2004 Monitoring of Special Status Plants

in the

Algodones Dunes, Imperial County, California

Bureau of Land Management
California State Office
Sacramento, California
March 24, 2005

Cover photograph of Peirson's milk-vetch
(*Astragalus magdalenae* var. *peirsonii*)
by Debbie Sebesta

Contents

Preface

The author of this report is John Willoughby, State Botanist, Bureau of Land Management (BLM), California State Office. Dunes-wide monitoring that began in 2004 was an expansion and refinement of a pilot monitoring study conducted in 2003 in two of the seven management areas of the Dunes that support Peirson's milk-vetch. The 2003 pilot study itself benefited from previous pilot sampling of Peirson's milk-vetch and Algodones Dunes sunflower in 2001 and 2002 that was conducted in conjunction with an abundance class monitoring study implemented by BLM between 1998 and 2002 (see Willoughby 2000, 2001, and 2004b for a description of the 1998-2002 monitoring study). The 2003 pilot sampling study is described in Willoughby (2004a); some results from that study are also included in this report.

The study was designed by John Willoughby in consultation with Chris Knauf of the El Centro Field Office, the BLM office responsible for management of the Algodones Dunes. Chris managed every aspect of monitoring implementation. The study would not have been possible without his extraordinary leadership. Joelle Viau was contracted by BLM to assist Chris and provided exemplary day-to-day oversight of the monitoring. Fran Evanisko of the BLM California State Office provided extremely valuable support in applying the ArcGIS Geographical Information System (ESRI 2002) to the planning of the study and to the analysis and presentation of the data collected. Bob Bower of the El Centro Field Office provided valuable assistance in manipulating GIS data supplied by Fran, downloading the data into the Hewlett Packard iPAQ Personal Data Assistants running ArcPad Mobile GIS (ESRI 2002)-- used in conjunction with GPS units to navigate the transects for the study--and providing training in the use of these units to the monitors. Daniel Steward of the El Centro Field Office provided valuable help in training the monitors and in many other aspects of study implementation.

The study itself was carried out by employees of the Environmental Careers Organization of Boston, Massachusetts, working in teams of 3. The following ECO personnel walked the 930 kilometers of transects, took and recorded the data required for the study, and provided data input and quality control: Ariel Andrews, Joe Colton, Melissa Cregger, Brent Eastly, Al Eastman, Teman Erhart, Sommer Fisher, Robbie Hannawacker, Jon Hoiland, Becky Hollender, Angela Hyder, Katie Jones, Liz Kay, Jennifer Krenz, Melinda Lucht, Carl Lundblad, Patrick McConnell, Justin Nobel, Adam Norikane, Jordan Okie, Anna Ollila, Raquel Ordorica, Steve Pearson, Steve Samuel, Sallie Scriber, Michael Seaman, Richard Sieduk, Candace Steimer, Jess Sutherland, Sarah Timmer, Robert Tomasetti, Jared White, and Carey Zinc. The success of the study is a direct result of their dedication and hard work.

Executive Summary

In 2004 the Bureau of Land Management (BLM) implemented a monitoring program to estimate density and population size of three special status plant species--Peirson's milk-vetch, Algodones Dunes sunflower, and sand food--and the cover of the associated vegetation in the Algodones Dunes (also called Imperial Sand Dunes), located in southeastern Imperial County, California.

The proposed Imperial Sand Dunes Recreation Area Management Plan (ISDRAMP), issued for public review by BLM in May 2003, identified eight management areas. The objective of the monitoring was to obtain estimates for the three species and vegetation in each of the seven management areas in which Peirson's milk-vetch occurs. The monitoring program detailed in this report is part of the Monitoring/Study Plan contained in the proposed ISDRAMP.

A total of 135 belt transects, ranging in length from 2.35 to 14.16 kilometers, were positioned systematically with a random start within 12 sampling areas located within the seven management areas. Sampling areas were positioned to incorporate as much Peirson's milk-vetch habitat as practical. Transects were 25m wide, and counts were recorded in 25m segments along each of the transects. Counts were made of the total number of plants and of the number of plants in each of several categories, including stage classes and (for Peirson's milk-vetch and Algodones Dunes sunflower) of the number of plants with evidence of damage from off-highway vehicles (OHVs) and other sources. Vegetation cover was estimated by measuring the distance intercepted by each shrub along 50m lines that were placed every 1 km along one side of each of the belt transects. These lines were positioned along the belts using systematic random sampling.

There were an estimated 286,374 Peirson's milk-vetch plants throughout the seven management areas of the Dunes in 2004. This translates into an estimated density of 13.5 plants/hectare, but the species was not uniformly distributed throughout the seven management areas. Large parts of the sampling areas within the Adaptive, Ogilby, and Buttercup management areas had few or no plants. Estimated density in the Ogilby Management Area was about four times the density of the Gecko Management Area, the management area with the next highest density. Densities were lowest in the Mammoth Wash, Wilderness, and Buttercup management areas.

Almost all (94%) of the Peirson's milk-vetch plants counted in 2004 were seedlings and juvenile, nonflowering plants. Few of these plants survived to produce seed. These plants were likely part of a cohort that germinated in response to February rains. The high ratio of seedling/ juvenile plants observed in 2004 is similar to the pattern observed in 2003 during pilot monitoring in the Wilderness and Gecko management areas, but is much different from patterns observed during 1998-2002 monitoring, when the ratio of flowering plants was much higher. There were far fewer plants in the Wilderness and Gecko management areas in 2004 than in 2003, despite similar rainfall amounts and timing. The higher February-April temperatures experienced in 2004 may account for this difference.

About 0.3% of the estimated total number of Peirson's milk-vetch plants showed evidence of OHV damage at the time of the survey. Estimates of OHV damage for each of the management areas ranged from 0.0% to 2.07%. Another 0.4% of the total number of plants showed evidence

of damage from agents other than OHVs, principally insects. Estimates of non-OHV damage for each of the management areas ranged from 0.0% to 5.1%.

There were an estimated 1,965,298 Algodones Dunes sunflower plants throughout the seven management areas of the Dunes in 2004. This translates into an estimated density of 92.7 plants/hectare. The distribution of this species was relatively uniform across the management areas. Except for the Glamis and Buttercup management areas, density was also uniform throughout the management areas. The density in the Glamis Management Area was considerably higher than the other 5 management areas, while the density in the Buttercup Management Area was considerably lower.

Seedlings comprised the majority of the Algodones Dunes sunflower plants (86%) counted in 2004. Most of the adult plants counted in 2004 were likely plants one or more years old. The high ratio of seedling/juvenile plants observed in 2004 is similar to the pattern observed in 2003 during pilot monitoring in the Wilderness and Gecko management areas, but is much different from patterns observed during 1998-2002 monitoring, when the ratio of flowering plants was much higher. Densities were essentially the same between 2003 and 2004 in the Gecko Management Area, but the density of plants in the Wilderness Management Area in 2003 was more than twice that of 2004; this "difference" may be the result of sampling error. The similar densities between 2003 and 2004 in the Gecko Management Area imply that the higher temperatures in 2004 affected HENIT recruitment less than ASMAP recruitment.

About 0.1% of the total number of Algodones Dunes sunflower plants showed evidence of OHV damage at the time of the survey. Estimates of OHV damage for each of the management areas ranged from 0.0% to 0.6%. Another 0.1% of the total number of plants showed evidence of damage from agents other than OHVs, principally insects. Estimates of non-OHV damage for each of the management areas ranged from 0.06% to 0.31%.

There were an estimated 46,470 sand food inflorescences throughout the seven management areas of the Dunes in 2004 (all that is visible above ground of this species is the inflorescence). The species is well distributed only in the two northern management areas, Mammoth Wash and the Wilderness. Its density is also highest in those two management areas. The next highest density is in the Adaptive Management Area. These are also the three management areas with the highest cover of desert buckwheat, one of sand food's host plants. This pattern was also observed in monitoring between 1998 and 2003.

Total estimated shrub cover was higher in the Mammoth Wash (2.7%) and Wilderness (3.0%) management areas than in the other management areas of the Dunes, none of which had a shrub cover greater than 1.6%. Because the dunes are lower in the Mammoth Wash and Wilderness management areas than in the management areas to the south, the Mammoth Wash and Wilderness management areas have fewer unvegetated dune areas and a higher overall shrub cover. Total shrub cover estimates for the other management areas are similar to one another, with Glamis having the lowest cover (0.9%). Though the total shrub cover estimate for the Buttercup Management Area is similar to the other management areas south of Highway 78, much of its shrub cover comes from creosote bush, a plant not considered part of the psammophytic (sand-loving) shrub community. The three psammophytic shrubs with the highest

cover values in 2004 were desert buckwheat (1.09% cover), longleaf jointfir (0.14% cover), and Wiggins' croton (0.01% cover).

Introduction

In late winter and spring 2004, the Bureau of Land Management (BLM) implemented a monitoring program to estimate density and population size of three special status plant species, Peirson's milk-vetch (*Astragalus magdalenae* var. *peirsonii*, hereafter referred to as ASMAP); Algodones Dunes sunflower (*Helianthus niveus* ssp. *tephrodes*, hereafter referred to as HENIT), and sand food (*Pholisma sonorae*, hereafter referred to as PHSO), in the Algodones Dunes (also called Imperial Sand Dunes), located in southeastern Imperial County, California. ASMAP is a Federally-listed threatened species and a State-listed endangered species. HENIT is a State-listed endangered species. PHSO is neither Federally- nor State-listed, but is managed as a sensitive species by BLM. Though the survey began in late winter 2004, it will be referred to simply as the spring 2004 survey hereafter.

The proposed Imperial Sand Dunes Recreation Area Management Plan (ISDRAMP), issued for public review by BLM in May 2003, identified eight management areas (Map 1). The objective of the 2004 monitoring was to obtain density and population size estimates of the species in each of the seven management areas in which it occurs (the species does not occur in the Dune Buggy Flats Management Area). The monitoring program detailed in this report is part of the Monitoring/Study Plan contained in the proposed ISDRAMP.

Methods

One or more rectangular sampling areas were delineated in each of the seven management areas of the Algodones Dunes (Map 2). Sampling area boundaries were placed so that the major part of the habitat of ASMAP was encompassed within the sampling areas.[1] Rectangles were used to facilitate the systematic random placement of belt transects. This resulted in single sampling areas in the Mammoth Wash, Wilderness, and Ogilby management areas, two sampling areas in each of the Gecko, Glamis, and Buttercup management areas, and three sampling areas in the Adaptive Management Area (AMA), for a total of 12 sampling areas. Each of the sampling areas was given a unique number, as shown on Map 2.

Each of the sampling areas consisted of a rectangle with its long sides oriented approximately northwest to southeast (the Buttercup 11 sampling area approximates a square). The shorter top side of each sampling area rectangle functioned as a baseline from which 25m wide belt transects were run perpendicular to the baseline and therefore parallel to each of the long sides of the sampling area rectangle. The starting points for each of the transects was determined using systematic sampling with a random start. As an example of how this sampling design was

[1] Although HENIT and PHSO were also targets of this monitoring, the sampling area boundaries were determined based principally on including as much ASMAP habitat as possible. Because HENIT occupies the same or very similar habitat as ASMAP—see previous monitoring reports of Willoughby 2000, 2001, and 2004—the sampling areas delineated for ASMAP are also optimal for HENIT. They are not, however, optimal for PHSO, which also occupies habitat outside of the sampling area boundaries, particularly on the west side of the Dunes. Estimates for PHSO will therefore be lower than if sampling area boundaries for this species were enlarged to encompass the entire habitat of PHSO.

employed, consider Sampling Area 3 in the Gecko Management Area. The baseline for that sampling area is 2900m long. Once it was determined that 9 transects would be run off the baseline, the baseline was divided into 9 segments, each 322m long. A random location in the first 322m of the baseline was then chosen for the start of the first transect. That random starting point was at the 176m point along the baseline. The first transect was then started at the 176m point, and subsequent transects were then started every 322m from the first one, so that the second transect started at the 176m + 322m = 498m point along the baseline, the third transect started at the 498m + 322m = 820m point, and so on. Each belt transect ran from the baseline to the southeast end of the sampling area. Thus the lengths of each transect varied by sampling area but were the same within each sampling area. Table 1 shows the number of transects placed in each of the sampling areas, the lengths of each transect, and the total area encompassed by each sampling area.

Table 1. Sampling areas for the 2004 special status plant monitoring in the Algodones Dunes. Each sampling area has a unique number from 1 to 12. The name in front of the sampling area number corresponds to the management area within which the sampling area is located.

Sampling Area Name and Number	Number of Transects	Transect Length (km)	Area Within Sampling Area (ha)
Mammoth Wash 1	15	8.91	1,336.44
Wilderness 2	15	14.16	2,492.91
Gecko 3	9	6.54	1,891.70
Gecko 4	9	6.54	1,888.60
Glamis 5	9	6.24	1,815.29
Glamis 6	9	6.24	1,817.87
AMA 7	5	6.15	1,362.91
AMA 8	5	5.38	1,176.88
AMA 9	9	6.95	3,054.97
Ogilby 10	18	7.73	3,396.98
Buttercup 11	16	2.35	463.63
Buttercup 12	16	3.58	509.23
Total	135	80.77	21,207.41

The number of transects to be placed in each of the sampling areas was determined based on the results of pilot sampling conduced in 2003 in the Wilderness and Gecko Management Areas.

Each transect was a 25m wide belt. The beginning and ending points of each transect were entered into Hewlett Packard iPAQ Personal Data Assistants running ArcPad Mobile GIS (ESRI 2002), along with points corresponding to each 25m segment along each transect. GPS units attached to the iPAQs were then used to navigate between each of the 25m points from the beginning to the end of each transect. Counts were made of the number of ASMAP, HENIT, and PHSO present within each of the 25m segments. This enabled the creation of maps showing the cells along each of the transects that were occupied by these species and the number of plants found in each of the cells. In addition to a simple count of all ASMAP and HENIT plants and

PHSO inflorescences (only the inflorescences of this root parasite are visible above ground), separate counts were made in other categories as follows:

> ASMAP: (1) seedlings and young, nonflowering plants, (2) flowering plants, (3) number of plants greater than 1-year old, (4) number of plants showing damage from OHVs, and (5) number of plants showing damage from other sources (e.g., insects, disease). The total number of plants equals the total of categories 1 and 2.
>
> HENIT: (1) seedlings, (2) adult nonflowering plants, (3) adult flowering plants, (4) number of plants showing damage from OHVs, and (5) number of plants showing damage from other sources (e.g., insects, disease). The total number of plants equals the total of categories 1, 2, and 3.
>
> PHSO: (1) live inflorescences, and (2) dead inflorescences. The total number of inflorescences equals the total of categories 1 and 2.

Individual plants and individual inflorescences can be determined with little difficulty for ASMAP and PHSO, respectively. HENIT, however, presents a problem in this regard. While individual HENIT seedling plants can be readily determined, the same is not true for adult plants, whether flowering or not. Because HENIT apparently spreads by branches that lie down in the sand and take root, it is difficult to actually determine genetic individuals except through tedious excavation that is too time consuming and too damaging to the plants for this monitoring effort. Therefore, the following rule was used to determine "individual" adult HENIT plants:

- If HENIT stems were greater than 1 m apart they were considered to be two different plants.
- If HENIT stems were less than 1 m apart they were considered to be one individual plant.

