RP038	830	1515	22	17	5	SW	20
4/4/95	95RP038	830	1515	22	17	5	SW	20
4/4/95	95RP038	830	1515	22	17	5	SW	20
4/4/95	95RP403	1230	1500	25	22	3	SE	5
4/5/95	95RP1048	1415	1515	30	27	15	SW	50
4/5/95	95RP009	1000	1115	23	21	10	SW	35
4/5/95	95RP2001	1000	1330	24	18	15	W	80
4/5/95	95RP2002	1430	1545	24	24	20	W	80
4/5/95	95RP2003	1610	1730	23	22	20	W	80
4/5/95	95RP3001	1130	1215	25	23.5	10	SW	40
4/5/95	95RP3002	1300	1400	28	26	20	SW	40
4/6/95	95RP3005	1700	1715	26	20	50	W	85
4/7/95	95RP1002	1610	1725	29	20	50	W	60
4/8/95	95RP001(B)	830	1600	18	13	35	W	15
4/9/95	95RP001(B)	750	1750	22	10	16	NW	50
4/9/95	95RP003(B)	830	1230	22	9	20	NW	50
4/10/95	95RP001(B)	810	1547	23	9	10	NE	10
4/10/95	95RP002(B)	830	1730	23	9	3	W	1
4/11/95	95RP002(B)	800	1730	22	12	5	W	10
4/12/95	95RP002(B)	815	1130	20	13	5	W	75
4/13/95	95RP5006	1434	1530	25	24	30	SSW	25
4/13/95	95RP5007	1539	1640	24	24	30	SSW	20
4/13/95	95RP5008	1650	1730	18	18	35	W	75
4/14/95	95RP5009	835	857	10	10	6	SW	98
4/14/95	95RP5014	1152	1220	15	14	0	NA	100
4/14/95	95RP5010	918	950	11	11	3	SW	100
4/14/95	95RP5011	1001	1029	14	14	1	W	100
4/14/95	95RP5012	1030	1107	16	15	1	W	98
4/14/95	95RP5013	1112	1142	14	14	3	N	95
4/14/95	95RP5015	1300	1334	19	19	3	SW	100
4/14/95	95RP5016	1530	1700	16	16	12	W	85
4/15/95	95RP420	925	955	12	12	8	W	1
4/15/95	95RP421	1000	1030	13	12	8	W	1
4/15/95	95RP424	1250	1325	18	17	10	W	3
4/15/95	95RP422	1040	1120	15	14	10	W	1
4/15/95	95RP423	1130	1200	17	15	8	W	3
4/15/95	95RP425	1330	1415	17	17	12	W	8
4/15/95	95RP426	1425	1520	18	18	12	W	15
4/15/95	95RP427	1530	1615	18	18	12	W	25

Date	Survey Area ID	Start Time	End Time	Max Temp (Celsius)	Min Temp (Celsius)	Max Wind Speed (kph)	Wind Direction	Cloud Cover (%)
4/15/95	95RP428	1615	1650	18	18	12	W	30
4/16/95	95RP5020	830	1200	11	9	15	SW	100
4/18/95	95RP4060	830	1745	14	8	25	W	80
4/18/95	95RP5020	950	1630	20	10	16	SE	25
4/19/95	95RP2004	1615	1650	22	14	10	SW	15
4/19/95	95RP4060	800	1730	15	12	30	SW	50
4/19/95	95RP434	1300	1345	18	16	20	NW	10
4/19/95	95RP435	1400	1445	16	16	25	NW	15
4/19/95	95RP5020	910	1045	24	12	9	W	20
4/19/95	95RP5022	1700	1740	18	14	10	W	15
4/20/95	95RP5023	840	925	22	11	20	SW	20
4/20/95	95RP5024	1000	1040	24	15	20	SW	20
4/20/95	95RP5025	1045	1415	18	14	30	SW	50
4/20/95	95RP5026	1120	1345	19	15	40	SW	70
4/20/95	95RP5027	1215	1300	19	15	35	SW	70
4/20/95	95RP5028	1515	1601	17	13	30	W	60
4/20/95	95RP5029	1615	1647	17	13	35	SW	65
4/20/95	95RP4060	800	1200	13	10	35	SW	50
4/20/95	95RP436	1300	1330	13	12	45	SW	30
4/20/95	95RP437	1340	1415	11	10	40	W	50
4/21/95	95RP5030	900	940	13	11	6	N	1
4/21/95	95RP5031	1000	1040	14	12	10	N	3
4/21/95	95RP5032	1100	1130	16	12	20	N	2
4/21/95	95RP5033	1143	1223	21	14	25	N	2
4/21/95	95RP5034	1318	1351	29	17	20	N	2
4/21/95	95RP5035	1400	1450	22	18	16	N	0
4/21/95	95RP5036	1500	1630	22	20	10	E	0
4/22/95	95RP5045	1510	1600	29	25	1	NE	0
4/22/95	95RP5046	1620	1701	28	25	1	W	0
4/22/95	95RP438	845	1005	18	14	10	NW	0
4/22/95	95RP439	1045	1130	19	18	5	NW	0
4/22/95	95RP440	1130	1215	20	19	5	W	0
4/22/95	95RP441	1300	1400	26	25	3	W	0
4/22/95	95RP442	1430	1500	22	22	5	NW	0
4/22/95	95RP5040	741	853	15	13	2	NE	0
4/22/95	95RP5041	911	955	16	13	3	N	0
4/22/95	95RP5042	1000	1039	19	17	7	N	0
4/22/95	95RP5043	1209	1250	24	23	3	NE	0
4/22/95	95RP5044	1345	1431	23	23	2	N	0
4/23/95	95RP5047	830	907	17	14	1	NE	0
4/23/95	95RP5048	920	955	23	21	1	NE	0

Date	Survey Area ID	Start Time	End Time	Max Temp (Celsius)	Min Temp (Celsius)	Max Wind Speed (kph)	Wind Direction	Cloud Cover (%)
4/23/95	95RP5051	1312	1410	25	24	10	NE	0
4/23/95	95RP5052	1430	1455	27	26	0	NA	10
4/23/95	95RP5049	1005	1050	24	23	5	NE	0
4/23/95	95RP5050	1100	1145	24	23	3	NE	0
4/23/95	95RP5053	1525	1600	27	25	2	NE	10
4/24/95	95RP5055	1110	1144	26	25	2	NW	0
4/24/95	95RP5057	1415	1450	26	25	2	NW	99.9
4/25/95	95RP5068	1700	1735	25	23	25	SW	0
4/25/95	95RP5066	1431	1505	26	22	15	W	0
4/26/95	95RP5070	820	845	22	22	4	W	25
4/26/95	95RP5071	910	940	23	23	1	W	85
4/26/95	95RP5072	950	1026	24	22	0	NA	30
4/26/95	95RP5073	1040	1105	24	22	5	W	30
4/26/95	95RP5074	1119	1148	27	25	1	N	60
4/26/95	95RP5075	1155	1230	28	25	1	N	60
4/26/95	95RP5076	1315	1355	27	27	0	NA	70
4/26/95	95RP5078	1620	1710	27	27	13	SW	70
4/26/95	95RP5077	1405	1440	26	26	5	W	50
4/27/95	95RP5081	1120	1150	21	18	10	SW	10
4/27/95	95RP5082	1315	1155	26	25	15	SW	15
4/27/95	95RP5083	1415	1445	25	25	15	SW	15
4/27/95	95RP5084	1500	1535	25	25	20	SW	20
4/27/95	95RP5080	815	1045	18	16	12	SW	10
5/2/95	95RP3014	910	950	20	20	15	W	20
5/2/95	95RP3015	1005	1045	19	18	15	W	30
5/2/95	95RP3016	1105	1150	22	20	15	W	20
5/2/95	95RP3017	1250	1335	25	22	30	W	10
5/2/95	95RP3018	1345	1420	23	22	20	W	15
5/2/95	95RP3019	1445	1515	23	23	50	W	20
5/2/95	95RP3020	1525	1600	23	21	50	W	20
5/2/95	95RP3021	1615	1645	22	22	35	W	15
5/2/95	95RP3040	800	900	20	17	10	W	20
5/2/95	95RP5085	837	915	15	14	30	NW	25
5/2/95	95RP5086	925	1012	15	14	20	W	15
5/2/95	95RP5087	1040	1120	16	15	20	W	30
5/2/95	95RP5089	1450	1530	21	20	40	SW	10
5/2/95	95RP5090	1613	1700	18	16	25	SW	40
5/2/95	95RP5088	1135	1430	22	22	25	NW	5
5/3/95	95RP3022	900	930	19	17	5	W	0
5/3/95	95RP3024	1210	1245	24	23	2	W	0
5/3/95	95RP3025	1300	1345	29	29	2	W	0