Density and population estimates were made based on the transect values. Estimates of densities and population totals were made separately for each sampling area, treating the systematic random samples as if they were simple random samples (this is a common practice in natural resource sampling—see, for example, Schreuder et al. 2004). These sampling area estimates are the same as the management area estimates for those management areas having just a single sampling area (Mammoth Wash, Wilderness, and Ogilby). For those management areas having two or three sampling areas, the sampling area estimates were consolidated into a management area estimate by treating each sampling area as a separate stratum and using formulas for stratified random sampling. The survey module in the statistical program Stata Release 8.2 (StataCorp 2004) automates these formulas and was used to calculate the estimates and confidence intervals reported here. Because transects were of different lengths, a ratio estimator of the mean number of plants per transect divided by the mean area per transect was used to estimate density and population size as recommended by Stehman and Salzer (2000) to avoid potential problems in estimating these parameters for the Dunes and a whole and for those management areas (AMA and Buttercup) with belt transects of unequal area. [2]

[2] Ratio estimation proved to be an unnecessary precaution with this dataset. The data were analyzed using both the svyratio and svytotal commands in Stata release 8.2 (the latter command ignores the difference in belt area) and the estimates of population densities and totals and their confidence intervals derived from these two commands were effectively equivalent.

Each of the 135 transects was sampled twice in 2004. The set of 135 transects was first sampled between February 23 and March 18, 2004. The entire set was then sampled again between March 21 and April 21, 2004. Only the results of the second run of transects are reported on here.

To assess how many ASMAP plants that were seedlings and juvenile nonflowering plants at the time of the spring 2004 survey plants may have survived and set seed, a subset of the 25m x 25m cells sampled in spring 2004 was resurveyed September 9-24, 2004. All cells with 30 or greater seedlings in the spring 2004 survey were resurveyed in September 2004. There were 121 cells meeting this criterion. Table 2 shows the number of cells sampled in September 2004 by management area.

Table 2. Number of 25m x 25m cells resurveyed for ASMAP in September 2004 by management area.

Management Area	Number of Cells
Mammoth Wash	3
Wilderness	0
Gecko	17
Glamis	10
AMA	24
Ogilby	62
Buttercup	5
Total	121

Precipitation data were obtained from two remote area weather stations (RAWS), one located in the northern half of the dunes at the Cahuilla Ranger Station near State Highway 78 on the western edge of the dunes and the other at Buttercup in the southern part of the dunes south of Interstate 8. These data were compared to long-term average precipitation obtained from the Western Regional Climate Center for weather stations in the vicinity of the Dunes. The locations of these stations are shown in Willoughby (2004).

Data were also collected for the psammophytic vegetation that is the habitat for the above three species. Line-intercept transects, each 50m in length, were used to measure the cover of perennial plants encountered at 1 km intervals along the left (eastern) edge of each of the belt transects used for the special status plant monitoring. These line-intercept transects were positioned using a systematic sample with a random start. The 25m segments used to sample the three special status plants were used to determine the starting point for the first vegetation transect along each belt transect. There are 40 such 25m segments in each 1 km of the belt transect. One of the first 39 segments was randomly selected (because the line-intercept transect is 50m in length, use of the 40th segment would result in the 50m transect running past the 1 km point). Additional transects were then run at 1 km from the first one. For example, the random starting point in Belt Transect 1 in the Mammoth Wash Management Area was the 800m mark (the beginning of segment 33) along the belt. Therefore, the first line-intercept transect began at

the 800m mark, the second began at the 1800m mark, the third at the 2800m mark, and so on until the last one at the 8800m mark.

The distance intercepted by each perennial plant along each 50m line was recorded by species. The distance intercepted expressed in meters divided by the 50m length of the line gives an estimate of the proportion of line intercepted by the species. Multiplying the proportion by 100% converts it to a percent, which is the estimate of percent cover for that species in the area sampled by the 50m line. The 50m lines were treated as the sampling units in estimating cover and confidence intervals for each sampling area. Weighted averaging was used to combine mean cover estimates for those management areas with more than one sampling area and for the Dunes as a whole. Confidence intervals around estimated weighted mean cover values were calculated by weighting separate variance estimates and summing these as described in Schreuder et al. 2004, page 21).

Except for the precipitation graphs, which were constructed using Microsoft Excel 2002, all graphs were constructed using SYSTAT version 10.2 (SYSTAT 2002).

Results and Discussion

Weather

Because weather is critical to the interpretation of the special status plant monitoring data, it will be discussed first.

Growing Season Precipitation. Growing season precipitation is defined as the amount of precipitation between the months of September 1 and June 30. This definition differs from that used in previous reports (Willoughby 2000, 2001, and 2004b). Those reports defined growing season precipitation as the amount of precipitation falling between July 1 and June 30. Changing the definition to encompass only the months between September and June matches the definition used by Sneva and Hyder 1962 in the Intermountain West (they term this period the "crop-year"). Although some rain often falls in the Dunes in the months of July and August as a result of tropical storms from the Gulf of California, this rain likely does not promote germination and growth of ASMAP because of the intense heat during those months.

Table 3 shows the total growing season precipitation recorded by the two RAWS stations for growing seasons 2002-2003 and 2003-2004. Figures 1 and 2 show the monthly precipitation totals recorded by each of the stations for these growing seasons.

Table 3. Growing season precipitation from the two remote area weather stations (RAWS) in the Algodones Dunes. The long-term average of the WRCC stations in the vicinity of the dunes is given for comparison. All units are in inches.

Growing Season	Cahuilla RAWS	Buttercup RAWs	Average of the two RAWS	Long-term average of all WRCC Stations
2002-2003	2.68	1.15	1.92	2.44
2003-2004	2.2	2.46	2.33	2.44

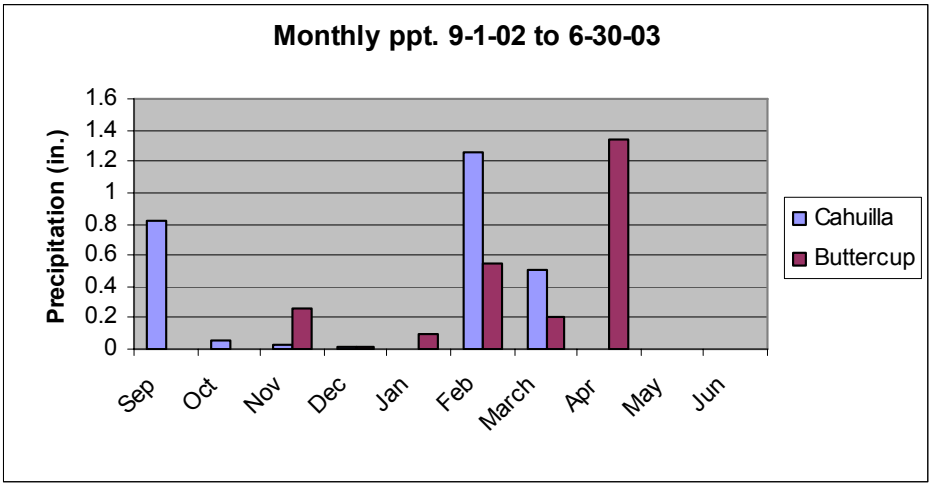

Figure 1. Monthly total precipitation between September 2002 and June 2003 for the two RAWS stations in the Algodones Dunes.

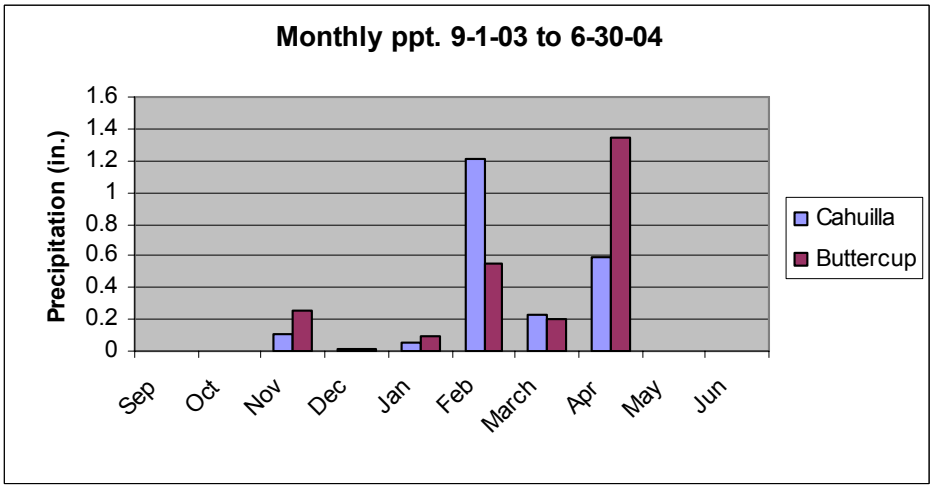

Figure 2. Monthly total precipitation between September 2003 and June 2004 for the two RAWS stations in the Algodones Dunes.

Astragalus magdalenae* ssp. *peirsonii

Figures 3 and 4 show the estimates of density (number of plants/hectare) and total population size, respectively, of ASMAP in each of the management areas and the contribution of the two stage classes (nonflowering and flowering) to the totals. Dot graphs and 95% confidence intervals showing estimates of ASMAP density (plants/ha) and total population size are given in Appendix 1, Figures 1-1 to 1-12, for each of the 5 categories for which data were collected and for the total number of plants. For each of these categories there is a pair of graphs, the first one showing estimates of density (number of plants/hectare) and the second one showing estimates of total population size. Density estimates are shown for each management area and the Dunes as a whole. Population estimates are shown for each management area.

Figures 5 and 6 are stacked bar graphs comparing the density and total population size estimates, respectively, from the 2004 values for the Wilderness and Gecko management areas to the values obtained for these two management areas from 2003 pilot sampling (only the Wilderness and Gecko management areas were sampled in 2003).

The actual density and population estimates are given in Appendix 1, Table 1-1. Map 3 shows the distribution and abundance of ASMAP in all of the 25m x 25m cells sampled in 2004.

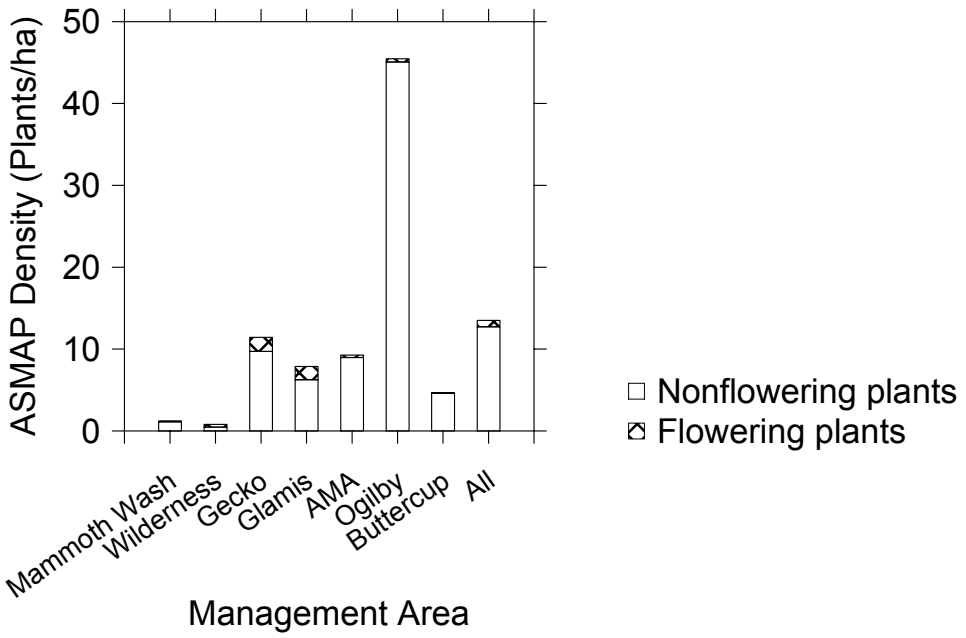

Figure 3. ASMAP density (plants/ha) for each of the management areas and the Dunes as a whole ("all") in spring 2004.

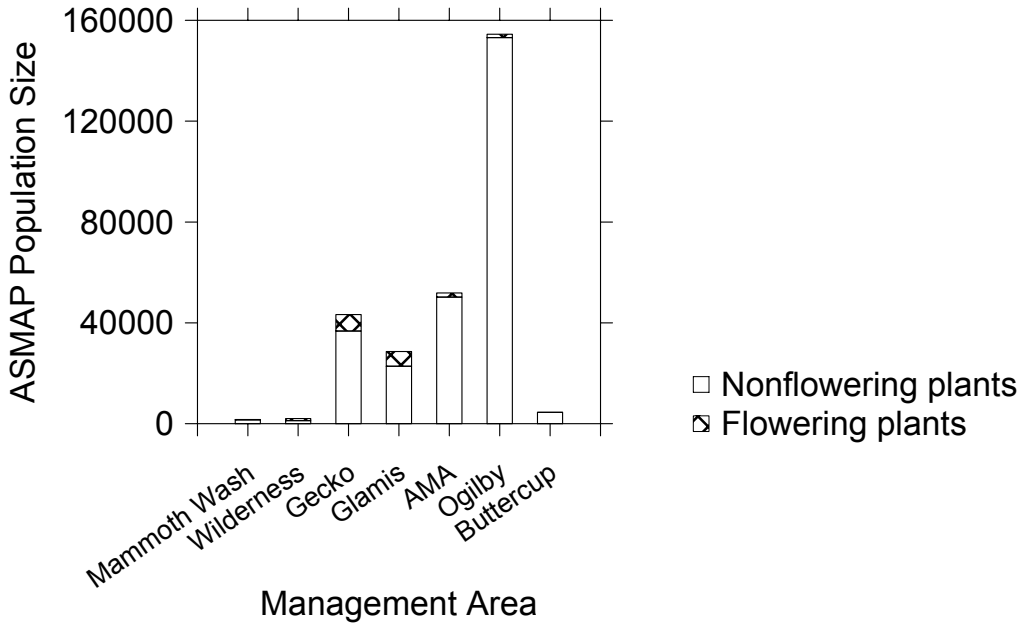

Figure 4. ASMAP population size for each of the management areas in spring 2004.

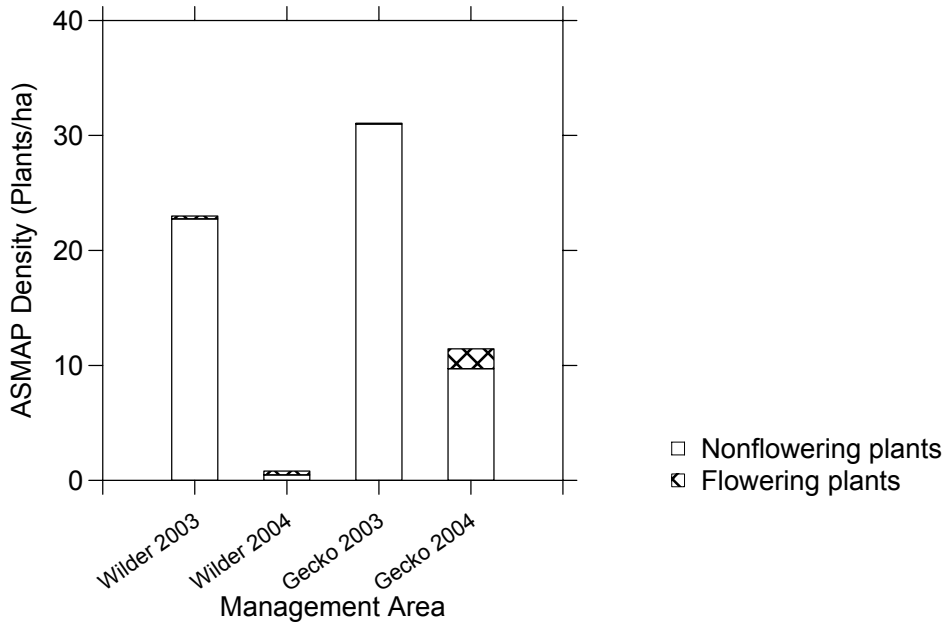

Figure 5. Comparison of ASMAP density (plants/ha) between 2003 and 2004 for the Wilderness and Gecko Management Areas.

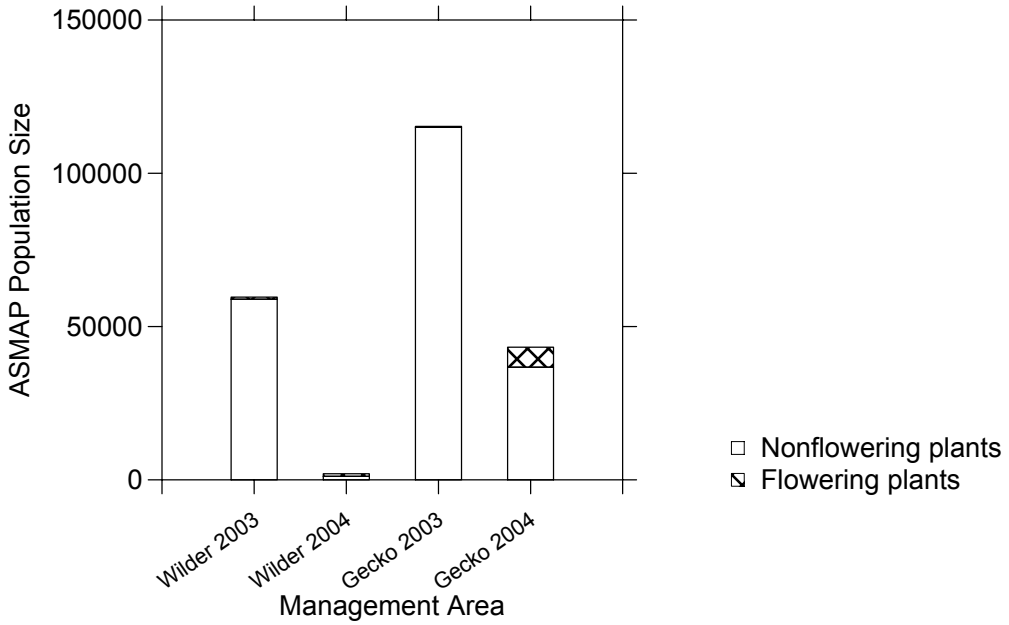

Figure 6. Comparison of ASMAP population size between 2003 and 2004 for the Wilderness and Gecko Management Areas.

Distribution and abundance. There were an estimated 286,374 ASMAP plants throughout the seven management areas of the Dunes in 2004. This translates into an estimated density of 13.5 plants/hectare, but as Figures 3 and 4 show, ASMAP was not uniformly distributed throughout these seven management areas.

Because management areas are different sizes, density (plants/ha) is a better parameter than population size to use to compare management areas. The highest estimated ASMAP density was in the Ogilby Management Area. Estimated density in the Ogilby Management Area (45.5 plants/ha) was about 4 times the density of the Gecko Management Area (11.4 plants/ha), the management area with the next highest density. Densities were lowest in the Mammoth Wash (1.2 plants/ha), Wilderness (0.8 plants/ha), and Buttercup (4.7 plants/ha) management areas. The low density in the Buttercup Management Area may be attributed to the intense OHV use in that management area, but OHV use is definitely not the reason for the low density in the Wilderness Management Area (which is closed to OHV use) and is likely not a reason for the low density in the Mammoth Wash Management Area, which receives relatively low OHV use.

It is unclear why the density in Ogilby should be so much higher than in the other management areas, particularly those in the northern part of the Dunes. The February rainfall recorded at the Buttercup RAWS station, which is the closer of the two stations to the Ogilby Management Area, was only about half that recorded at the Cahuilla RAWS station, which is closer to the northern management areas, Mammoth Wash, Wilderness, Gecko and Glamis. If the amount of precipitation was the only factor affecting numbers of plants, one would expect higher densities in the management areas in the northern part of the Dunes, assuming that the Cahuilla and Buttercup RAWS accurately reflect actual precipitation in the northern and southern parts of the Dunes, respectively. It is possible that a localized rainfall event occurred in the Ogilby Management Area that was not captured by the Buttercup RAWS. It is possible, however, that temperature also played a role in the abundance patterns shown. Temperature will be discussed below as a possible factor in the differences in densities observed between 2003 and 2004, but while it may well explain differences between the two years, it is unclear how it could explain differences between management areas in the same year.

Map 3 shows that the distribution of ASMAP was not uniform throughout each of the 12 sampling areas. Most of the plants in the Ogilby Mangement Area, which had the highest ASMAP density, occurred in the western third of Sampling Area 10, the single sampling area in the Ogilby Management Area. Few plants were found in Sampling Area 8 and the eastern part of Sampling Area 9 in the Adaptive Management Area. All of the plants in the Buttercup Management Area were found in the southwestern part of Sampling Area 11; no plants at all were found in Sampling Area 12, the easternmost of the two Buttercup sampling areas. The most even distribution of plants was found in Sampling Areas 3 and 4, both in the Gecko Management Area, helping to explain why the density estimates for that management area are more precise than those for the other management areas. This will be discussed further below.

Stage-class composition. As the figures show, almost all (94.3%) of the plants counted in spring 2004 were in the nonflowering stage class, which includes seedlings and young, nonflowering plants. An estimated 16,324 (5.7%) of the dune-wide estimate of 286,374 plants in 2004 were flowering adults; of these, 9,775 were plants that were more than 1-year old (see Appendix 1,

Table 1-1). Thus, only 6,594 (2.3%) of plants that germinated in fall/winter 2003-2004 were flowering at the time of the spring 2004 survey.

Most of the seedling/juvenile plants likely represent a cohort that germinated in response to February 2004 rains (see Figure 2). The few flowering plants that germinated in fall-winter 2003-2004 (2.3% of the Dunes-wide estimate) may represent a cohort that germinated in response to rainfall in November 2003. Because the November 2003 rainfall event was relatively small (see Figure 2), this cohort was also small.

This pattern of high numbers of seedling/juvenile plants and low numbers of adult, flowering plants is similar to that observed in 2003, following a growing season which experienced a rainfall pattern similar to the 2003-2004 growing season, with the principal germinating rainfall event occurring in February (Figure 1). Only 0.5% of the estimated 174,858 plants in 2003 for the combined Wilderness and Gecko management areas were flowering at the time of monitoring. The 2003 proportion of flowering plants was even smaller than 2004 probably because, except for rains in September 2002, which apparently came too early to result in a recruitment event, there was insufficient rainfall in any month until February to result in significant germination.

The stage-class composition of the ASMAP plants tallied during the 1998-2002 monitoring was far different than that observed during the 2003 and 2004 monitoring. Seedling/juvenile plants comprised only 1% of the ASMAP tallied in 1998, 0% of those tallied in 1999 and 2000, 12.5% of those tallied in 2001, and 6.7% of those tallied in 2002 (Willoughby 2004b). As this report goes to press, it appears from ongoing monitoring that the stage-class composition in 2005 will more closely resemble that observed between 1998 and 2002, with flowering plants comprising a higher percentage of the total number of plants than seedling/juvenile plants. Given that most plants that are not flowering at the time of spring monitoring do not survive to reproduce, it is good that the more typical situation (at least for the period 1998 to 2005) is for the stage-class composition in late winter and spring to consist primarily of flowering plants.

Survival to reproduction. Based on the resurvey of 121 cells in September 2004, a very small percentage of plants that were seedlings and juvenile, nonflowering plants at the time of the spring 2004 survey survived to produce seed. A total of 19,242 seedling/juvenile plants were counted in these 121 cells during spring 2004. During the September 2004 survey 10,977 plants were counted in these cells, of which 1,587 plants were still alive and 9,390 plants were dead. Assuming the exact cell boundaries used in the spring survey were relocated in the September survey, 8,265 (43%) of the original 19,242 seedling/juvenile plants were unaccounted for in the September survey. Due to the error inherent in relocating areas using GPS, it is unlikely that the exact same cell boundaries were used during both surveys. Accordingly, the unaccounted-for plants likely result from a combination of some plants desiccating and blowing away and some miscounts due to differential positioning of cells at the two survey dates. A few cells actually had more plants (though most were dead) in September 2004 than in spring 2004. This may also be the result of differential positioning of cells but may also be the result of some germination of plants after the cells were surveyed in spring 2004. There was a precipitation event on April 2, 2004, after many of the cells were surveyed, that could have resulted in germination of plants (though high temperatures in April and May would likely have quickly desiccated these plants).

Only 56 of the 10,977 plants counted during the September resurvey showed any evidence of fruiting, 25 of which were alive and 31 of which were dead. When compared to the original seedling/juvenile count of 19,242, this means that only about 0.3% of the plants that were seedling and juvenile plants in spring 2004 actually survived to set fruit. The remaining 99.7% of the plants that were seedlings/juveniles in spring 2004 were therefore lost to the gene pool. It is likely that the same thing happened in 2003.

Differences in ASMAP density and abundance between 2003 and 2004. Although there were similarities between 2003 and 2004 in terms of stage-class composition, there were big differences in ASMAP density and abundance, at least in the Wilderness and Gecko management areas, which were the only two areas monitored in 2003. In 2003 there were an estimated 174,858 plants in these two management areas alone compared to 286,374 plants in all seven management areas in 2004.

As Figure 5 shows, estimated ASMAP density in the Wilderness Management Area in 2003 (22.8 plants/ha) was more than 45 times the estimated density in 2004 (0.5 plants/ha). Though the difference is not as striking, the estimated density for the Gecko Management Area in 2003 (31 plants/ha) was still almost 3 times the estimated density in 2004 (11.4 plants/ha).

Rainfall is insufficient by itself to explain these differences since both the rainfall amounts and timing at the Cahuilla RAWS (the station nearest the Wilderness and Gecko management areas) were similar in both years, with both years receiving rainfall principally in February. Based on rainfall alone one would expect the densities to be similar between years. The fact that the densities were much lower in 2004 may be the result of higher temperatures in February, March, and April 2004. Table 4 shows February, March, and April average maximum temperatures for 2003 and 2004 as recorded by the Cahuilla RAWS.

Table 4. Differences in average maximum temperatures recorded at the Cahuilla Remote Area Weather Station between 2003 and 2004.

	Average Maximum Temperature (degrees F)		
Month	Year		Difference (2004-2003)
	2003	2004	
Feburary	72.4	79.6	+ 7.2
March	80.9	90.0	+ 9.1
April	81.1	88.2	+ 7.1

Average monthly maximum temperatures were considerably higher during 2004 for all three months. Virtually all of the February 2004 rainfall came during a February 22 storm. Germination of the seedling/juvenile cohort observed in the 2004 monitoring would have occurred following this February 22 rainfall event. But as Table 4 shows, maximum temperatures in February and March were quite high compared to those in 2003. These higher temperatures may not have been as conducive to germination as the lower 2003 temperatures. Alternatively, even if the rate of germination were as high in 2004 as in 2003, a higher

proportion of germinating plants may have senesced at an early stage in 2004 compared to 2003, with the result that they did not survive to be counted during 2004 monitoring. Additionally, most of the February 2003 rainfall came earlier in the month, on February 12 and 13, than the February 2004 rainfall, giving the February 2003 cohort more time to develop before it experienced higher temperatures.

Precision of the estimates. As the figures and table of Appendix 1 show, 95% confidence intervals are wide for most of the 2004 estimates. The discussion here will focus only on the precision of the density estimates for all plants (because of the relationship between density and population size, the precision of density estimates is the same as that for population size). Precision is calculated by dividing the confidence interval half width by the mean density and multiplying by 100 to express the value as a percent. The smaller the precision is the better the estimate. Precision ranges from a low of 35% for the Gecko Management Area to a high of 132% for the Buttercup Management Area. Precision for the Dunes-wide estimate is 50%. This large variation in precision is mostly due to the variation in the distribution of the species in each of the management areas as illustrated in Map 3 and discussed above. The density estimate for the Gecko Management Area is the most precise largely because the plant is much more evenly distributed there than it is in the other management areas. In contrast, the Buttercup density estimate is the least precise because the species is absent from one sampling area and concentrated in a small corner of the other sampling area. Precisions are poor in the Adaptive Management Area (118%) and the Ogilby Management Area (91%) for the same reasons.

It is impossible to tell from this single year's monitoring whether the observed ASMAP distribution will be similar in future years, particularly given that the rainfall pattern in the 2003-2004 growing season is likely atypical. However, to improve precision several changes were implemented for 2005, including dividing the Mammoth Wash, Wilderness, and Ogilby management areas into two sampling areas each, and dividing one of the three AMA sampling areas in half, resulting in four sampling areas in that management area. Sample sizes were also increased substantially in all of the management areas for the 2005 sampling.

OHV effects. Figures 1-9 and 1-10 in Appendix 1 display the density and population size, respectively, of plants with signs of damage from OHVs at the time of the survey. Actual numbers are included in Table 1-1. Dunes-wide, an estimated 731 plants showed OHV impacts, representing 0.3% of the total estimated plants. The density of OHV impacted plants was highest in the Glamis (0.103 plants/ha) and Buttercup (0.096 plants/ha) management areas (Figure 1-9) and lowest in the Mammoth Wash (0.003 plants/ha), Wilderness (0.000 plants/ha), AMA (0.000 plants/ha), and Ogilby (0.012 plants/ha) management areas. The Gecko Management Area was intermediate between these extremes, with 0.058 plants/ha. This pattern of damage is consistent with OHV use patterns in the Dunes. The Buttercup, Glamis, and Gecko management areas are more intensively used by OHVs than the other management areas (the Wilderness Management Area is completely closed to OHVs). About a third of the Gecko Management Area has been closed to OHVs as a result of a lawsuit settlement instituted in November 2000; this may partly account for the lower density of plants impacted by OHVs in the Gecko Management Area compared to the Glamis and Buttercup management areas. The density of impacted plants is low, however, in all of the management areas when compared to the Dunes-wide estimated density of 13.5 plants/ha.