Date	Survey Area ID	Start Time	End Time	Max Temp (Celsius)	Min Temp (Celsius)	Max Wind Speed (kph)	Wind Direction	Cloud Cover (%)
5/3/95	95RP3025	1300	1345	29	29	2	W	0
5/3/95	95RP3027	1530	1615	32	28	4	W	10
5/3/95	95RP5091	1500	1611	27	26	5	S	0
5/3/95	95RP5092	1615	1700	26	24	10	W	25
5/3/95	95RP3023	945	1115	26	19	5	W	0
5/3/95	95RP3026	1400	1530	34	30	4	W	5
5/4/95	95RP3028	910	950	16	16	20	W	75
5/4/95	95RP3029	955	1030	17	16	25	W	80
5/4/95	95RP3030	1050	1230	19	17	30	W	50
5/4/95	95RP3031	1345	1420	25	22	30	W	50
5/4/95	95RP3032	1430	1500	22	21	20	SW	30
5/4/95	95RP3033	1510	1530	22	21	20	SW	25
5/4/95	95RP3034	1540	1645	22	18	35	W	20
5/4/95	95RP5094	1200	1308	18	17	35	SW	60
5/4/95	95RP5095	1400	1445	23	23	30	SW	15
5/4/95	95RP5093	930	1130	16	15	30	SW	80
5/4/95	95RP5096	1430	1655	25	25	35	SW	60
5/5/95	95RP003C	1500	1800	18	16	35	SW	50
5/6/95	95RP4050	845	932	17	16	20	W	60
5/6/95	95RP4051	945	1020	16	16	25	SW	75
5/6/95	95RP4052	1030	1115	17	17	20	W	80
5/6/95	95RP4053	1130	1215	16	16	20	W	75
5/6/95	95RP4054	1300	1345	18	16	20	W	70
5/6/95	95RP4055	1400	1445	18	18	10	W	85
5/6/95	95RP4056	1445	1535	21	18	20	W	85
5/6/95	95RP4057	1550	1650	16	16	25	W	90
5/6/95	95RP002C	915	1700	23	10	25	W	90
5/7/95	95RP002C	830	1700	23	11	10	W	50
5/7/95	95RP029A	945	1400	22	16	20	SW	20
5/8/95	95RP002C	900	1730	26	10	12	W	30
5/10/95	95RP001C	830	1730	30	17	15	SW	50
5/11/95	95RP001C	830	1730	26	16	40	W	60
5/12/95	95RP001C	1500	1645	21	19	30	W	45

Surveys of Known Populations

The following paragraphs present the results and data for the detailed and population size surveys.

Detailed Surveys

Table 5 presents population data for the three detailed survey areas. These sites were known as the Mars Boulevard detailed survey area (95RP001 on Figure 11), Tortoise Pens detailed survey area (95RP002 on Figure 8), and the Railroad detailed survey area (95RP003 on Figure 9). The total population area identified during detailed surveys was 105.6 ha, out of the total 134.5 ha surveyed in the 3 detailed survey areas. A total peak population of 4,398 individuals were observed at these three sites (Table 5).

The area surveyed at the Mars Boulevard detailed survey area was approximately 56.7 ha, with a population area of 45 ha, and a peak population of 3,228 individuals. The area surveyed at the Tortoise Pens detailed survey area was approximately 62 ha. The population area covered approximately 57 ha, with a peak population of 1,075 individuals. The Railroad detailed survey area was approximately 15.75 ha, with a population area of 3.6 ha and a peak population of 95 individuals. At the Mars Boulevard and Tortoise Pens detailed survey areas the peak population occurred during Observation Period B. At the Railroad detailed survey area the peak population occurred during Observation Period C.

All three of the detailed survey areas showed an increase in individuals between Observation Period A and Observation Period B but the increase was not the same for any of the survey areas. The Mars Boulevard detailed survey area showed a 4 percent increase from 3,121 individual observed in Observation Period A to 3,228 individuals observed in Observation Period B. The Tortoise Pens detailed survey area showed a 1 percent increase from 1,064 individuals observed in Observation Period A to 1,075 individuals observed in Observation Period B. The Railroad detailed survey area showed a 12 percent increase from 84 individuals observed in Observation Period A to 94 individuals observed in Observation Period B. From Observation Period B to Observation Period C, two of the detailed survey areas showed a decrease in population numbers observed and the third detailed survey area showed a slight increase in population numbers. The Mars Boulevard detailed survey area showed a 5 percent decrease to 3,058 individuals observed in Observation Period C. The Tortoise Pens detailed survey area showed a similar decrease of 3 percent to 1,047 individuals observed in Observation Period C. The Railroad detailed survey area showed a 1 percent increase from 94 individuals observed in Observation Period B to 95 individuals observed in Observation Period C.

Table 5

Summary of *Cymopterus deserticola* Detailed Surveys

Study Area ID	Transect ID	Obs. ID	Shown on Figure Number	Number of Individuals	Population Area (hectares)	Area surveyed (hectares)	Zonal Habitat	Azonal Habitat	Geomorphology	Soil Texture	Elevation (meters)	Slope Angle (degrees)	Slope Aspect
95RP001	95CD5001	A	11	3121	45	56.7	JTW	DW	ALLPLN, SLOPE	SND	877	4	S
95RP001	95CD5001	B	11	3228	45	56.7	JTW	DW	ALLPLN, SLOPE	SND	877	4	S
95RP001	95CD5001	C	11	3058	45	56.7	JTW	DW	ALLPLN, SLOPE	SND	877	4	S
95RP002	95CD1037	A	8	1064	57	62	JTW	N/D	ALLPLN	SND,SNDLM	732	5	NW
95RP002	95CD1037	B	8	1075	57	62	JTW	N/D	ALLPLN	SND,SNDLM	732	5	NW
95RP002	95CD1037	C	8	1047	57	62	JTW	N/D	ALLPLN	SND,SNDLM	732	5	NW
95RP003	95CD5002	A	9	84	3.56	15.75	JTW	N/D	ALLPLN, SLOPE	SND	753	3	NW
95RP003	95CD5002	B	9	94	3.56	15.75	JTW	N/D	ALLPLN, SLOPE	SND	753	3	NW
95RP003	95CD5002	C	9	95	3.56	15.75	JTW	N/D	ALLPLN	SND	753	3	NW

Legend:

Zonal Habitat
JTW = Joshua tree woodland

Azonal Habitat
DW = Desert wash without mesquite woodland
N/D = Not determined

Geomorphology
ALLPLN = Alluvial Plain
SLOPE = Slope

Soil Texture
SND = Sand
SNDLM = Sandy loam

Slope Aspect
S = South
NW = Northwest

The zonal habitat in all three detailed survey areas was Joshua tree woodland. The only azonal habitat recorded was desert wash without mesquite woodlands. All three detailed survey areas were in areas with alluvial plain geomorphology with two of the three survey areas also containing slope geomorphology. The dominant soil texture was sand. Sandy loam soil texture was also found in one of the detailed survey areas. Two of the three detailed survey areas had a slope aspect of northwest with the third survey area having a south slope aspect. The slope angle for the three detailed survey areas averaged four degrees. The elevation at the three detailed survey areas ranged from 732 m to 877 m.

Individual plant data was collected for 500 individuals, if there were at least 500 individuals in the survey area, as described in the methodology section. Thus, individual plant data was collected for 16 percent of the Mars Boulevard population and 48 percent of the Tortoise Pens population. Because the Railroad population was less than 500 (a peak of 95 individuals were observed) individual plant data was recorded for 100 percent of the Railroad population.

Table 6 presents the data of the phenological stages of desert cymopterus recorded at each of the three detailed survey areas during the three observation periods. During each of the three observation periods for the three detailed survey areas, the majority of the individuals in the desert cymopterus populations were in distinct phenological stages; first in full flower, then in flower and fruit, and finally in fruit and seed dispersal stage.

During Observation Period A, the Mars Boulevard detailed survey area had 82 percent of the individuals in the flowering stage; the Tortoise Pens detailed survey area had 86 percent in flowering stage; and the Railroad detailed survey area had 84 percent in the flowering stage. The remainder of the plants at each site were either at bud, or fruiting stages or remained vegetative during Observation Period A.

Observation Period B was dominated by plants in fruit, or flower and fruit phenological stages. The Mars Boulevard detailed survey area had 47 percent of the individuals in fruiting stage and 21 percent in fruiting and flowering stage for a combined total of 68 percent exhibiting fruit. The Tortoise Pens detailed survey area had 58 percent of the individuals in fruiting stage and 26 percent in fruiting and flowering stage for a combined total of 84 percent. The Railroad detailed survey area had 61 percent of the individuals in fruiting stage and 24 percent in fruiting and flowering stage for a combined total of 85 percent. The number of plants that were unidentifiable due to dormancy or were missing due to herbivory or mortality was very low for Observation Period B. Both the Mars Boulevard detailed survey area and the Railroad detailed survey areas had less than five percent of their individuals becoming unidentifiable (2.6% and 3.2% respectively). The Tortoise Pens detailed survey area had a slightly larger number of individuals becoming

Table 6

Phenological Stages of *Cymopterus deserticola* at the Detailed Survey Areas

Phenological Stage	Number of Individuals in each Phenological Stage (percent of sample)								
	Mars Boulevard Detailed Survey Area			Tortoise Pens Detailed Survey Area			Railroad Detailed Survey Area		
	Observation A	Observation B	Observation C	Observation A	Observation B	Observation C	Observation A	Observation B	Observation C
Vegetative	75 (15%)	80 (16.0%)	109 (21.8%)	36 (7.2%)	32 (6.4%)	36 (7.2%)	9 (10.7%)	8 (8.5%)	13 (13.7%)
Bud	12 (2.4%)	11 (2.2%)		22 (4.4%)	2 (0.4%)		3 (3.6%)		
Flowering	345 (69%)	56 (11.2%)	1 (0.2%)	308 (61.6%)	23 (4.6%)	8 (1.6%)	63 (75%)	4 (4.3%)	
Fruiting	2 (0.4%)	221 (44.2%)	26 (5.2%)	2 (0.4%)	277 (55.4%)	50 (10.0%)	2 (2.4%)	56 (59.6%)	62 (65.3%)
Bud and Flowering	58 (11.6%)	3 (0.6%)		109 (21.8%)	1 (0.2%)		5 (5.9%)		
Bud, Flowering, and Fruiting		3 (0.6%)		2 (0.4%)	5 (1.0%)			2 (2.1%)	
Bud and Fruiting	1 (0.2%)	13 (2.6%)		11 (2.2%)	11 (2.2%)			1 (1.0%)	
Flowering and Fruiting	7 (1.4%)	100 (20.0%)		10 (2.0%)	121 (24.2%)		2 (2.4%)	20 (21.3%)	
Seed Drop			172 (34.4%)			240 (48.0%)			
Aborted			131 (26.2%)			86 (17.2%)			1 (1.0%)
Unidentifiable*		13 (2.6%)	61 (12.2%)		28 (5.6%)	80 (16.0%)		3 (3.2%)	19 (20.0%)
Sample Size	**500 (100%)**	**500 (100%)**	**500 (100%)**	**500 (100%)**	**500 (100%)**	**500 (100%)**	**84 (100%)**	**94 (100%)**	**95 (100%)**

* Individuals marked as unidentifiable were not found in their previous location and are assumed to be either dormant or missing due to herbivory or mortality.

unidentifiable (5.6%) but the percentage is still only a small portion of the population. The remainder of the plants at each site were either in flowering or pre-flowering stages or remained vegetative during Observation Period B.