When viewed from the perspective of percent of total plants impacted by OHVs, the following are the estimated percentages for each of the management areas: Mammoth Wash (0.24%), Wilderness (0.00%), Gecko (0.50%), Glamis (1.3%), AMA (0.00%), Ogilby (0.03%), and Buttercup (2.07%).

Other damage. Figures 1-11 and 1-12 in Appendix 1 display the density and population size, respectively, of plants damaged by sources other than OHVs, principally insects. An estimated 1,083 plants in the Dunes as a whole showed evidence of non-OHV damage, comprising about 0.4% of the total estimated number of plants. As Figure 1-11 shows, the density of damaged plants was uniformly low throughout all of the management areas, ranging from a low of 0.00 plants/ha in the Buttercup Management Area to a high of 0.09 plants/ha in the AMA. The estimate of the total number of plants showing non-OHV damage was quite a bit higher in the AMA (Figure 1-12) but the 95% confidence interval around the AMA estimate is wide and overlaps considerably with the confidence intervals for the Gecko and Glamis management areas (the two management areas with the next highest estimated numbers of non-OHV damaged plants), so it is quite possible that there was not a true difference between the total number of plants for the AMA and the other management areas.

When viewed from the perspective of percent of total plants impacted by agents other than OHVs, the following are the estimated percentages for each of the management areas: Mammoth Wash (5.08%), Wilderness (1.16%), Gecko (0.50%), Glamis (0.72%), AMA (0.93%), Ogilby (0.04%), and Buttercup (0.00%). The reason for the much larger percentage of non-OHV damaged plants in the Mammoth Wash Management Area compared to the other management areas is unclear; it represents an estimate of 84 non-OHV damaged plants divided by an estimated total number of 1,653 plants.

Helianthus niveus* ssp. *tephrodes

Figures 7 and 8 graph the estimates of density (number of plants/hectare) and total population size, respectively, of HENIT in each of the management areas and the contribution of the three stage classes (seedlings, nonflowering adults, and flowering adults) to the totals.

Dot graphs and 95% confidence intervals showing estimates of HENIT density (plants/ha) and population size are given in Appendix 2, Figures 2-1 to 2-12, for each of the 5 categories for which data were collected and for the total number of plants. For each of these categories there is a pair of graphs, the first one showing estimates of density (number of plants/hectare) and the second one showing estimates of population size. Density estimates are shown for each management area and the Dunes as a whole. Population estimates are shown for each management area.

Figures 9 and 10 are stacked bar graphs comparing the density and population size estimates, respectively, from the 2004 values for the Wilderness and Gecko management areas to the estimated values obtained for these two management areas from 2003 pilot sampling (only the Wilderness and Gecko management areas were sampled in 2003).

The actual density and population estimates are given in Appendix 2, Table 2-1. Map 4 shows the distribution and abundance of HENIT in all of the 25m x 25m cells sampled in 2004.

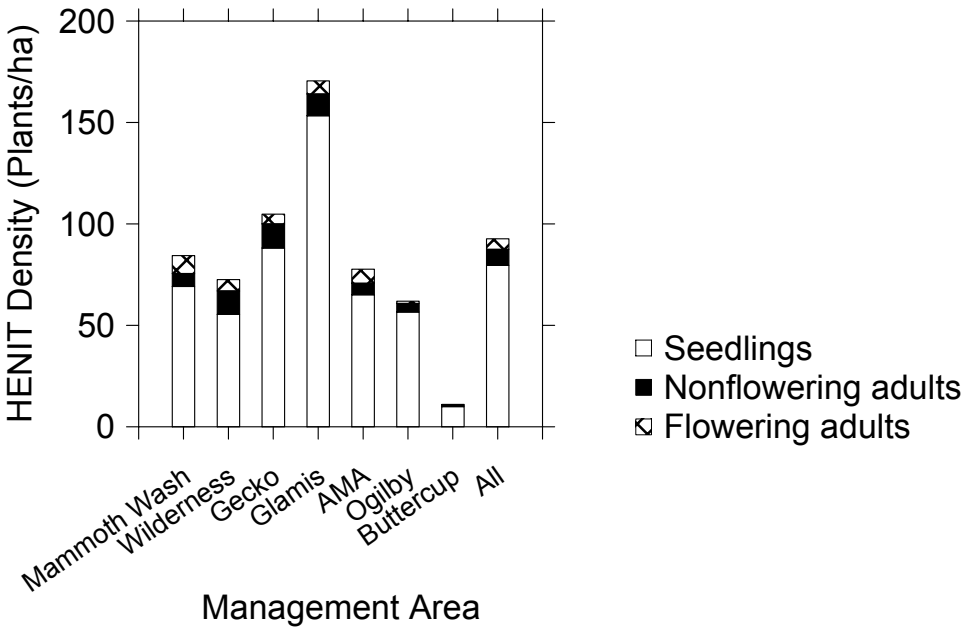

Figure 7. HENIT density (plants/ha) for each of the management areas and the Dunes as a whole ("all") in spring 2004.

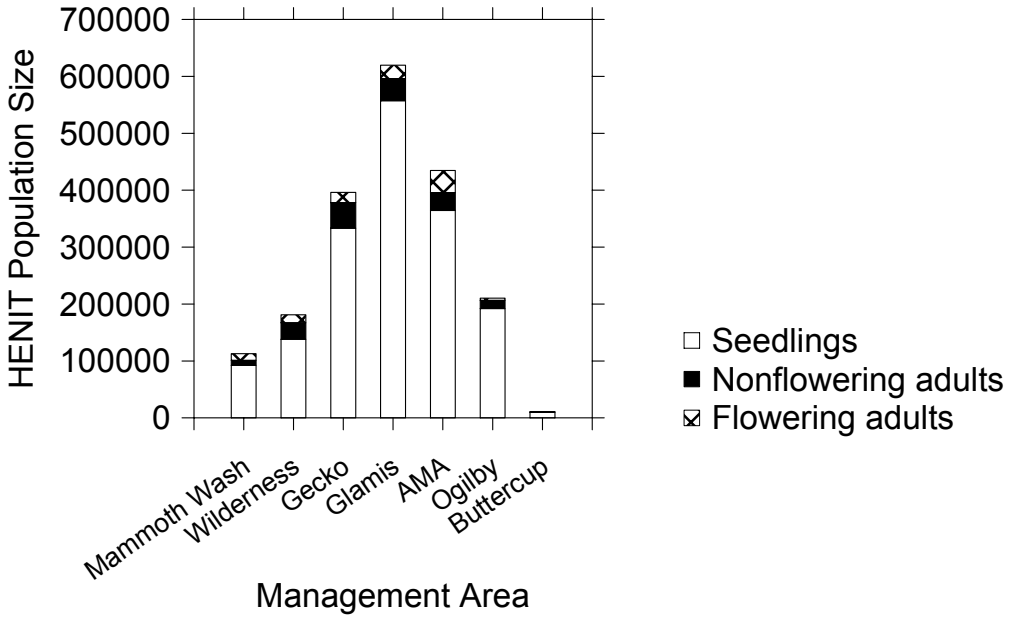

Figure 8. HENIT population size for each of the management areas in spring 2004.

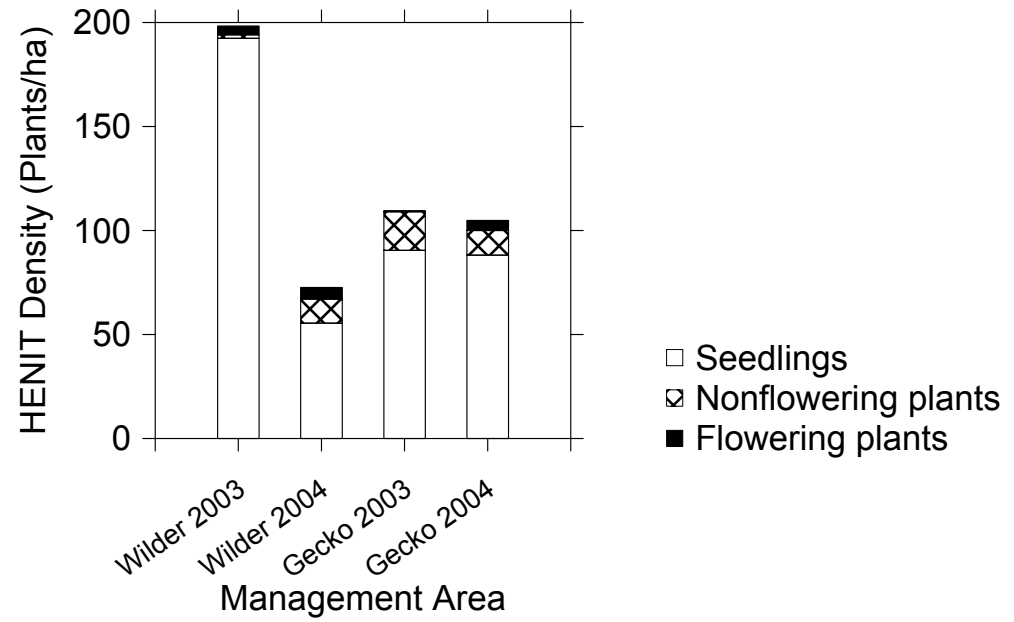

Figure 9. Comparison of HENIT density (plants/ha) between 2003 and 2004 for the Wilderness and Gecko Management Areas.

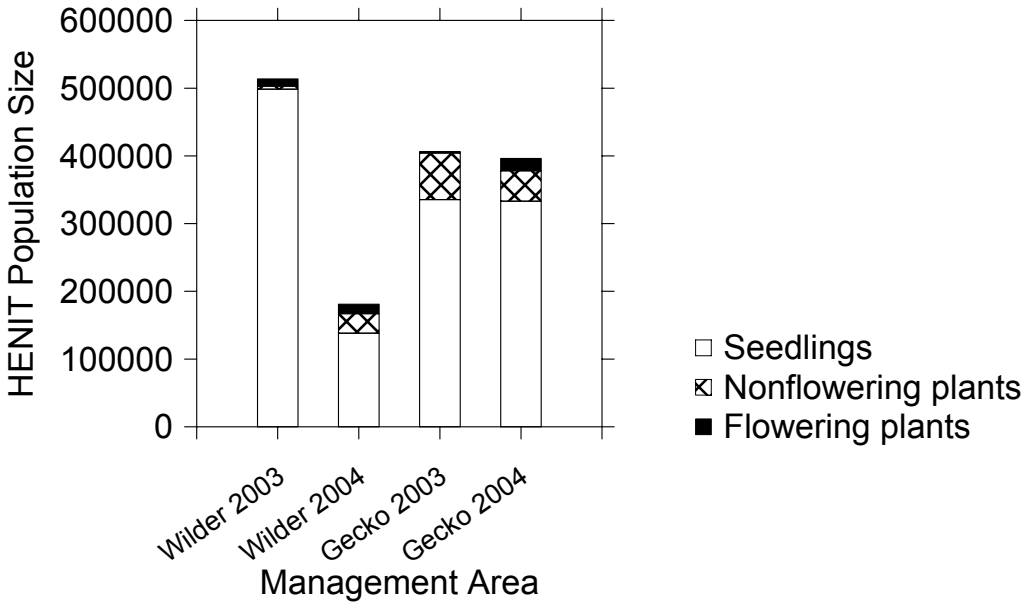

Figure 10. Comparison of HENIT population size between 2003 and 2004 for the Wilderness and Gecko Management Areas.

Distribution and abundance. There were an estimated 1,965,298 HENIT plants throughout the seven management areas of the Dunes in 2004. This translates into an estimated density of 92.7 plants/hectare. Except for Glamis and Buttercup, density was remarkably uniform throughout the management areas (Figure 7). The density in the Glamis Management Area (170.5 plants/ha) was considerably higher than the other 5 management areas, while the density in the Buttercup Management Area (11.1 plants/ha) was considerably lower.

Map 4 shows that the distribution of HENIT is also relatively uniform throughout all seven management areas. Unlike ASMAP, HENIT occupies many cells throughout the Glamis Management Area and the eastern parts of the Adaptive Management, Ogilby, and Buttercup management areas.

Stage-class composition. Seedlings comprised the majority of the HENIT plants counted in 2004. Of the Dunes-wide estimate of 1,965,298 plants, 167,567 (8.5%) were adult, nonflowering plants and 110,388 (5.6%) were adult, flowering plants. The remaining 85.9% were seedling plants. It is likely that the majority of these seedlings germinated in response to the February 2004 rains. Based on previous monitoring (Willoughby 2000, 2001, and 2004b) HENIT appears to be relatively long-lived, at least longer lived than ASMAP. Therefore, most of the adult plants were likely plants one or more years old.

The high percentage of seedling HENIT plants observed in 2004 was similar to that observed in the Wilderness and Gecko management areas during 2003 monitoring. Of the 920,100 estimated plants in the combined Wilderness and Gecko management areas in spring 2003, 834,022 (90.6%) were seedlings, 73,149 (14.1%) were adult, nonflowering plants, and 12,929 (8.0%) were adult, flowering plants.

The stage-class composition of HENIT plants tallied during the 1998-2002 monitoring was different from that observed during the 2003 and 2004 monitoring. Seedlings comprised only 14% of the HENIT tallied in 1998, 0.4% of those tallied in 1999, 0.4% of those tallied in 2000, 40.3% of those tallied in 2001, and 12.5% of those tallied in 2002 (Willoughby 2004b). Of these years only 2001 was even remotely close to 2003 and 2004 in having seedlings comprise a rather large percentage of the total number of plants.

Differences in HENIT density and abundance between 2003 and 2004. Densities were essentially the same between 2003 and 2004 in the Gecko Management Area, but the density of plants in the Wilderness Management Area in 2003 (198.3 plants/ha) was more than twice that of 2004 (92.7 plants/ha; see Figure 9). As most of the plants in both years were seedlings, it is certainly possible that more seedlings germinated and survived to be counted in 2003 than 2004, but if this was the cause of the difference in the Wilderness Management Area one would expect to see the same difference in the Gecko Management Area. It seems more likely that the differences observed in the Wilderness Management Area are the result of sampling error. The 95% confidence interval around the 2003 estimated density is very wide, ranging from a low of 38.0 plants/ha to a high of 358.5 plants/ha, a precision of 81%. So it is possible that the true 2003 mean density in the Wilderness Management Area was lower than the sample mean of 198.3 plants/ha.

The similar densities between 2003 and 2004 in the Gecko Management Area imply that the higher temperatures in 2004 affected HENIT recruitment less than ASMAP recruitment (see discussion above regarding the differences between 2003 and 2004 in the number of ASMAP seedlings observed).

Precision of the estimates. Precisions of the estimates for the density of all plants range from a low of 26% for the Glamis Management Area to a high of 85% for the Buttercup Management Area. Except for the Buttercup Management Area and the Adaptive Management Area, with a precision of 56%, precisions for all of the management areas are 50% or less. The Dunes-wide estimate has a precision of 17%. These precisions are much lower than those for ASMAP, mostly as a result of more even distribution of plants throughout the areas sampled.

OHV effects. Figures 2-9 and 2-10 in Appendix 2 display the density and population size, respectively, of plants with signs of damage from OHVs at the time of the survey. Actual numbers are included in Table 2-1. Dunes-wide, an estimated 1,083 plants showed OHV impacts, representing 0.1% of the total estimated plants.

The density of OHV impacted plants was highest in the Glamis Management Area (0.435 plants/ha), but this is not surprising because that management area also had the highest density of all plants. The management area with the next highest density of OHV damaged plants was Ogilby (0.118 plants/ha). The other management areas had lower densities of OHV damaged plants (the Wilderness had a density of 0.000 plants/ha). The overall estimated density of 0.106 OHV damaged plants/ha is very low compared to the Dunes-wide plant density of 92.7 plants/ha.

When viewed from the perspective of percent of total plants impacted by OHVs, the following are the estimated percentages for each of the management areas: Mammoth Wash (0.07%), Wilderness (0.00%), Gecko (0.02%), Glamis (0.26%), AMA (0.01%), Ogilby (0.19%), and Buttercup (0.55%).

Other damage. Figures 2-11 and 2-12 in Appendix 2 display the density and population size, respectively, of plants damaged by sources other than OHVs, principally insects. An estimated 2,653 plants in the Dunes as a whole showed evidence of non-OHV damage, constituting about 0.1% of the total estimated number of plants. As Figure 2-11 shows, the density of damaged plants was relatively low throughout all of the management areas, ranging from a low of 0.03 plants/ha in the Buttercup Management Area to a high of 0.21 plants/ha in the Gecko Management Area. The Wilderness (0.16 plants/ha), Gecko (0.21 plants/ha), and Glamis (0.18 plants/ha) management areas had slightly higher densities of non-OHV damaged plants than the other management areas.

When viewed from the perspective of percent of total plants impacted by agents other than OHVs, the following are the estimated percentages for each of the management areas: Mammoth Wash (0.13%), Wilderness (0.22%), Gecko (0.20%), Glamis (0.10%), AMA (0.06%), Ogilby (0.18%), and Buttercup (0.31%).

Pholisma sonorae

Figures 11 and 12 show the estimates of density (number of inflorescences/hectare) and total population size, respectively, of PHSO in each of the management areas and the contribution of the two stage classes (live inflorescences and dead inflorescences) to the totals.

Dot graphs and 95% confidence intervals showing estimates of PHSO density (inflorescences/ha) and total population size are given in Appendix 3, Figures 3-1 to 3-6, for each of the stage classes for which data were collected and for the total number of plants. For each of these categories there is a pair of graphs, the first one showing estimates of density (number of inflorescences/hectare) and the second one showing estimates of total population size. Density estimates are shown for each management area and the Dunes as a whole. Population estimates are shown for each management area.

Figures 13 and 14 are stacked bar graphs comparing the density and total population size estimates, respectively, from the 2004 values for the Wilderness and Gecko management areas to the values obtained for these two management areas from 2003 pilot sampling (only the Wilderness and Gecko management areas were sampled in 2003).

The actual density and population estimates are given in Appendix 3, Table 3-1. Map 5 shows the distribution and abundance of PHSO in all of the 25m x 25m cells sampled in 2004.

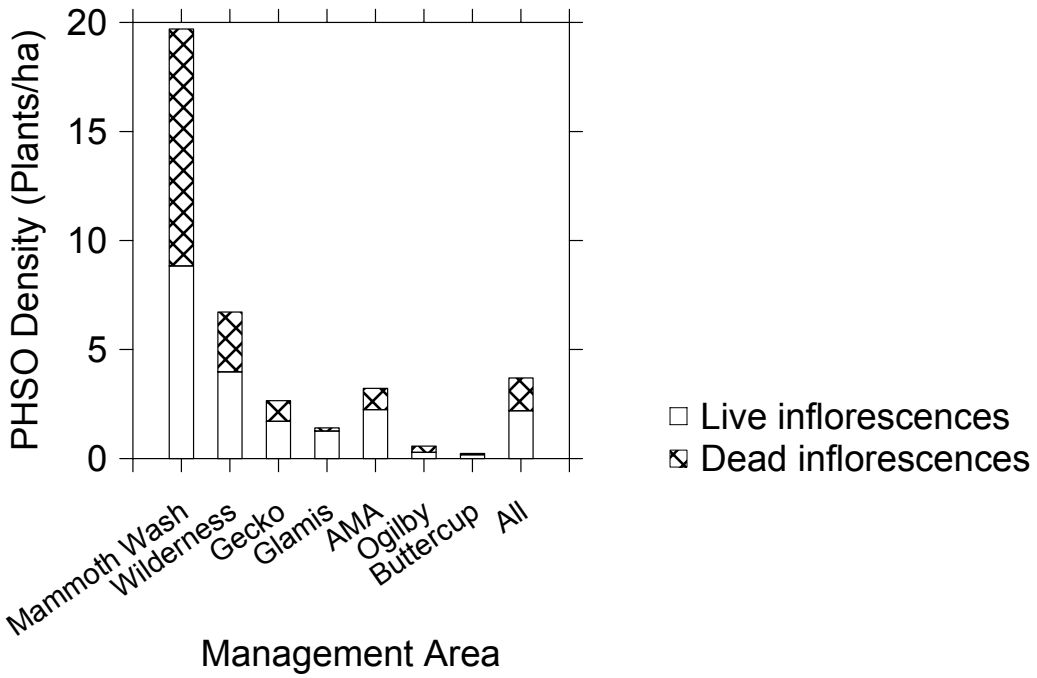

Figure 11. PHSO density (plants/ha) for each of the management areas and the Dunes as a whole ("all") in spring 2004.

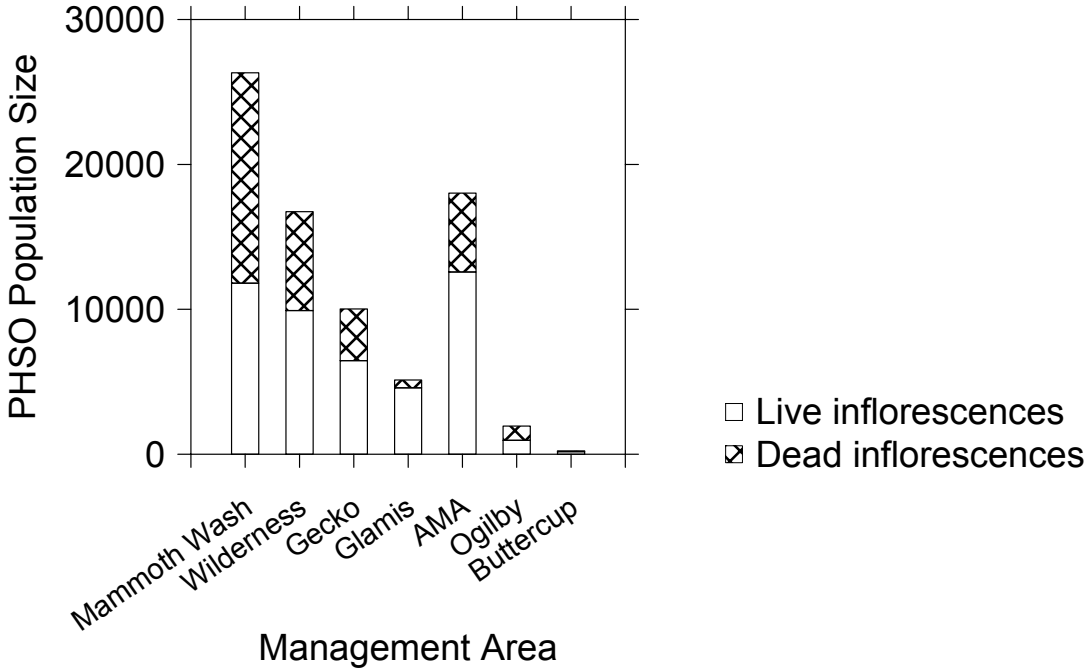

Figure 12. PHSO population size for each of the management areas in spring 2004.

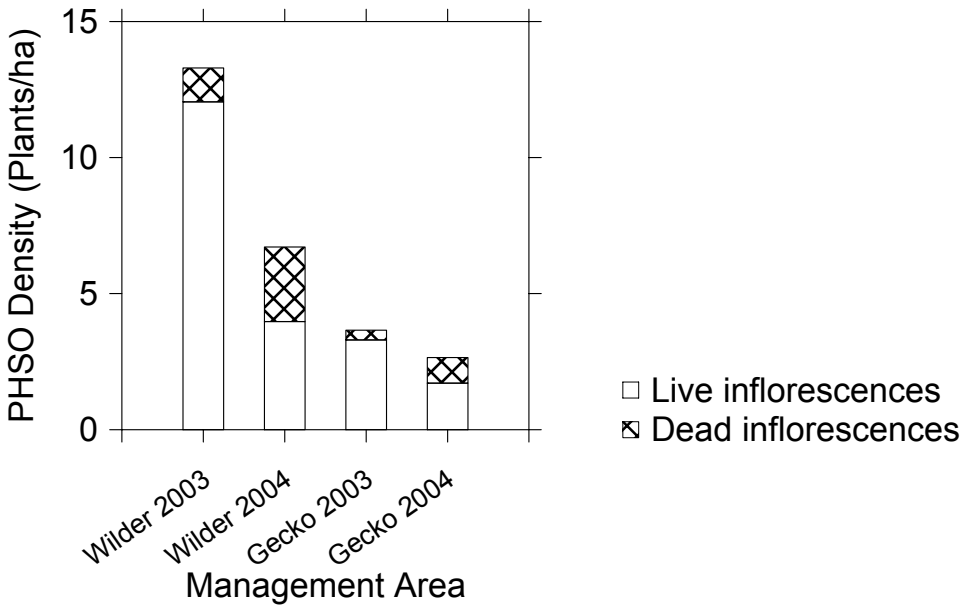

Figure 13. Comparison of PHSO density (inflorescences/ha) between 2003 and 2004 for the Wilderness and Gecko Management Areas.

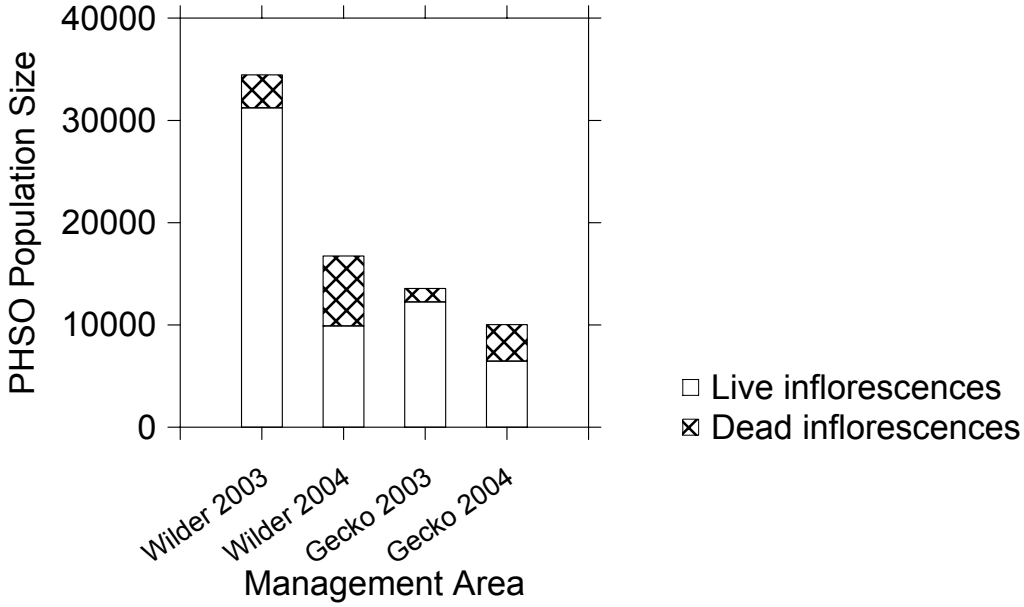

Figure 14. Comparison of PHSO population size (number of inflorescences) between 2003 and 2004 for the Wilderness and Gecko Management Areas.

Distribution and abundance. There were an estimated 46,470 PHSO inflorescences throughout the seven management areas of the Dunes in 2004. This translates into an estimated density of 3.7 inflorescences/hectare. As Figure 9 shows, there appears to be a north-south density gradient for this species, with the number of inflorescences high in the northern part of the Dunes and low in the southern part of the Dunes. There is a bit of a blip in this pattern in that the Adaptive Management Area had more inflorescences than the Gecko and Glamis management areas to the north. The density gradient for PHSO is somewhat similar to the cover gradient of *Eriogonum deserticola*, the shrub that functions as one of its host plants. As Figure 16 shows, *Eriogonum deserticola* had higher cover in the Mammoth Wash and Wilderness management areas than in the management areas to the south. There is a similar blip in the cover of *Eriogonum deserticola* in the Adaptive Management Area, where its cover was higher there than in the other management areas south of Highway 78.

It is clear that—at least in 2004—the Mammoth Wash Management Area was more favorable to PHSO than anywhere else in the areas of the Dunes that were sampled. The Wilderness Management Area also appears to be favorable for PHSO, based both on 2004 and 2003 monitoring (see discussion below). Dunes tend to be rather low in Mammoth Wash and the northern part of the Wilderness management areas compared to the management areas to the south, and there is greater cover of the host plant *Eriogonum deserticola* This may explain why PHSO is more abundant there. Another host plant, *Tiquilia plicata*, is much smaller than *Eriogonum deserticola*. Because of this size difference, *Tiquilia* cover was insufficient to be adequately measured by the methodology employed in this survey and no inferences can be made between the PHSO density gradient observed and the distribution of *Tiquilia*. As explained in the Methods section, PHSO occurs outside of the ASMAP habitat that is the focus of this monitoring study and may in fact be more numerous in areas that are not being sampled as part of this study.

Map 5 further emphasizes the non-uniform nature of PHSO distribution in the area sampled in this monitoring study. The species is well distributed only in the Mammoth Wash and Wilderness management areas. Elsewhere it only occurs sporadically. This pattern is very similar to that observed in the 1998-2002 monitoring (Willoughby 2000, 2001, and 2004b). It seems clear that for whatever reason, PHSO is more common in the northern part of the Dunes.