Observation Period C was dominated by plants in post-flowering stages, including fruit, seed dispersal, and aborted inflorescence. Less than 2 percent of the plants in each detailed survey area remained in flower at this observation period. The Mars Boulevard detailed survey area had 66 percent of the individuals in the various post flowering stages. Twenty-two percent of the plants at this site were in the vegetative stage. At the Tortoise Pens detailed survey area, 76 percent of the individuals were in the post flowering stages, and 8 percent remained vegetative. The Railroad detailed survey area still had 66 percent of the individuals in the fruiting stage, and 14 percent of the individuals still vegetative, with only one percent in the post fruiting stages. The number of plants which were unidentifiable due to dormancy or were missing due to herbivory or mortality showed an increase from Observation Period B to Observation Period C at all three of the detailed survey areas. The Mars Boulevard detailed survey area had an increase from 2.6 percent in Observation Period B to 12.2 percent in observation Period C. The Tortoise Pens detailed survey area had an increase from 5.6 percent in Observation Period B to 16 percent in Observation Period C. The Railroad detailed survey area showed the largest increase in unidentifiable individuals from 3.2 percent in Observation Period B to 20 percent in Observation Period C.

Table 7 presents the results of the measurement of the distance to the nearest plant of the same species. The mean distance to the nearest plant of the same species ranged from a low of 177 cm during Observation Period C at the Railroad detailed survey area to a high of 289 cm during Observation Period C at the Tortoise Pens detailed survey area. The mean distances did not change significantly between the three observation periods at all three of the detailed survey areas.

Table 7

Mean Distance to Nearest Plant of Same Species (cm) for *Cymopterus deserticola* Detailed Survey Areas on Edwards AFB, March Through May 1995

	Detailed Survey Area		
Observation Period	**Mars Blvd.**	**Tortoise Pens**	**Railroad**
A	213	281	193
B	209	273	195
C	236	289	177

To determine the distribution of desert cymopterus plants within each population area, the data for the distances to the nearest plant of the same species during Observation Period A at each of the three detailed survey areas, was analyzed using index of dispersion calculations. The results are presented in Table 8, and show that the distribution was clumped for all three sites, rather than randomly or uniformly spaced. The high z-value at each site also indicates a strongly clumped distribution .

Table 8

Index of Dispersion, Using Distance to Nearest Plant of the Same Species Data, for Observation Period A at the *Cymopterus deserticola* Detailed Survey Areas on Edwards AFB, March Through May 1995

	Detailed Survey Area		
Statistic*	**Mars Blvd.**	**Tortoise Pens**	**Railroad**
Index of Dispersion	16.99	14.76	15.75
Z-value	3.49	3.28	5.32
Sample Size	500	500	84

Note: * The index of dispersion is a statistic measuring the distribution of nearest neighbor distances. If the value equals 2, the distribution is uniform. If it is less than 2, the distribution is random. If it is greater than 2, the distribution is clumped or grouped. The Z-value measures the number of standard deviations away from a uniformly distributed population. The larger the Z-value the more random or clumped the distribution.

Table 9 presents mean parameter values for the subset of plants producing inflorescences. For all detailed survey areas and observation periods, between 66 and 93 percent of the plants in the measured sample had one or more inflorescences (Table 9). Browsing on inflorescences was most frequent at the Mars Boulevard detailed survey area, with 11, 10, and 9 percent of the flowering plants showing signs of herbivory during Observation Periods A, B, and C respectively. The frequency of plants with aborted inflorescences and the mean number of aborted inflorescences increased over time at each site. Aborted inflorescences were most common at the Tortoise Pens detailed survey area, affecting up to 50 percent of the flowering plants surveyed during Observation Period C. The mean number of fertile inflorescences per plant was smallest at the Mars Boulevard detailed survey area during Observation Period C (0.7) and largest at the Railroad detailed survey area during Observation Period A (2.1). The percentage calculated by the mean number of fertile inflorescences recorded during Observation Period C divided by the mean number of all inflorescences recorded during Observation Period B, ranged from 46.6 percent at the Mars Boulevard detailed survey area to 64.7 percent at the Tortoise Pens detailed survey area, with the Railroad detailed survey area at 62.5 percent.. This is an approximate measure of total reproductive success at each site.

Table 9
Summary Data for Individuals Producing Inflorescences at the *Cymopterus deserticola* Detailed Survey Areas on Edwards AFB, March through May 1995

Parameter	Statistic	Mars Boulevard			Tortoise Pens			Railroad		
		Obs. A 3/18/95	Obs. B 4/10/95	Obs. C 5/12/95	Obs. A 3/17/95	Obs. B 4/12/95	Obs. C 5/8/95	Obs. A 3/15/95	Obs. B 4/9/95	Obs. C 5/5/95
Number of All	Mean*	1.4	1.5	1.1	1.8	1.7	1.8	2.1	2.4	1.7
Inflorescences per Plant	Standard Deviation*	1.0	1.3	1.0	1.1	1.4	1.3	1.6	1.9	1.9
	Number of Plants producing Inflorescences	425	407	330	464	440	384	75	83	63
	Percent of Flowering Plants	100	100	100	100	100	100	100	100	100
	Percent of Total Sample	85	82	66	93	88	77	89	88	66
Number of Browsed	Mean*	1.3	1.3	1.1	1.0	1.0	1.4	1.0	1.7	1.0
Inflorescences per Plant	Standard Deviation*	0.8	0.7	0.4	0.0	0.0	0.6	---	1.2	0.0
	Number of plants with browsed inflorescences	46	40	28	13	11	30	1	3	2
	Percent of Flowering Plants	11	10	9	3	3	8	1.3	4	3
	Percent of Total Sample	9	8	6	3	2	6	1.2	3	2
Number of Aborted	Mean*	1.0	1.1	1.5	---	1.1	1.4	---	1.4	1.6
Inflorescences per Plant	Standard Deviation*	---	0.3	0.7	---	0.3	0.7	---	0.6	0.8
	Number of plants with aborted inflorescences	1	42	101	0	63	193	0	16	14
	Percent of Flowering Plants	0.2	10	31	0	14	50	0	19	22
	Percent of Total Sample	0.2	8	20	0	13	39	0	17	15
Number of Fertile	Mean*	1.3	1.3	0.7	1.8	1.5	1.1	2.1	2.0	1.5
Inflorescences per Plant	Standard Deviation*	0.9	1.2	0.8	1.1	1.3	1.1	1.6	1.8	1.7
	Number of plants with fertile inflorescences**	425	407	199	464	440	298	75	83	62
	Percent of Flowering Plants	100	100	60	100	100	78	100	100	98
	Percent of Total Sample	85	82	40	93	88	60	89	88	65
Inflorescence	Mean	9.9	10.8	8.6	11.3	12.3	11.0	11.1	12.3	12.0
Height per Plant	Standard Deviation	2.8	2.8	3.6	4.7	2.6	2.8	2.5	2.3	2.3
	Number of plants measured	425	407	330	464	440	384	75	83	63
	Percent of Flowering Plants	100	100	100	100	100	100	100	100	100
	Percent of Total Sample	85	82	66	93	88	76	89	88	66
Total Number of Flowering Plants		**425**	**407**	**330**	**464**	**440**	**384**	**75**	**83**	**63**
Sample Size		**500**	**500**	**500**	**500**	**500**	**500**	**84**	**94**	**95**

Notes: * The mean and standard deviations presented represent the mean number of inflorescences per plant for each parameter within the plants that exhibit the parameter. The number of plants exhibiting the parameter and the percentages of flowering plants and total sample are given to show what weighting the presented numbers can be given in regards to the total populati

** Plants which were vegetative, unidentifiable, or aborted were excluded from count of plants with fertile inflorescences.

Table 10 presents the data for persistantly vegetative individuals. The number of plants that were observed not to flower throughout the three observation periods was small. The combined mean frequency for these persistently vegetative plants at all sites was 6.3 percent.