Differences in PHSO density and abundance between 2003 and 2004. There was a small difference in the estimated number of inflorescences between 2003 and 2004 in the Gecko Management Area, with more plants observed in 2003 than in 2004. There was a much larger difference between these years in the Wilderness Management Area (Figure 14). This difference may be the result of differences in the timing of monitoring between 2003 and 2004. In 2003, transects in the Wilderness Management Area were monitored between April 10 and May 30, while in 2004 transects in this management area were monitored between March 27 and April 20. It is quite possible that PHSO inflorescences emerged after the 2004 transects were read and that the number of inflorescences would have been more comparable to 2003 had the 2004 monitoring been conducted later. The monitoring in the Gecko Management Area was also earlier in 2004 than it was in 2004, but if the PHSO habitat in the Gecko Management Area is not as good as the Wilderness Management Area, which appears to be the case based on previous monitoring and the distribution shown on Map 5, the difference in density resulting from the

timing issue would not be as great. If later monitoring in 2004 would have resulted in higher estimates of PHSO in the Wilderness Management Area, such monitoring would probably also have resulted in even higher estimates in the Mammoth Wash Management Area.

Precision of the estimates. Precision for estimates of the density of all inflorescences ranged from a low of 32% for the Wilderness Management Area to a high of 105% for the Buttercup Management Area. Poor precisions are a logical outcome of the sporadic distribution of the species in the management areas south of Highway 78 (Map 5). However, even in the Mammoth Wash Management Area, which had a fairly even distribution of plants in 2004, the precision was only 53%, resulting from a relatively large difference in transect values there: two of the 2004 transects had values of 1,435 and 1,301 inflorescences compared to other much lower values (two of the transects had values of only 23 and 26 inflorescences).

Psammophytic Shrub Vegetation

Figures 15-19 graph shrub cover estimates by management area and the dunes as a whole. These estimates apply only to the areas actually sampled in each of the management areas and are representative primarily of psammophytic (sand-loving) shrub vegetation. Inclusions of other vegetation types do exist within the areas sampled. The most important of these is creosote bush scrub; estimates of *Larrea tridentata* (creosote bush) are given to highlight this fact.

Figure 15 graphs total shrub cover. Figures 16-18 show cover of the three most dominant plants of the psammophytic shrub, *Eriogonum deserticola* (desert buckwheat), *Croton wigginisii* (Wiggins' croton), and *Ephedra trifurca* (longleaf jointfir). Figure 19 shows the cover of creosote bush.

Figures 20 and 21 compare the 2003 estimated cover values in the Gecko and Wilderness management areas to those estimated from the 2004 monitoring.

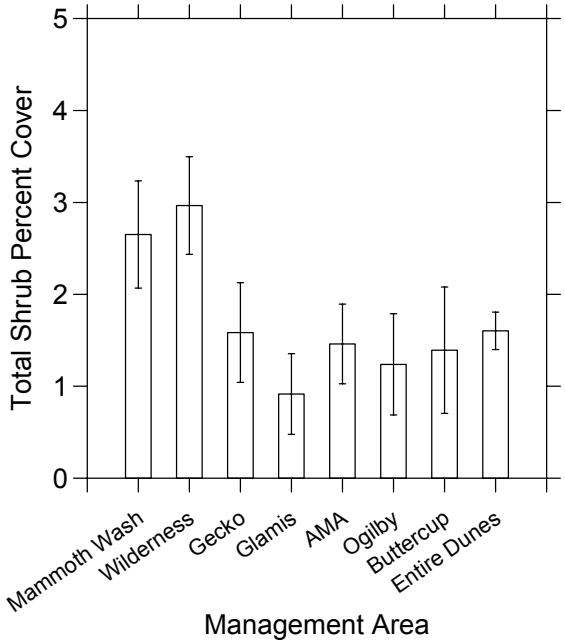

Figure 15. Total shrub cover in each of the management areas and in the dunes as a whole. Error bars are 95% confidence intervals.

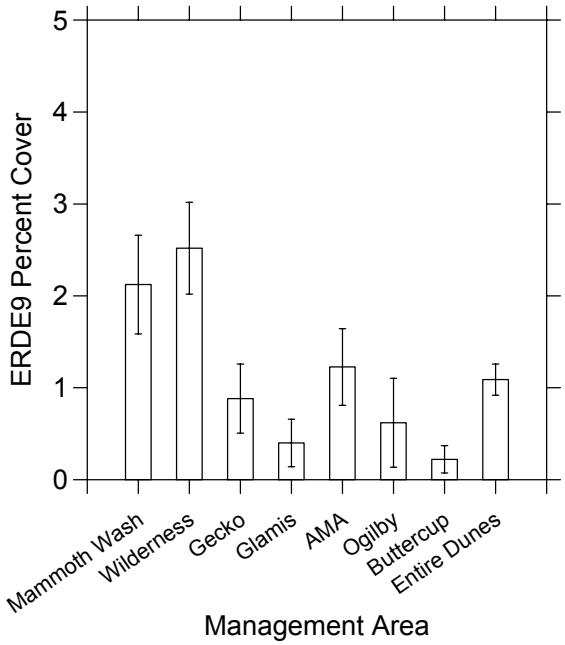

Figure 16. Estimated cover of *Eriogonum deserticola* (desert buckwheat) in the psammophytic shrub vegetation of the Algodones Dunes. Error bars are 95% confidence intervals.

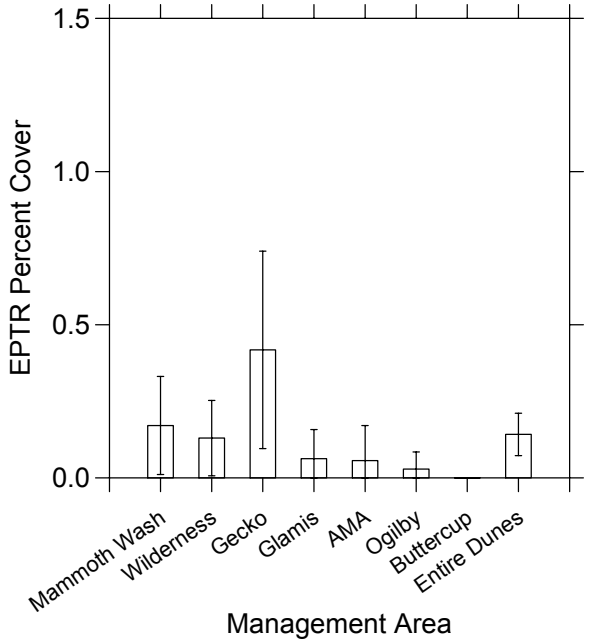

Figure 17. Estimated cover of *Ephedra trifurca* (longleaf jointfir) in the psammophytic shrub vegetation of the Algodones Dunes. Error bars are 95% confidence intervals.

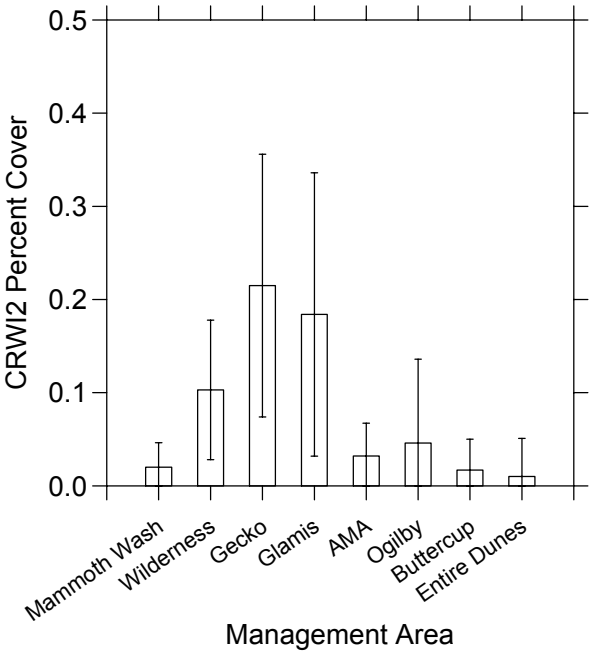

Figure 18. Estimated cover of *Croton wigginsii* (Wiggins' croton) in the psammophytic shrub vegetation of the Algodones Dunes. Error bars are 95% confidence intervals.

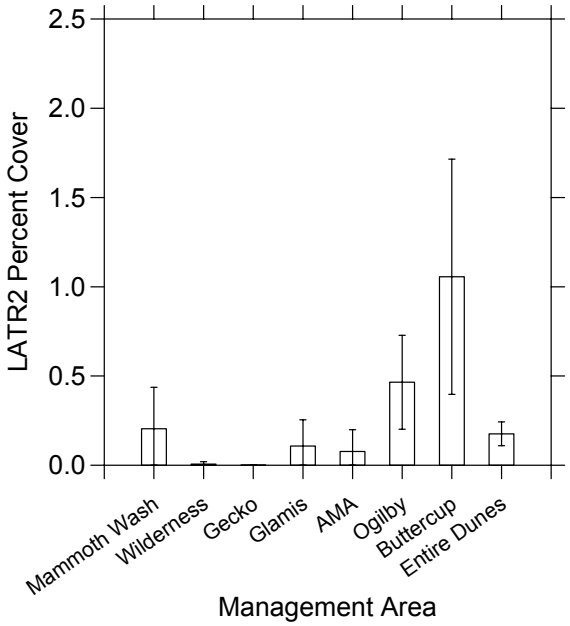

Figure 19. Estimated cover of *Larrea tridentata* (creosote bush) in the areas sampled in the Algodones Dunes. Error bars are 95% confidence intervals.

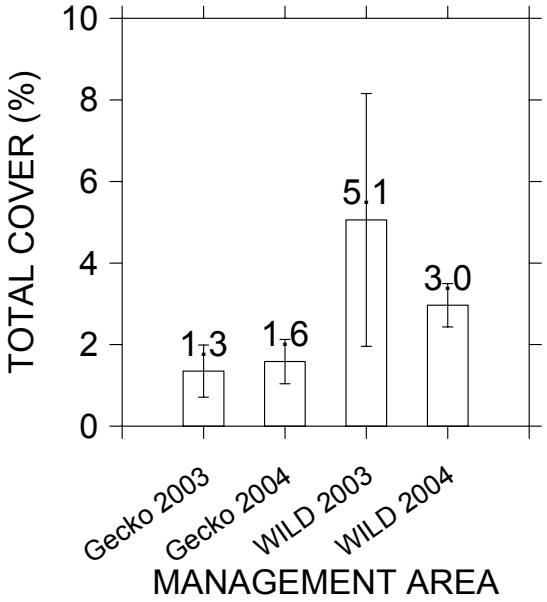

Figure 20. Comparison of estimates of total psammophytic shrub cover from 2003 and 2004 monitoring in the Gecko and Wilderness Management Areas. Actual cover estimates are shown at the top of each bar. Error bars are 95% confidence intervals.

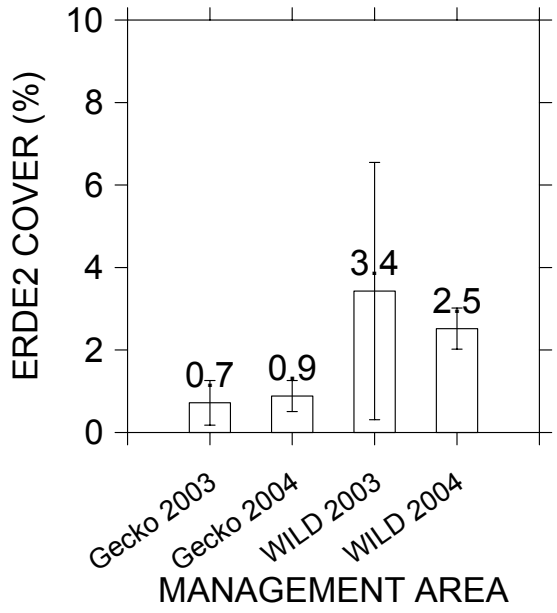

Figure 21. Comparison of estimates of *Eriogonum deserticola* cover from 2003 and 2004 monitoring in the Gecko and Wilderness Management Areas. Actual cover estimates are shown at the top of each bar. Error bars are 95% confidence intervals.

As Figure 15 shows, total estimated shrub cover was higher in the Mammoth Wash (2.7%) and Wilderness (3.0%) management areas than in the other management areas of the Dunes, none of which had a shrub cover greater than 1.6%. As mentioned previously, the dunes are lower in the Mammoth Wash and Wilderness management areas than in the management areas to the south. Consequently there are fewer unvegetated dune areas and a higher overall shrub cover. Total shrub cover estimates for the other management areas are similar to one another, with Glamis having the lowest cover (0.9%). Though the total shrub cover estimate for the Buttercup Management Area is similar to the other management areas south of Highway 78, much of its shrub cover comes from *Larrea tridentata* (Figure 19), a plant not considered part of the psammophytic shrub community.

The three psammophytic shrubs with the highest estimated cover values in 2004 were *Eriogonum deserticola* (desert buckwheat, Figure 16), *Ephedra trifurca* (longleaf jointfir, Figure 17), and *Croton wigginsii* (Wiggins' croton, Figure 18), with Dunes-wide cover of 1.09%, 0.14%, and 0.01% cover, respectively. Note how much lower the cover for the last two of these species is compared to *Eriogonum deserticola*.

As Figure 20 illustrates, the estimated total cover values for the Gecko Management Area are similar between 2003 and 2004, but the cover values for the Wilderness Management Area are considerably different between those two years (estimated cover in 2003 was 5.1% compared to 3.0% in 2004). Given the very wide 95% confidence interval in 2003 (Figure 20), it is likely that this difference is attributable to sampling error and that the true cover is closer to the 2004

estimate of 3.0%. The same is true for the cover of *Eriogonum deserticola* (Figure 21): its true cover in the Wilderness Management Area is likely closer to the 2004 estimate of 2.5%.

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Appendix 1 – Estimates of ASMAP density and total population size.

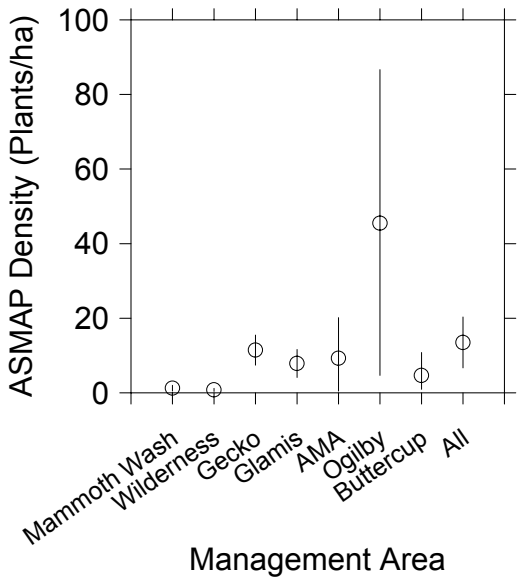


Figure 1-1. Density (plants/ha) of all ASMAP plants in spring 2004 for each of the management areas and the Dunes as a whole ("All"). Error bars are 95% confidence intervals.

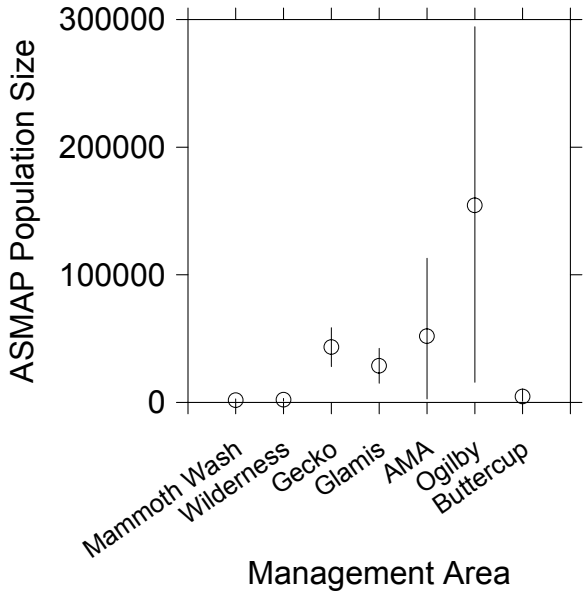


Figure 1-2. Population size of all ASMAP plants in spring 2004 for each of the management areas. Error bars are 95% confidence intervals.

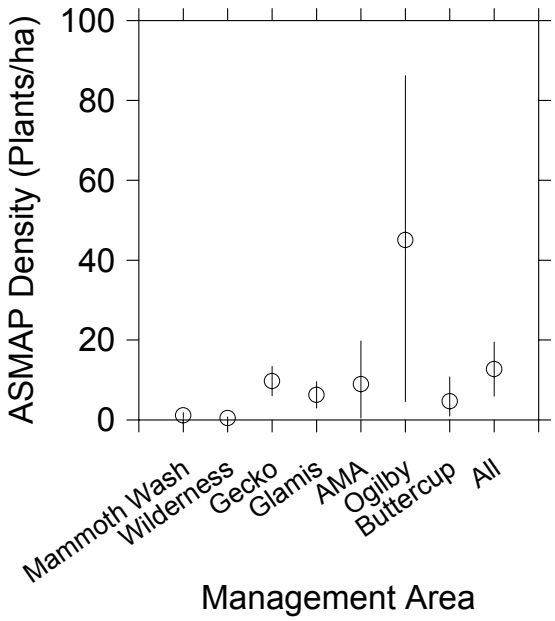


Figure 1-3. Density (plants/ha) of seedlings and young, nonflowering ASMAP plants in spring 2004 for each of the management areas and the Dunes as a whole ("All"). Error bars are 95% confidence intervals.

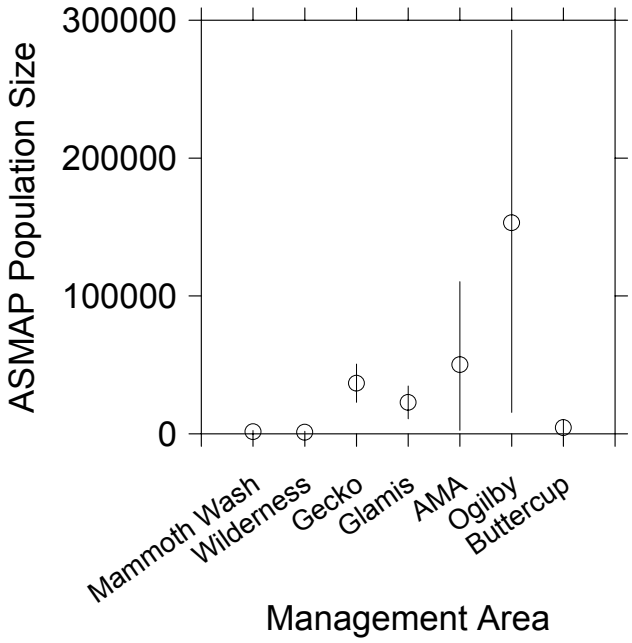


Figure 1-4. Population size of seedling and young, nonflowering ASMAP plants in spring 2004 for each of the management areas. Error bars are 95% confidence intervals.

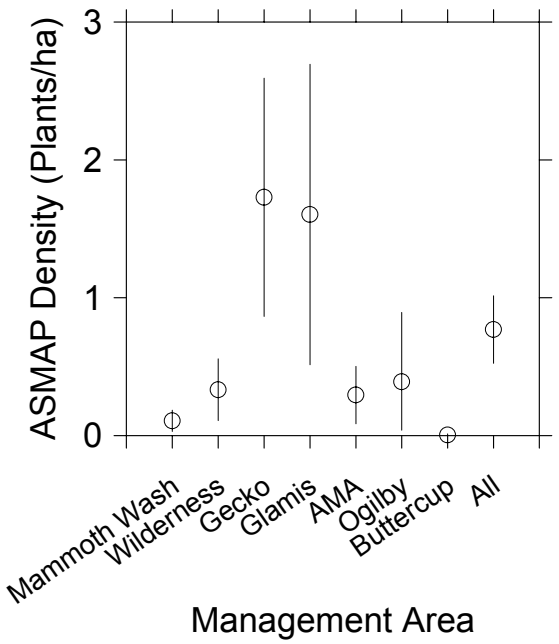


Figure 1-5. Density (plants/ha) of flowering ASMAP plants in spring 2004 for each of the management areas and the Dunes as a whole ("All"). Error bars are 95% confidence intervals.

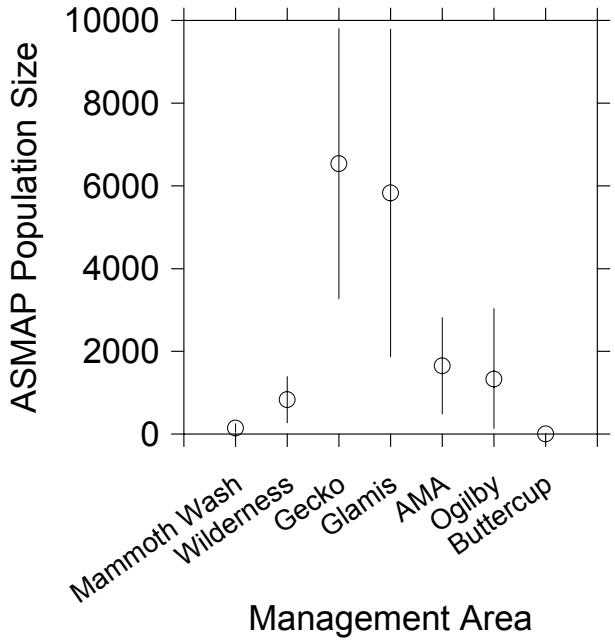


Figure 1-6. Population size of flowering ASMAP plants in spring 2004 for each of the management areas. Error bars are 95% confidence intervals.

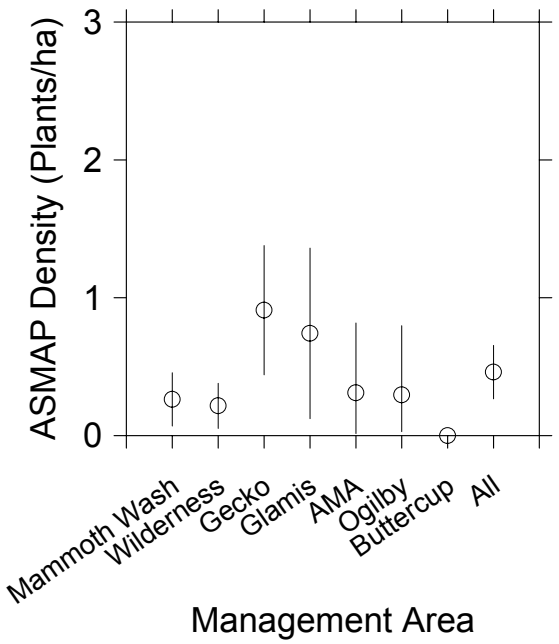


Figure 1-7. Density (plants/ha) of > 1 year-old ASMAP plants in spring 2004 for each of the management areas and the Dunes as a whole ("All"). Error bars are 95% confidence intervals.

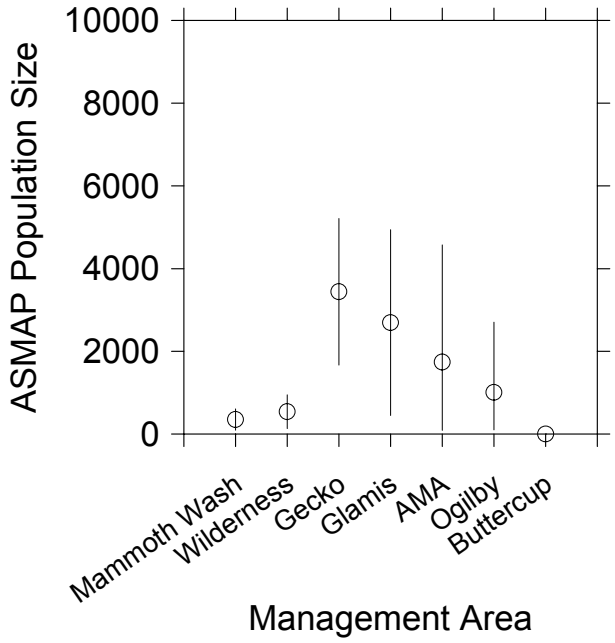


Figure 1-8. Population size of > 1 year-old ASMAP plants in spring 2004 for each of the management areas. Error bars are 95% confidence intervals.

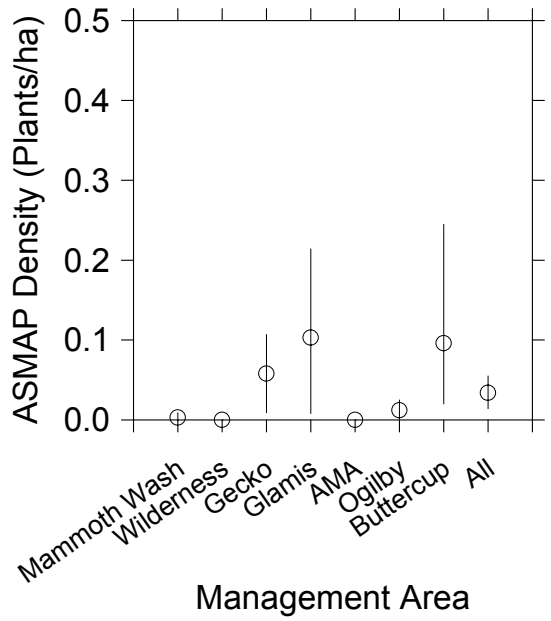


Figure 1-9. Density (plants/ha) of ASMAP plants showing OHV damage in spring 2004 for each of the management areas and the Dunes as a whole ("All"). Error bars are 95% confidence intervals.

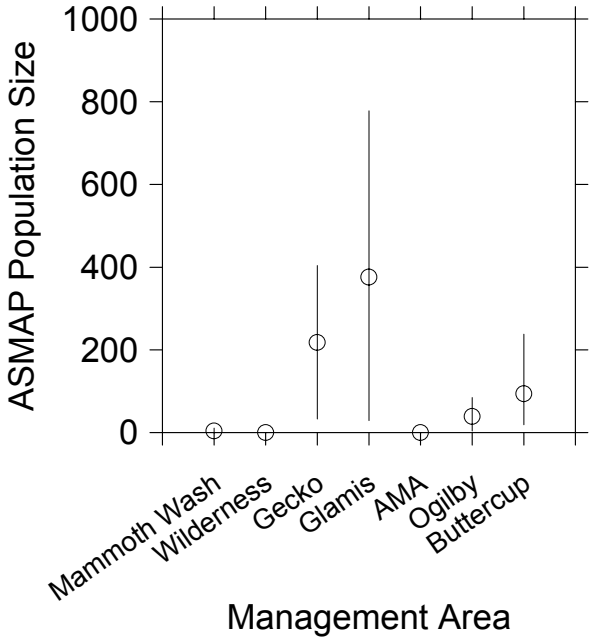


Figure 1-10. Population size of ASMAP plants showing OHV damage in spring 2004 for each of the management areas. Error bars are 95% confidence intervals.

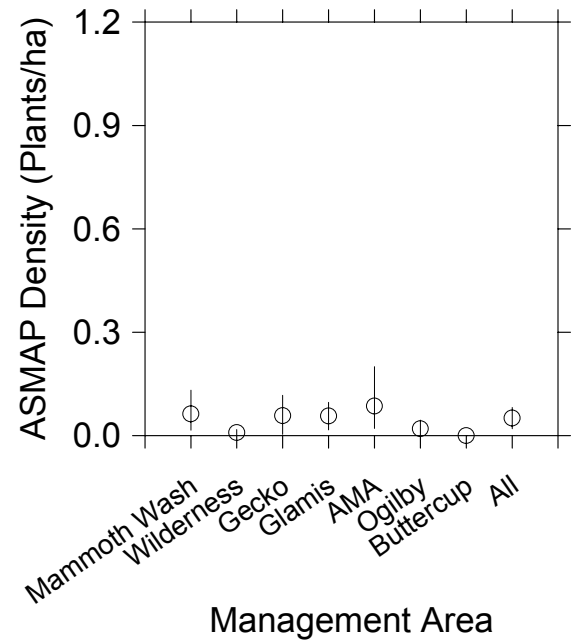


Figure 1-11. Density (plants/ha) of ASMAP plants showing non-OHV damage in spring 2004 for each of the management areas and the Dunes as a whole ("All"). Error bars are 95% confidence intervals.

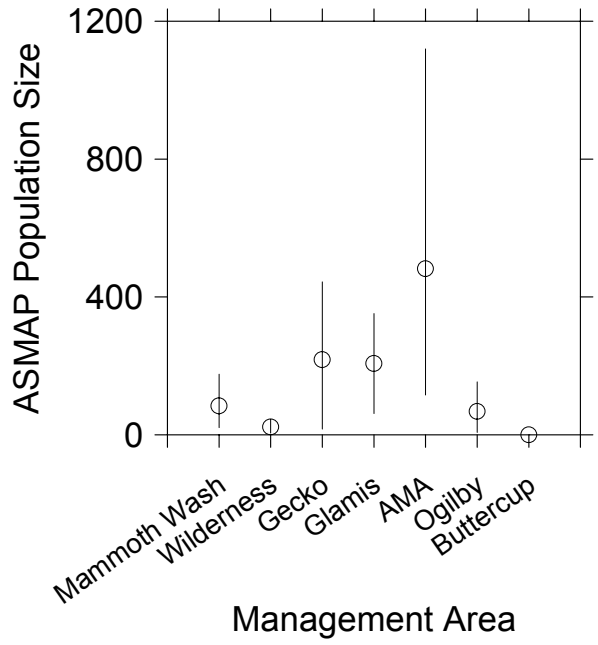


Figure 1-12. Population size of ASMAP plants showing non-OHV damage in spring 2004 for each of the management areas. Error bars are 95% confidence intervals.

Table 1-1. Spring 2004 population and density estimates for ASMAP in the 7 management areas of the Algodones Dunes and the entire dunes. Data from survey module of Stata release 8.2.