Table 10

Persistently Vegetative Individuals in the Measured Sample of *Cymopterus deserticola* at the Detailed Survey Areas for all Observation Periods on Edwards AFB, March Through May 1995

Detailed Survey Area	Number Persistently Vegetative throughout Observation Periods A, B, and C	Mean Sample Size for Observations A, B, and C	Percent of Total
Mars Boulevard	37	500	7.4
Tortoise Pens	25	500	5.0
Railroad	7	91*	7.7
Total:	**69**	**1091**	**6.3**

Note: *The Railroad Detailed Survey Area had different sample sizes at each of the three observations. This number was calculated as the mean of the three numbers.

Table 11 presents a summary of the individual plant measured parameter data for unbrowsed plants at the detailed survey areas. The number of leaves per plant ranged from a mean of 3.8 reported at the Mars Boulevard detailed survey area during Observation Period C to a mean of 6.9 at the Railroad detailed survey area during Observation Period B. The means for petiole length ranged from 3.3 cm reported at the Mars Boulevard detailed survey area during Observation Period C to 5.3 cm at the Railroad detailed survey area during Observation Period A. The means for blade length ranged from 3.6 cm reported at the Mars Boulevard detailed survey area during Observation Period C to 6.4 cm reported at both the Tortoise Pens detailed survey area during Observation Period A and the Railroad detailed survey area during Observation Period B. The means for blade width ranged from 3.2 cm reported at the Mars Boulevard detailed survey area during Observation Period C to 6.3 cm reported at the Tortoise Pens detailed survey area during Observation Period A. The final measured parameter, inflorescence length, ranged from 8.6 cm reported at the Mars Boulevard detailed survey area during Observation Period C to 12.3 cm reported at both the Tortoise Pens detailed survey area during Observation Period B and the Railroad detailed survey

Table 11
Summary of Parameter Data for the *Cymopterus deserticola* Detailed Survey Areas

		Mars Boulevard		Tortoise Pens		Railroad	
Parameter (per individual plant)	**Observation Period**	**Mean with Confidence Interval***	**Standard Deviation**	**Mean with Confidence Interval***	**Standard Deviation**	**Mean with Confidence Interval***	**Standard Deviation**
Number of Leaves	A	4.4 ± 0.01	2.2	5.4 ± 0.01	3.1	6.5 ± 0.03	4.3
	B	4.5 ± 0.01	2.6	4.8 ± 0.01	3.6	6.9 ± 0.03	4.7
	C	3.8 ± 0.01	2.7	4.8 ± 0.01	3.2	5.1 ± 0.03	4.7
Unbrowsed Petiole Length (cm)	A	4.7 ± 0.0	1.3	5.0 ± 0.0	1.2	5.3 ± 0.01	1.6
	B	4.6 ± 0.0	1.6	4.4 ± 0.01	2.2	5.4 ± 0.01	1.2
	C	3.3 ± 0.01	1.9	4.3 ± 0.0	1.6	3.7 ± 0.01	2.1
Unbrowsed Blade Length (cm)	A	5.6 ± 0.00	1.5	6.4 ± 0.0	1.5	6.3 ± 0.01	1.5
	B	5.4 ± 0.01	1.9	5.5 ± 0.01	2.7	6.4 ± 0.01	1.4
	C	3.6 ± 0.01	2.4	4.7 ± 0.01	2.2	4.4 ± 0.01	2.6
Unbrowsed Blade Width (cm)	A	5.1 ± 0.00	1.5	6.3 ± 0.0	1.5	5.7 ± 0.01	1.5
	B	4.9 ± 0.00	1.7	5.5 ± 0.01	2.8	6.1 ± 0.01	1.5
	C	3.2 ± 0.01	2.1	4.4 ± 0.01	2.1	3.9 ± 0.01	2.4
Unbrowsed Inflorescence Length (cm)	A	9.9 ± 0.01	2.8	11.3 ± 0.01	4.7	11.1 ± 0.02	2.5
	B	10.8 ± 0.01	2.8	12.3 ± 0.01	2.6	12.3 ± 0.02	2.4
	C	8.6 ± 0.01	3.6	11.0 ± 0.01	2.8	12.0 ± 0.01	2.3

Note: * Confidence interval is plus or minus 95 percent.

area during Observation Period B. For all of the measured parameters the lowest mean measurement was recorded at the Mars Boulevard detailed survey area during Observation Period C.

Herbivory did not significantly affect measured parameters during Observation Period A or Observation Period B, except at the Mars Boulevard detailed survey area (Table 12). During Observation Period C, herbivory was evident and affected measurements at all sites. Observation Period C at the Tortoise Pens detailed survey area reported the single highest frequency of herbivory effects with 72.1 percent of the individuals showing signs of herbivory in the leaf count measured parameter. Leaves were the predominant target of herbivores. Approximately 27 percent of all leaves were browsed at the three detailed survey areas in all three observation periods, as opposed to approximately 6 percent of inflorescences.

Population Size Surveys

Table 13 presents the results of the population size surveys. Seventeen population size surveys were conducted on a total of 331.6 ha. Populations were observed in 15 of the 17 survey areas. Individuals observed numbered 4,914 in a total area of 165.4 ha. The number of individuals observed ranged from one to 1,929, with population areas varying from 1 square meter to 32.4 ha. Fourteen of the 15 populations (93%) were located in Joshua tree woodland zonal habitat. One individual was located in arid-phase saltbush scrub. The most common geomorphology types were alluvial plain and slope, each observed in 6 of the 15 populations (40%). Other geomorphologies found were alluvial fan, hill, and dune. All of the populations occurred in sandy soils or soils with sand components. Elevation ranged from 695m to 933m. Slope angles ranged from 1 to 5 degrees and the aspects were generally south or southwest.

Potential Habitat Surveys

Table 14 presents the results of the 125 potential habitat surveys. Populations were observed in 49 of the 125 potential habitat surveys. A total of 1,209 ha was surveyed throughout the 125 potential survey areas. A total of 4,777 individuals were observed in 321.8 ha of population area. The number of individuals per survey area ranged from 1 to 3,448 individuals, with population areas ranging from less than 1 square meter to 122.3 ha. The most common zonal habitat was Joshua tree woodland, which occurred in 32 of the 49 populations (65%). Other zonal habitats recorded included creosote bush scrub, halophytic phase

Table 12

Summary of Measured Parameters[1] Affected by Herbivory for *Cymopterus deserticola* Detailed Survey Areas on Edwards AFB, Spring 1995

Parameter 1,2	Percent of Total								
	Mars Boulevard Site			Tortoise Pens Site			Railroad Site		
	Obs. A 3/18/95	Obs. B 4/10/95	Obs. C 5/12/95	Obs. A 3/17/95	Obs. B 4/12/95	Obs. C 5/8/95	Obs. A 3/15/95	Obs. B 4/9/95	Obs. C 5/5/95
Leaf Count	17.2	34.1	43.5	4.4	7.8	72.1	9.5	8.8	43.4
Petiole Length	1.8	0.2	20.5	0	0	1.4	0	0	2.6
Blade Length	5.8	11.7	44.6	1.0	1.0	18.8	0	0	11.8
Blade Width	5.2	16.4	44.6	0	1.3	22.4	0	0	15.8
Inflorescence Count	10.8	9.8	8.5	2.8	2.5	7.8	1.3	3.6	3.2
Inflorescence Length	0	0.4	7.3	0	0	0.3	0	0	0
Leaf Sample Size (n) 1	**500**	**487**	**439**	**500**	**472**	**420**	**84**	**91**	**76**
Inflorescence Sample Size (n) 2	**425**	**407**	**330**	**464**	**440**	**384**	**75**	**83**	**63**

Notes: [1]Plants recorded as unidentifiable excluded.

[2]Plants with no inflorescences or those recorded as unidentifiable excluded.

Table 13

Summary of *Cymopterus deserticola* Population Size Surveys

Study Area ID	Transect ID	Shown on Figure Number	Number of Individuals	Population Area	Area surveyed (hectares)	Zonal Habitat	Azonal Habitat	Geomorphology	Soil Texture	Elevation (meters)	Slope Angle (degrees)	Slope Aspect
95RP005	5CD300	8	394	10 ha	25.5	JTW	N/D	ALLPLN	SND	716	2	N
95RP006	5CD300	8	1084	29.5 ha	29.5	JTW	N/D	ALLPLN	SND	716	3	N
95RP007	5CD300	18	553	32.4 ha	52	JTW	N/D	HILL	SND	933	4	SW
95RP008	95CD008	18	125	6 ha	21	JTW	N/D	ALLPLN	SND, GR	872	3	W
95RP009	5CD301	12	37	2.25 ha	2.25	JTW	N/D	SLOPE	SND	884	3	S
95RP010	5CD301	12	5	0.08 ha	4	JTW	N/D	SLOPE	SND	853	5	SW
95RP011	95CD011	11	1929	30 ha	97.5	JTW	N/D	ALLFAN, SLOPE	SND	896	3	SW
95RP012	5CD400	11, 18	58	6 ha	17.6	JTW	N/D	ALLPLN, SLOPE	SND	927	3	W
95RP015	5CD300	5	1	1 sq m	2	APSS	CLAY	DUNE	SND	712	2	E
95RP017	NA	7	0	0	2.25	APSS	DU	ALLPLN	SND, GR	713	2	SW
95RP018A	NA	7	0	0	1	HPSS	N/D	ALLPLN	GR	722	2	SW
95RP018B	5CD300	7	24	4.5 ha	6.75	JTW	N/D	SLOPE	SND	725	5	SW
95RP018C	5CD300	7	2	0.03 ha	2.25	JTW	N/D	SLOPE	SND, GR	736	6	S
95RP020	5CD300	15	32	9.6 ha	13.6	JTW	DU	DUNE	SND	695	5	N
95RP021	95CD021	16	49	1 ha	13.75	JTW	CLAY, DU	ALLPLN	SND	701	1	W
95RP037	95CD037	8	594	30 ha	35	JTW	N/D	ALLPLN	SND	728	1	NW
95RP5016	5CD500	7	27	4 ha	5.6	JTW	DU	ALLPLN	SND	732	3	SW

Legend:

sq m = square meters

ha = hectares

Zonal Habitat

JTW = Joshua tree woodlands

HPSS = Halophytic phase saltbush scrub

APSS = Arid phase saltbush scrub

Azonal Habitat

CLAY = Clay pans

DU = Dunes

N/D = None Reported

Geomorphology

ALLPLN = Alluvial plain

DUNE = Dune

SLOPE = Slope

ALLFAN = Alluvial fan

HILL = Hill

Soil Texture

SND = Sand

GR = Gravel

Slope Aspect

N = North

SW = Southwest

W = West

E = East

NW = Northwest

S = South

Table 14

Summary of *Cymopterus deserticola* Potenential Habitat Surveys

Study Area ID	Transect ID	Shown on Figure Number	Number of Individuals	Population Area (hectares)	Area Surveyed (hectares)	Zonal Habitat	Azonal Habitat	Geomorphology	Soil Texture	Elevation (meters)	Slope Angle (degrees)	Slope Aspect
95RP038	95CD3011	11, 18	1	<1 sq m	43.35	JTW	N/D	SLOPE	SND	920	10	N
95RP038	95CD3012	11, 18	1	<1 sq m	2.25	JTW	N/D	SLOPE	SND	917	3	E
95RP038	95CD3013	11, 18	3	0.06 ha	3	JTW	N/D	SLOPE	SND	905	3	E
95RP1002	95CD1001	14	11	2.25	2.25	JTW	DU	DUNE, PAN	SND	701	2	SE
95RP1048	NA	11	0	0	10	CBS	N/D	SLOPE	SNDLM	866	3	SW
95RP2001	95CD2001	15	25	0.15 ha	8	JTW	DU	DUNE	SND	695	5	SE
95RP2002	95CD1005	15	2	2 sq m	8	JTW	DU	DUNE	SND	695	2	N
95RP2003	95CD1006	15	7	0.1 ha	8	JTW	DU	DUNE	SND	695	2	N
95RP2004	NA	15	0	0	8	HPSS	CLAY, DU	DUNE, PAN	SND	692	2	NW
95RP3001	95CD3016	12	31	4 ha	4	JTW	N/D	SLOPE	SND	884	3	S
95RP3002	95CD3015	12	119	6.5 ha	6.5	JTW	N/D	SLOPE	SND	875	3	SW
95RP3014	NA	14	0	0	8	JTW	CLAY, DU	DUNE, PAN	SND, SLTCL	701	4	N
95RP3015	NA	14	0	0	8	JTW	CLAY, DU	DUNE, PAN	SND, SLT	701	5	N
95RP3016	NA	14	0	0	8	JTW	CLAY, DU	DUNE, PAN	SND, SLTCL	701	5	N
95RP3017	NA	14	0	0	8	CBS	CLAY, DU	PAN, HILL	SND, SLTCL	710	10	N
95RP3018	NA	14	0	0	8	HPSS	CLAY, DU	DUNE, PAN	SND, SLTCL	704	3	N
95RP3019	NA	14	0	0	8	JTW	CLAY, DU	DUNE, PAN	SND, SLTCL	704	6	N
95RP3020	NA	14	0	0	8	HPSS	CLAY, DU	DUNE, PAN	SND, SLTCL	698	4	N

Table 14, Page 2 of 7

Study Area ID	Transect ID	Shown on Figure Number	Number of Individuals	Population Area (hectares)	Area Surveyed (hectares)	Zonal Habitat	Azonal Habitat	Geomorphology	Soil Texture	Elevation (meters)	Slope Angle (degrees)	Slope Aspect
95RP3021	NA	13, 14	0	0	8	HPSS	CLAY, DU	DUNE, PAN	SND, SLTCL	698	3	N
95RP3022	NA	14, 15	0	0	8	JTW	CLAY, DU	DUNE, PAN	SND, SLTCL	698	5	N
95RP3023	95CD3020	14	4	35 sq m	8	JTW	CLAY, DU	DUNE, PAN	SND	701	3	N
95RP3024	NA	14	0	0	8	HPSS	CLAY, DU	DUNE, PAN	SND, SLTCL	698	5	N
95RP3025	NA	14	0	0	8	HPSS	CLAY, DU	DUNE, PAN	SND, SLT	701	3	N
95RP3026	95CD3021	14	1	< 1 sq m	8	HPSS	DU	DUNE, PAN	SND	701	4	N
95RP3027	NA	13, 14	0	0	8	HPSS	CLAY, DU	DUNE, PAN	SND, SLTCL	701	3	N
95RP3028	NA	13	0	0	4	JTW	DU	DUNE	SND	703	1	NW
95RP3029	NA	13	0	0	8	JTW	DU	DUNE	SND	703	0	ND
95RP3030	NA	13	0	0	8	HPSS	CLAY, DU	DUNE, PAN	SNDCL	701	1	NW
95RP3031	NA	13	0	0	8	JTW	DU	DUNE, PAN	SNDCL	701	1	NW
95RP3032	NA	13, 14	0	0	4	JTW	CLAY, DU	DUNE, PAN	SNDCL	704	1	NE
95RP3033	NA	13, 14	0	0	4	JTW	DU	DUNE	SNDCL	704	1	N
95RP3034	NA	14	0	0	8	JTW	CLAY, DU	DUNE, PAN	SNDCL	702	1	NW
95RP3040	NA	15	0	0	8	JTW	DWMW, CLAY, DU	DUNE, PAN	SND, SLTCL	707	3	SW
95RP4050	NA	15	0	0	8	HPSS	DWMW, CLAY, DU	DUNE, PAN	SND, SLT	710	0	ND
95RP4051	NA	15	0	0	8	HPSS	CLAY, DU	DUNE, PAN	SND, SLTCL	704	0	ND
95RP4052	NA	15	0	0	8	HPSS	CLAY, DU	DUNE, PAN	SNDCL	701	0	ND

Table 14, Page 3 of 7

Study Area ID	Transect ID	Shown on Figure Number	Number of Individuals	Population Area (hectares)	Area Surveyed (hectares)	Zonal Habitat	Azonal Habitat	Geomorphology	Soil Texture	Elevation (meters)	Slope Angle (degrees)	Slope Aspect
95RP4053	NA	15	0	0	8	JTW	N/D	ALLPLN	SND	719	2	NW
95RP4054	NA	15	0	0	8	HPSS	CLAY, DU	ALLPLN	SND	698	0	ND
95RP4055	NA	15	0	0	8	HPSS	CLAY, DU	DUNE, PAN	SND, SLT	985	0	ND
95RP4056	NA	15	0	0	8	HPSS	DU, RUD	ALLPLN	SND	701	1	SW
95RP4057	NA	14, 15	0	0	8	JTW	CLAY, DU	DUNE, PAN	SND, SLTCL	698	0	ND
95RP4060	95CD4060	11	3448	122.3 ha	150.6	JTW	DW	ALLPLN	SND	869	4	S
95RP420	NA	11	0	0	8	CBS	CLAY	ALLPLN	SND	808	3	S
95RP421	NA	10	0	0	8	CBS	CLAY	ALLPLN	SND	786	3	S
95RP422	95CD2005	10	13	6 ha	8	CBS	N/D	ALLPLN	SND	756	6	S
95RP423	95CD2006	10, 17	1	<1 sq m	8	CBS	N/D	ALLPLN	SND	741	2	SW
95RP424	NA	17	0	0	8	CBS	N/D	ALLPLN	SND	738	2	W
95RP425	95CD2007	17	3	< 1 sq m	8	CBS	N/D	ALLPLN	SND	750	2	SW
95RP426	95CD2009	17	8	3 ha	8	CBS	N/D	ALLPLN	SND	750	2	SW
95RP427	95CD2010	17	8	2 ha	8	JTW	N/D	ALLPLN	SND	756	2	SW
95RP428	95CD2012	17	2	1 sq m	8	CBS	N/D	ALLPLN	SND	725	2	N
95RP434	95CD5102	17	5	<0.25 ha	8	CBS	N/D	ALLPLN	SND, SLT	732	2	W
95RP435	95CD4103	17	28	8 ha	8	JTW	N/D	ALLPLN	SND	719	1	W
95RP436	95CD1046	11, 18	11	4.25 ha	8	CBS	N/D	ALLPLN	SND	847	3	W
95RP437	95CD1020	17	4	100 sq m	8	JTW	N/D	ALLPLN	SND	762	2	W
95RP438	95CD1042	17	31	8 ha	8	JTW	N/D	ALLPLN	SND	780	1	W
95RP439	95CD2020	17	2	6 ha	6	CBS	N/D	ALLPLN	SND	774	1	N
95RP440	95CD2021	17	13	8 ha	8	JTW	N/D	ALLPLN	SND	780	1	W
95RP441	95CD2022	18	87	4 ha	6	JTW	N/D	ALLPLN	SND	863	2	W
95RP442	95CD1040	18	5	0.1 ha	6	JTW	N/D	ALLPLN	SNDCL	844	2	W
95RP5006	95CD1021	10	6	8 ha	8	CBS	N/D	ALLPLN	SND, GR	716	3	SE
95RP5007	95CD1022	8, 10	7	8 ha	8	JTW	DU	ALLFAN	SND	732	1	SW
95RP5008	95CD1023	10	6	8 ha	8	CBS	DU	ALLFAN	SND	747	0	ND

Table 14, Page 4 of 7

Study Area ID	Transect ID	Shown on Figure Number	Number of Individuals	Population Area (hectares)	Area Surveyed (hectares)	Zonal Habitat	Azonal Habitat	Geomorphology	Soil Texture	Elevation (meters)	Slope Angle (degrees)	Slope Aspect
95RP5009	NA	10	0	0	8	JTW	DU	ALLPLN	SND, SLT	762	1	NW
95RP5010	95CD1024	10	17	8 ha	8	JTW	DU	ALLPLN	SND	725	1	SW
95RP5011	95CD1025	10	50	8 ha	8	JTW	DU	ALLPLN	SND	717	1	NE
95RP5012	95CD1026	10	1	1 sq m	8	CBS	CLAY, DU	ALLPLN	SND, SNDCL	711	1	SE
95RP5013	95CD1027	17	4	8 ha	8	JTW	DU	ALLPLN	SND	712	1	NE
95RP5014	NA	17	0	0	8	HPSS	N/D	DUNE, PAN	SND	707	0	ND
95RP5015	95CD1028	17	3	8 ha	8	JTW	DU	ALLPLN	SND	738	1	NW
95RP5020	95CD3001	8	538	49.45 ha	53	JTW	N/D	ALLFAN, ALLPLN	SND	725	5	NW
95RP5022	95CD1047	15	11	2 ha	8	HPSS	CLAY, DU	DUNE, PAN	SND	695	2	NW
95RP5023	NA	15	0	0	9.5	HPSS	CLAY, DU	DUNE, PAN	SNDCL	695	0	ND
95RP5024	NA	15	0	0	8	HPSS	CLAY, DU	DUNE, PAN	SNDCL	695	1	E
95RP5025	NA	15	0	0	8	HPSS	N/D	ALLPLN	SNDCL	695	2	E
95RP5026	NA	15	0	0	8	HPSS	CLAY, DU	DUNE, PAN	SNDCL	695	1	E
95RP5027	NA	15	0	0	8	HPSS	CLAY, DU	DUNE, PAN	SNDCL	695	1	SE
95RP5028	NA	15	0	0	8	HPSS	N/D	DUNE, PAN	SNDCL	695	1	SE
95RP5029	NA	15	0	0	8	HPSS	N/D	DUNE, PAN	SND	695	1	SE
95RP5030	NA	15	0	0	8	HPSS	CLAY, DU	DUNE, PAN	SNDCL	698	1	SE
95RP5031	NA	15	0	0	8	HPSS	CLAY, DU	DUNE, PAN	SNDCL	698	1	SE

Table 14, Page 5 of 7

Study Area ID	Transect ID	Shown on Figure Number	Number of Individuals	Population Area (hectares)	Area Surveyed (hectares)	Zonal Habitat	Azonal Habitat	Geomorphology	Soil Texture	Elevation (meters)	Slope Angle (degrees)	Slope Aspect
95RP5032	NA	15	0	0	8	HPSS	CLAY, DU	DUNE, PAN	SNDCL	695	1	SE
95RP5033	NA	15	0	0	8	HPSS	CLAY, DU	DUNE, PAN	SNDCL	695	1	S
95RP5034	NA	15	0	0	8	HPSS	CLAY	ALLPLN	SNDCL	692	0	ND
95RP5035	NA	15	0	0	8	HPSS	CLAY	ALLPLN	SNDCL	695	0	ND
95RP5036	95CD1044	5	13	0.2 ha	8.4	HPSS	N/D	ALLPLN	SND	710	2	SE
95RP5040	95CD1029	11, 18	15	1.5 ha	8	JTW	N/D	ALLPLN	SND	896	4	S
95RP5041	95CD1030	11, 18	38	2 ha	8	JTW	N/D	ALLPLN	SND	853	2	N
95RP5042	95CD1031	11, 18	19	2 ha	8	JTW	N/D	ALLPLN	SND	811	1	N
95RP5043	95CD1032	11	1	1 sq m	8	JTW	N/D	ALLPLN	SND	801	2	S
95RP5044	95CD1033	11, 18	71	8 ha	8	JTW	N/D	ALLPLN	SND	890	4	W
95RP5045	NA	6	0	0	8	APSS	N/D	DUNE	SNDCLLM, GR	701	2	W, NE
95RP5046	NA	6	0	0	8	APSS	N/D	DUNE	SNDCLLM, GR	701	2	N
95RP5047	NA	5	0	0	8	APSS	N/D	ALLPLN	SNDCLLM	741	2	S
95RP5048	NA	5	0	0	8	APSS	N/D	ALLPLN	SND	722	0	ND
95RP5049	95CD1034	5	64	2 ha	8.1	APSS	N/D	ALLPLN	SND	716	1	E
95RP5050	95CD1035	5	5	1 ha	8	APSS	N/D	ALLPLN	SND, CLLM	710	1	E
95RP5051	NA	6	0	0	8	HPSS	CLAY, DU	PAN, RIDGE	SNDCL	709	2	SW
95RP5052	NA	8	0	0	8	CBS	DU	ALLPLN, DUNE	SND, SNDCL	707	2	SW

Table 14, Page 6 of 7

Study Area ID	Transect ID	Shown on Figure Number	Number of Individuals	Population Area (hectares)	Area Surveyed (hectares)	Zonal Habitat	Azonal Habitat	Geomorphology	Soil Texture	Elevation (meters)	Slope Angle (degrees)	Slope Aspect
95RP5053	95CD1036	6	3	1.5 ha	8	JTW	DU	DUNE,ALLPLN	SND, SLTCL	704	0.5	E
95RP5068	NA	14	0	0	8	JTW	CLAY	DUNE, ALLPLN	SND	698	1	W
95RP5070	NA	16	0	0	8	CBS	N/D	ALLPLN	SLTCLLM, GR	722	1	NW
95RP5071	NA	16	0	0	8	CBS	N/D	ALLFAN	SNDCL, GR	738	3	NW
95RP5072	NA	16	0	0	8	CBS	N/D	ALLFAN	SLTCLLM	716	5	N
95RP5073	NA	16	0	0	8	JTW	DU	ALLFAN	SNDLM, GR	707	3	NW
95RP5074	NA	16	0	0	8	JTW	CLAY	ALLFAN, DUNE	SNDLM, SND	707	1	N
95RP5075	NA	16	0	0	8	CBS	CLAY	ALLFAN, DUNE	SNDCLLM	707	3	W
95RP5076	NA	16	0	0	8	JTW	CLAY, DU	DUNE, PAN	SNDCL	698	2	W
95RP5077	95CD5005	16	13	2 ha	8	JTW	CLAY, DU	DUNE, PAN	SNDCL	695	6	W
95RP5078	NA	16	0	0	8	JTW	N/D	DUNE, PAN	SND, CL	695	2	E
95RP5080	95CD5006	16	11	6.4 ha	8	JTW	N/D	DUNE, PAN	SND, SNDLM	695	8	N
95RP5081	NA	15, 16	0	0	8	JTW	CLAY	DUNE, PAN	SND, SNDCL	695	2	E
95RP5082	NA	15	0	0	8	JTW	CLAY	DUNE, PAN	LMSND, SNDCL	698	0	ND
95RP5083	NA	15	0	0	8	JTW	CLAY	DUNE, PAN	SNDLM, SNDCL	698	0	ND
95RP5084	NA	15	0	0	8	JTW	CLAY	DUNE, PAN	SND, SNDCL	698	0	ND
95RP5085	NA	15	0	0	8	JTW	CLAY, DU	DUNE, PAN	SND, CL	694	0	ND
95RP5086	NA	15	0	0	8	JTW	DWMW, CLAY, DU	DUNE, PAN	SNDCL	698	0	ND

Study Area ID	Transect ID	Shown on Figure Number	Number of Individuals	Population Area (hectares)	Area Surveyed (hectares)	Zonal Habitat	Azonal Habitat	Geomorphology	Soil Texture	Elevation (meters)	Slope Angle (degrees)	Slope Aspect
95RP5087	NA	15	0	0	8.1	JTW	DU	DUNE, ALLPLN	SND	700	0	ND
95RP5088	95CD588	15	4	2 ha	10.5	JTW	CLAY, DU	DUNE, PAN	SND, CL	701	0	ND
95RP5089	NA	14	0	0	8	JTW	CLAY, DU	DUNE, PAN	SNDCL	698	1	S
95RP5090	NA	15	0	0	8	JTW	CLAY, DU	DUNE, PAN	SNDCL	710	0	ND
95RP5091	NA	13	0	0	8	HPSS	DU	DUNE	SNDCL	701	4	SW
95RP5092	NA	13	0	0	8	HPSS	CLAY, DU	DUNE, PAN	SND, SLT	698	1	S
95RP5093	95CD5093	15, 16	3	75 sq m	10	HPSS	DU, DWMW	DUNE	SND	695	1	SE
95RP5094	NA	16	0	0	8	HPSS	DU, DWMW	DUNE	SND, SLT	695	1	S
95RP5095	NA	16	0	0	8	HPSS	DU	ALLPLN,DUNE	SND, SLTCL	698	1	N
95RP5096	95CD5096	16	4	0.75 ha	9.5	JTW	CLAY, DU	ALLPLN,DUNE	SND	698	3	SW

Legend:

sq m = square meters

ha = hectares

Zonal Habitat

JTW = Joshual tree woodland

CBS = Creosote bush scrub

HPSS = Halophytic phase saltbush scrub

APSS = Arid phase saltbush scrub

Azonal Habitat

CLAY = Clay pans

DU = Dunes

DW = Desert wash without mesquite woodlands

DWMW = Desert wash with mesquite woodlands

RUD = Ruderal

N/D = None Reported

Geomorphology

ALLFAN = Alluvial fan

ALLPLN = Alluvial plain

DUNE = Dune

HILL = Hill

PAN = Pan

RIDGE = Ridge

SLOPE = Slope

Soil Texture

SND = Sand

SNDLM = Sandy loam

SLTCL = Silty clay

SLT = Silt

SNDCL = Sandy clay

SNDCLLM = Sandy clay loam

GR = Gravel

CLLM = Clay loam

SLTCLLM = Silty clay loam

LMSND = Loamy sand

Slope Aspect

ND = Not determined

N = North

S = South

E = East

W = West

NW = Northwest

SW = Southwest

SE = Southeast

saltbush scrub, and arid phase saltbush scrub. The most common azonal habitats recorded were dunes and dunes with clay pans. Other azonal habitats recorded were desert wash with mesquite woodlands, and desert wash without mesquite woodlands. Thirty-three of the 49 populations (67%) were in areas with alluvial plain geomorphology. Other geomorphologies recorded were dune, slope, pan, and alluvial fan. Sandy soil textures occurred in all of the survey areas where desert cymopterus was found. Nine of the survey areas also contained silt, loam, or clay components. Population elevations where desert cymopterus was found ranged from 695m to 920m with a mean of 763m. Slope angles ranged from flat to 10 degrees with a mean of 2.5 degrees. Fifty-one percent of the survey areas had aspects faced north, west, or northwest.

Incidental Detections

Seven incidental detections of desert cymopterus occurred during the Spring 1995 surveys for sensitive plant species. Approximately 200 individuals were estimated to occur in approximately 4.2 ha. Figures 5 through 18 show the locations of incidental detections, and Table 15 presents data recorded for these areas. The most common zonal habitat was Joshua tree woodland, which occurred in four of the seven sites. Other zonal habitats recorded were creosote bush scrub and halophytic phase saltbush scrub. Four of the seven incidental detections occurred in alluvial plains; one of these areas also had a dune component. Other geomorphologies recorded were slope and alluvial fan. Soil textures for five of the seven incidental detections included sand components with the remaining two survey areas containing sandy clay soil texture. Elevations ranged from 692 m to 774 m above msl with a mean of 738m. Slopes ranged from 0 to 6 degrees with a mean of 2.1 degrees most commonly with north, west, or northwest aspects.

Other sensitive plant species were observed in 30 of the 67 survey areas that supported desert cymopterus populations (39%). All numbers of these individuals were estimated not directly counted. Pigmy poppy (*Canbya candida*) was the most common of the other sensitive species, observed in 20 survey areas with several thousand individuals estimated to occur. Crowned muilla (*Muilla coronata*) was observed in five survey areas, with fewer than 200 plants estimated to occur. Several hundred golden goodmania (*Goodmania luteola*) were estimated to occur in two survey areas, and more than 10,000 plants were estimated to occur in a third survey area. Mojave spineflower (*Chorizanthe spinosa*) was observed in one area, with several hundred plants estimated to occur. These four species are CNPS watch list species. Alkali mariposa lily (*Calochortus striatus*) occurred in five of the survey areas with desert cymopterus.

Table 15

Summary of *Cymopterus deserticola* Incidental Detections

Study Area ID	Transect ID	Shown on Figure Number	Number of Individuals	Population Area	Area surveyed (hectares)	Zonal Habitat	Azonal Habitat	Geomorphology	Soil Texture	Elevation (meters)	Slope Angle (degrees)	Slope Aspect
95RP018D	95CD1008	7	>44	>0.2 ha	0.2	CBS	N/D	SLOPE	SND	741	6	S
95RP029A	95CD1045	15	3	<0.2 ha	11	HPSS	DWMW, CLAY, DU	ALLPLN	SND	692	1	N
95RP3005	95CD3017	9	14	0.3 ha	10	JTW	N/D	SLOPE	SND, GR	771	4	W
95RP403	95CD1038	8	59	3 ha	25	JTW	N/D	ALLPLN	SND	719	1	NW
95RP5055	95CD1039	9	66	0.5 ha	8	CBS	DU	DUNE, ALLPLN	SNDCL	774	2	NW
95RP5057	95CD1043	9	1	<1 sq m	8	JTW	CLAY	ALLFAN	SNDCL	762	1	W
95RP5066	95CD1041	8	1	< 1 sq m	6	JTW	N/D	ALLPLN	SND	710	0	ND

Legend:

sq m = square meters

ha = hectares

Zonal Habitat

JTW = Joshua tree woodlands

CBS = Creosote bush scrub

HPSS = Halophytic phase saltbush scrub

Azonal Habitat

CLAY = Clay pans

DU = Dunes

DWMW = Desert wash with mesquite woodlands

N/D = None Reported

Geomorphology

ALLPLN = Alluvial plain

ALLFAN = Alluvial fan

Soil Texture

SND = Sand

GR = Gravel

Slope Aspect

N/D = Not Determined

N = North

NW = Northwest

S = South

W = West

Eight survey areas contained an estimated several hundred loeflingia (*Loeflingia* ***squarrosa).*** However, the plants were not identified to subspecies. The subspecies *artemisiarum* (sage loeflingia) is a CNPS List 1B species, but the subspecies *squarrosa* is relatively common and not considered sensitive. Both subspecies are known to exist on Edwards AFB (Charlton 1992).

Three sensitive animal species ***were*** recorded ***in*** 10 survey areas. The desert tortoise (*Gopherus agassizii*) was the most commonly observed sensitive animal in survey areas with desert cymopterus. Tortoises or tortoise sign were reported in eight survey areas. LeConte's thrasher (*Toxostoma lecontei*) was observed in four areas. Kit fox (*Vulpes macrotis*) dens were recorded in two survey areas.

DISCUSSION

Desert cymopterus was found in higher numbers of individuals and in more population areas on Edwards AFB than was previously known. Fewer than 2,000 desert cymopterus individuals had been reported in 29 populations, including fewer than 1,000 at the Mars Boulevard detailed survey area. During the current survey, over 7 times the number of plants previously found on Edwards AFB were recorded (Table 16). Fifty-six new locations were discovered. The increase in the number of documented sites and number of desert cymopterus individuals recorded during the current study are likely due to the larger scope of this survey and the favorable weather conditions during Spring 1995. Many previous surveys were conducted during drought conditions from the late-1980's through 1994 (Charhon 1993b)

Seventy-four percent (10,402) of all individuals observed were recorded at the previously reported populations. The Mars Boulevard survey area and the adjacent potential habitat survey areas included three previously reported populations (Figure 1, populations 18, 19, 20). Because these survey areas were contiguous and desert cymoptetus occurred at or near the boundaries where they joined, these three areas could be considered one population in future studies.

Zonal habitats where desert cymopterus were found were very consistent throughout the survey areas and during incidental detections of the species. Joshua tree woodland was by far the most common zonal habitat, occurring in 73 percent of the populations. The most common azonal habitat recorded was dunes often found together with clay pan azonal habitat. Desert cymopterus was observed most often in areas with alluvial plain and/or dune geomorphology and sandy soils. This is consistent with previous studies, which reported desert cymopterus in

Table 16

Comparison of 1995 Population Data with Previously Reported Data for *Cymopterus deserticola* on Edwards AFB

Population Number (Figure 1)	1995 Study Area ID Number	Number Previously Reported	Number Observed in 1995	Proportion of No. in 1995 to Previously Reported	Area Previously Reported (hectares)	Population Area Observed in 1995	Proportion of Area in 1995 to Previously Reported
1	95RP015	16	1	0.06	2	0.0001	<0.001
2	95RP5016	about 12	27	about 2.3	0.18	4	22.2
3	95RP017	unknown	0	NA	unknown	0	NA
4, 5, 6	95RP018A	6	0	4.3	0.18	4.53	25.2
	95RP018B		24				
	95RP018C		2				
8	95RP5027 thru -5035	a few	0	NA	unknown	0	NA
9	95RP5024	unknown	0	NA	unknown	0	NA
10	95RP020	24	32	1.3	12	9.6	0.8
11	95RP021	18	49	2.7	10	1	0.1
13, 14, 15	95RP037	65	594	28.8	4	30	7.5
	95RP006		1,084		4	29.5	7.4
	95RP005		394		4	10	2.5
16	95RP002	162	1,089	6.7	38	57	1.5
17	95RP003	67	96	1.4	13	3.56	0.3
18	95RP4060	unknown	1,009	NA	unknown	27	NA
19	95RP001	about 1,000	3,294	3.3	54	45	0.8
20	95RP011	33	1,929	58.5	unknown	30	NA
21	95RP008	54	125	2.3	15	6	0.4
22	95RP007	141	553	3.9	25	32.4	1.3
23	955RP012	3	58	19.3	unknown	6	NA
24	95RP1048	a few	0	NA	unknown	0	NA
25	95RP009	4	37	9.3	unknown	2.25	NA
26	95RP010	1	5	5.0	unknown	0.08	NA

Note: NA = Not Applicable

sandy soils of alluvial plains, often in swales or stabilized low dune areas (Charlton 1993b). All of these components together make up important habitat charachteristics for areas where desert cymopterus may be found. For future surveys the survey areas may be picked where these important habitat characteristics occur together.

Previous studies reported that creosote bush, Joshua tree, saltbush, burro-weed, box-thorn, *Hymenoclea salsola*, croton, and ricegrass are common associates of desert cymopterus (Charlton 1993b). Although this study was not designed to determine indicator species for desert cymopterus, data gathered during this survey confirm these species as associates. In addition, goldenhead, *A. canescens*, and *Eurotia lanata* were each found in association with at least 40 percent of desert cymopterus populations. Future studies could investigate the potential for these species to indicate the presence of desert cymopterus.

Incidental detections of desert cymopterus were generally located near areas where the species is known to exist. Incidental detections were also in association with Joshua tree woodland zonal habitat, alluvial plain or dune geomorphology, and sandy soils just as the populations found in the other survey areas.

Phenological stages were measured during three observation periods at all three detailed survey areas. Each detailed survey area displayed desert cymopterus populations in distinct phenological stages, first in flower, then in flower and fruit, and finally in fruit and seed drop stages. The Mars Boulevard detailed survey area had smaller percentages of total plants in the more advanced phenological stage for each observation period than the other detailed survey areas. This is likely due to the timing of the Mars Boulevard surveys, which occurred up to 4 days prior to the Tortoise Pens detailed survey area observations and 1 week prior to the Railroad detailed survey area observations.

The distribution of individual desert cymopterus plants, as measured by nearest plant of the same species distances, was measured using the Index of Dispersion statistic (Table 8). The results of this test showed that the distribution of desert cymopterus plants at all three detailed survey areas was strongly clumped, rather than uniformly or randomly spaced. This could be attributed to the fact that desert cymopterus plants were found in low lying channels and swales. These areas tend to be found in uneven distribution because they appear only in low areas between dunes hills and slopes. Therefore the desert cymopterus occur in clumped groups because of their habitat. Thus, future surveys may also utilize these findings to plan survey areas where desert cymopterus is more likely to be found.

Between 85 percent and 95 percent of all plants sampled at the detailed survey areas during Observation Period B had one or more infloresences (Table 9) as compared to between 7 and 21 percent observed at these sites in 1992 (Charlton 1993b). This measures the characteristic reproductive effort for the individuals at the detailed survey areas. The high proportion of plants with fertile inflorescences was a different result than that reported by Charlton (1993b) for the 1992 field season at these sites. The mean number of fertile inflorescences observed in 1992 was 0.03, 0.0, and 0.09 inflorescences per plant for the Mars Boulevard, Tortoise Pens, and Railroad detailed survey areas, respectively (Charlton 1993b). Comparable values from 1995 are 1.3, 1.8, and 2.1 mean fertile inflorescences per plant respectively. The number of plants which made no observable effort to flower was small (6.3%, Table 10). The exceptionally favorable growing conditions of the 1995 field season likely accounts for this increased flowering and fruit production.

The proportion of desert cymoperus experiencing herbivory increased over time. Plants at the Mars Boulevard detailed survey area experienced a higher initial intensity of herbivory, but the Tortoise Pens detailed survey area showed the largest intesity of herbivory at the end of the observation periods. Leaves, as opposed to inflorescences, were predominantly the target of herbivores. Remarks on the original field data sheets note that some inflorescences were cut off at ground level but left uneaten nearby; possibly, they are unpalatable. Browsed leaves suffered from a range of damage, from small portions of the blade removed, through all but the midrib consumed, and to the leaf petiole removed to ground level. Rabbits, caterpillars, and beetles were observed browsing on desert cymopterus, but no precise identifications or collections were made, and no proportion of the damage was attributed to a particular organism.

The current study indicates that desert cymopterus may exist in scattered occurrences over much of the eastern portion of the base. This species appears to reach its westerly distributional limit near the southwestern portion of Buckhorn Dry Lake. However, although the potential habitat surveys were extensive, they were not exhaustive, and additional populations are likely to exist in areas not surveyed.

Many areas in the northeastern portion of the base were not surveyed and may contain potential habitat for desert cymopterus, particularly areas near incidental detections of the species. Further quantitative studies could be conducted to determine whether there are indicator species and/or indicative geomorphic and soils components that could be used to predict the occurrence of desert cymopterus.

LITERATURE CITED

Abrams, L. 1951. *Illustrated Flora of the Pacific States. Vol. 3.* Stanford Univ. Press, Stanford, Calif. 866 pp.

Bagley, M. and J. Eckert. 1994. California Native Species Field Survey Forms. On file with the AFFTC Environmental Management Office, Edwards AFB, Calif.

California Department of Fish and Game (CDFG). 1994. Natural Diversity Data Base records. State of Calif. Resources Agency, Sacramento, Calif. Data from 7 Jan. 1994.

Charlton, D. 1992. *An Introduction to the Plant Communities and Habitats of California Deserts and The Flora and Vegetation of Edwards AFB.* Prepared by Computer Sciences Corp. for the Air Force Flight Test Center, Environmental Management Office, Edwards Air Force Base, Calif.

Charlton, D. 1993a. *Guide to Locating and Identifying Plants of Limited Distribution at Edwards Air Force Base (Draft).* Prepared by Computer Sciences Corp. for the Air Force Flight Test Center, Environmental Management Office, Edwards Air Force Base, Calif. 11 pp.

Charlton, D. 1993b. *Characterization Study of Desert Cymopterus Populations, Edwards Air Force Base, California.* Prepared by Computer Sciences Corp. for the Air Force Flight Test Center, Environmental Management Office, Edwards Air Force Base, Calif. 9 pp. + appen.

Dames & Moore. 1993. *Mead/McCullough–Victorville/Adelanto Transmission Project, 1993 Sensitive Plant Survey Results for California.* Prepared for City of Los Angeles Dept. of Water and Power, Los Angeles, Calif.

ENSR Consulting and Engineering. 1989. *Final Biological Baseline Report for the Luz SEGS XI and XII Project Area, Harper Lake, California.* Prepared by ENSR, Fort Collins, Colo., for Luz Finance and Development Corp., Los Angeles, Calif. Submitted to Calif. Energy Commission, Sacramento, Calif.

Heckard, L. and L.M. Moe. 1977. Map: *Rare Plant Survey, 1977 -- Edwards Air Force Base, Calif.* On file with the California Natural Diversity Data Base. Calif. Dept. of Fish and Game, Sacramento, Calif. Prepared for Smithsonian Institution (1978a) report.

Hickman, J.C., ed. 1993. *The Jepson Manual: Higher Plants of California.* Univ. of Calif. Press, Berkeley, Calif. 1400 pp.

Mitchell, D.R., K.E. Buescher, J.R. Eckert, D.M. Laabs, M.L. Allaback, S. Montgomery and R.C. Arnold Jr. 1993. *Biological Resources Environmental Planning Technical Report.* Prepared in support of the Programmatic Environmental Assessment for basewide implementation of the Installation Restoration Program (IRP) at Edwards AFB, California. Prepared by Tetra Tech, Inc., San Bernardino, Calif., for the Air Force Flight Test Center, Environmental Management Office, Edwards Air Force Base, Calif.

Moe, L.M. 1981. California Native Species Field Survey Forms. On file with the California Natural Diversity Data Base. Calif. Dept. of Fish and Game, Sacramento, Calif.

Moe, L.M. 1988. California Native Species Field Survey Forms. On file with the California Natural Diversity Data Base. Calif. Dept. of Fish and Game, Sacramento, Calif.

Munz, P.A. 1974. *A Flora of Southern California.* Univ. of Calif. Press, Berkeley, Calif. 1986pp.

Smithsonian Institution. 1978a. *Interim Technical Report, Endangered and Threatened Plants of Edwards, Eglin and Tyndall AFB.* Prepared for the U.S. Air Force under AFOSR contract F44620-75-C-0052. March, 1978.

Smithsonian Institution. 1978b. *Final Scientific Report, Endangered and Threatened Plants of Edwards, Eglin and Tyndall AFB.* Prepared for the U.S. Air Force under AFOSR contract F44620-75-C-0052. July, 1978.

ACKNOWLEDGEMENTS

This work was performed by Tetra Tech, Inc., and its subcontractors and consultants under contract to GRW Engineers, Inc. and the U.S. Army Corps of Engineers, Sacramento District, for the Air Force Flight Test Center, Environmental Management Office, Edwards Air Force Base, California, Contract Number DCA05-C-91-0130. This report is based on an early draft and extensive data analysis compiled by Mark Bagley, John Chesnut and Jody Sawasaki. Field surveyors included Mark Bagley, John Chesnut, Brenda Ellis, Steve Ingram, Denise LaBerteaux, Matt Lorne, Mike McGovern, Richard Potashin, Daniel Pritchett, and Jody Sawasaki. Ed Hickey of GRW Engineers, Inc. provided GPS support. The authors wish to thank the many people who contributed to this effort. Special thanks to Mark Hagan, Base Biologist, and Wanda Deal of the Environmental Management Office, for the opportunity to participate in such a tremendous effort. Many thanks to the Tetra Tech production and technical support staff for substantial assistance in data analysis, technical writing, editing, word processing, graphics preparation, and peer review. This team included: Felicia Bradfield, Kevin Doyle, Dovey Dee, Shelley Simpson, Steve Hoerber, Brian Smith, David Cisneros, Mary Jones, Sandi Palkki, Blair Bradley, and Fred Hickman.