Mammoth Wash

Category	Density Estimate (plants/ha)	95% Confidence Limits		Population Estimate	95% Confidence Limits		Precision (+/- percent of mean)
		Lower	Upper		Lower	Upper	
Nonflowering seedlings and juveniles	1.129	0.406	1.852	1,509	542	2,475	64.07%
Flowering and past flowering	0.108	0.031	0.185	144	42	247	71.18%
Total number of plants	1.237	0.476	1.998	1,653	636	2,670	61.55%
Plants > 1 year old	0.263	0.071	0.456	352	95	610	73.11%
Plants with OHV damage	0.003	0.001	0.009	4	1	11	185.76%
Plants with other damage	0.063	0.016	0.132	84	21	176	109.72%

Wilderness

Category	Density Estimate (plants/ha)	95% Confidence Limits		Population Estimate	95% Confidence Limits		Precision (+/- percent of mean)
		Lower	Upper		Lower	Upper	
Nonflowering seedlings and juveniles	0.478	0.193	0.764	1,193	481	1,905	59.71%
Flowering and past flowering	0.333	0.109	0.557	831	273	1,389	67.17%
Total number of plants	0.812	0.400	1.223	2,024	998	3,049	50.69%
Plants > 1 year old	0.217	0.053	0.380	540	132	948	75.54%
Plants with OHV damage	0.000	0.000	0.000	0	0	0	0.00%
Plants with other damage	0.009	0.002	0.018	23	5	45	90.97%

Gecko

Category	Density Estimate (plants/ha)	95% Confidence Limits		Population Estimate	95% Confidence Limits		Precision (+/- percent of mean)
		Lower	Upper		Lower	Upper	
Nonflowering seedlings and juveniles	9.718	6.057	13.380	36,738	22,897	50,580	37.68%
Flowering and past flowering	1.729	0.865	2.593	6,536	3,271	9,802	49.96%
Total number of plants	11.447	7.427	15.468	43,275	28,076	58,473	35.12%
Plants > 1 year old	0.910	0.442	1.379	3,441	1,669	5,213	51.49%
Plants with OHV damage	0.058	0.009	0.107	218	33	404	85.06%
Plants with other damage	0.058	0.004	0.117	218	17	444	103.48%

Table 1-1. Spring 2004 population and density estimates for ASMAP in the 7 management areas of the Algodones Dunes and the entire dunes. Data from survey module of Stata release 8.2.

Glamis

Category	Density Estimate (plants/ha)	95% Confidence Limits		Population Estimate	95% Confidence Limits		Precision (+/- percent of mean)
		Lower	Upper		Lower	Upper	
Nonflowering seedlings and juveniles	6.275	2.996	9.554	22,797	10,885	34,710	52.25%
Flowering and past flowering	1.604	0.515	2.694	5,829	1,871	9,787	67.89%
Total number of plants	7.879	4.116	11.643	28,627	14,953	42,301	47.77%
Plants > 1 year old	0.742	0.123	1.360	2,694	448	4,940	83.36%
Plants with OHV damage	0.103	0.008	0.214	376	29	778	106.98%
Plants with other damage	0.057	0.017	0.097	207	62	352	70.03%

Adaptive Management Area

Category	Density Estimate (plants/ha)	95% Confidence Limits		Population Estimate	95% Confidence Limits		Precision (+/- percent of mean)
		Lower	Upper		Lower	Upper	
Nonflowering seedlings and juveniles	8.971	0.462	19.734	50,191	2,585	110,408	119.97%
Flowering and past flowering	0.295	0.086	0.503	1,650	484	2,815	70.68%
Total number of plants	9.266	0.478	20.185	51,841	2,672	112,929	117.84%
Plants > 1 year old	0.311	0.016	0.817	1,741	90	4,573	162.66%
Plants with OHV damage	0.000	0.000	0.000	0	0	0	N/A
Plants with other damage	0.086	0.021	0.200	482	116	1,120	132.43%

Ogilby

Category	Density Estimate (plants/ha)	95% Confidence Limits		Population Estimate	95% Confidence Limits		Precision (+/- percent of mean)
		Lower	Upper		Lower	Upper	
Nonflowering seedlings and juveniles	45.069	4.612	86.200	153,097	15,667	292,821	91.26%
Flowering and past flowering	0.391	0.040	0.894	1,329	136	3,036	128.41%
Total number of plants	45.460	4.652	86.668	154,426	15,803	294,409	90.65%
Plants > 1 year old	0.296	0.030	0.797	1,007	103	2,706	168.88%
Plants with OHV damage	0.012	0.001	0.025	39	4	85	116.25%
Plants with other damage	0.020	0.002	0.045	68	7	154	125.63%

Table 1-1. Spring 2004 population and density estimates for ASMAP in the 7 management areas of the Algodones Dunes and the entire dunes. Data from survey module of Stata release 8.2.

Buttercup

Category	Density Estimate (plants/ha)	95% Confidence Limits		Population Estimate	95% Confidence Limits		Precision (+/- percent of mean)
		Lower	Upper		Lower	Upper	
Nonflowering seedlings and juveniles	4.650	0.944	10.795	4,524	918	10,502	132.15%
Flowering and past flowering	0.005	0.001	0.014	5	1	14	182.33%
Total number of plants	4.655	0.945	10.801	4,529	919	10,507	132.01%
Plants > 1 year old	0.000	0.000	0.000	0	0	0	N/A
Plants with OHV damage	0.096	0.020	0.245	94	19	238	154.32%
Plants with other damage	0.000	0.000	0.000	0	0	0	N/A

Entire Dunes

Category	Density Estimate (plants/ha)	95% Confidence Limits		Population Estimate	95% Confidence Limits		Precision (+/- percent of mean)
		Lower	Upper		Lower	Upper	
Nonflowering seedlings and juveniles	12.734	5.954	19.513	270,050	126,274	413,825	53.24%
Flowering and past flowering	0.770	0.525	1.015	16,324	11,130	21,518	31.82%
Total number of plants	13.503	6.686	20.321	286,374	141,800	430,947	50.48%
Plants > 1 year old	0.461	0.267	0.655	9,775	5,668	13,882	42.02%
Plants with OHV damage	0.034	0.014	0.055	731	292	1,169	60.02%
Plants with other damage	0.051	0.020	0.082	1,083	426	1740	60.67%

Appendix 2 – Estimates of HENIT density and total population size.

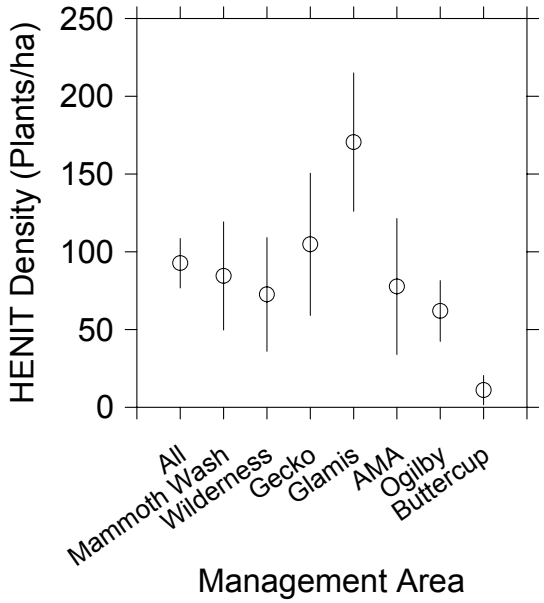


Figure 2-1. Density (plants/ha) of all HENIT plants in spring 2004 for each of the management areas and the Dunes as a whole ("All"). Error bars are 95% confidence intervals.

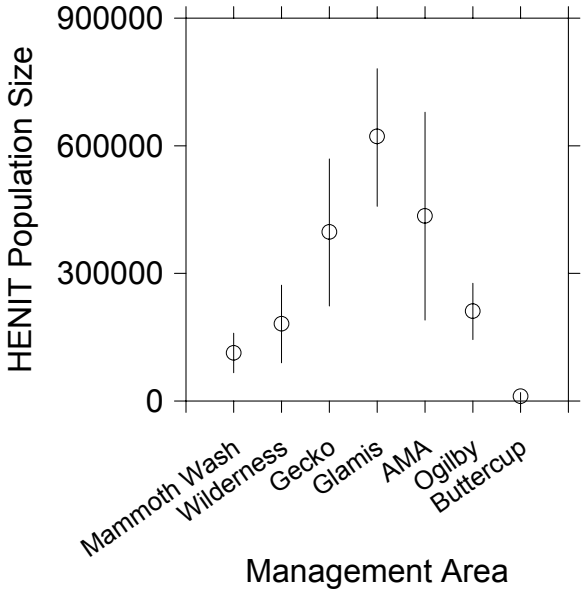


Figure 2-2. Population size of all HENIT plants in spring 2004 for each of the management areas. Error bars are 95% confidence intervals.

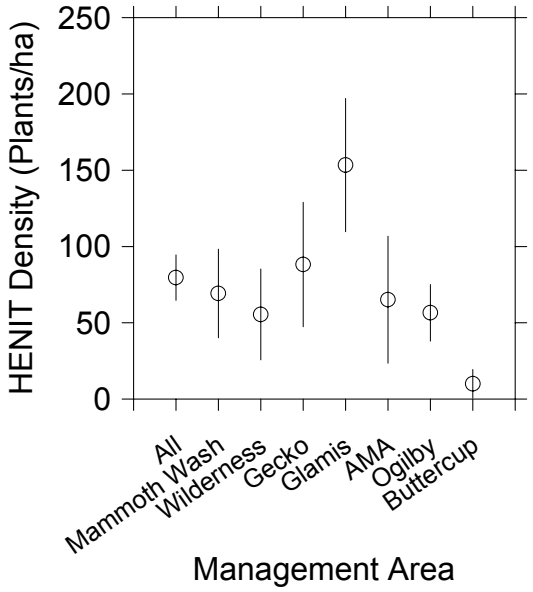


Figure 2-3. Density (plants/ha) of HENIT seedlings in spring 2004 for each of the management areas and the Dunes as a whole ("All"). Error bars are 95% confidence intervals.

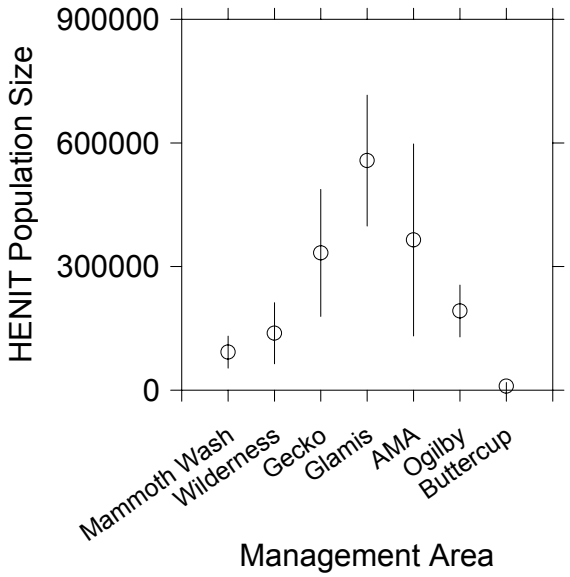


Figure 2-4. Population size of HENIT seedlings in spring 2004 for each of the management areas. Error bars are 95% confidence intervals.

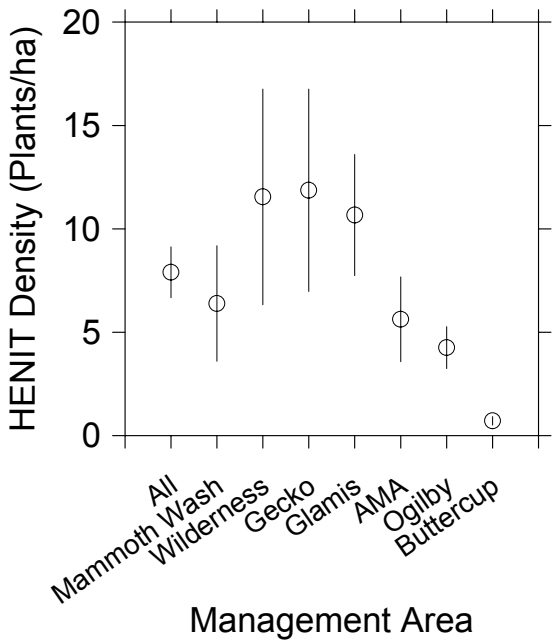


Figure 2-5. Density (plants/ha) of adult nonflowering HENIT plants in spring 2004 for each of the management areas and the Dunes as a whole ("All"). Error bars are 95% confidence intervals.

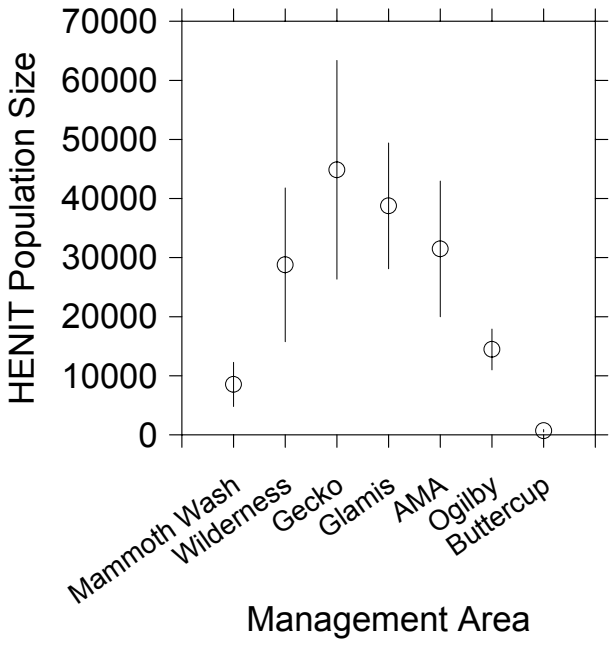


Figure 2-6. Population size of adult nonflowering HENIT plants in spring 2004 for each of the management areas. Error bars are 95% confidence intervals.

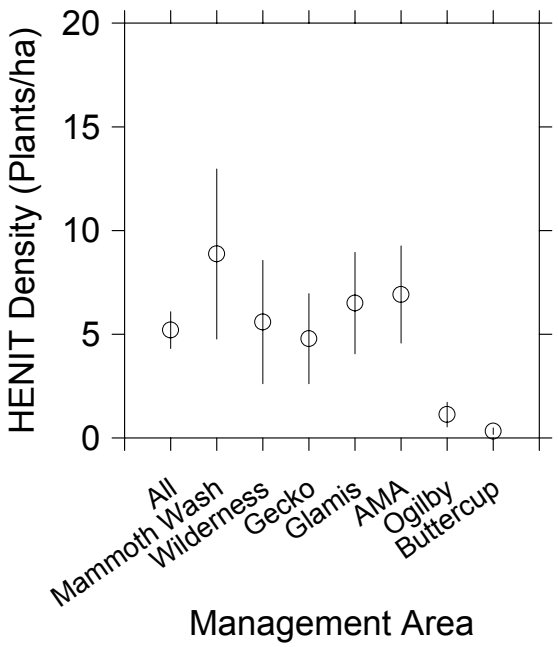


Figure 2-7. Density (plants/ha) of flowering HENIT plants in spring 2004 for each of the management areas and the Dunes as a whole ("All"). Error bars are 95% confidence intervals.

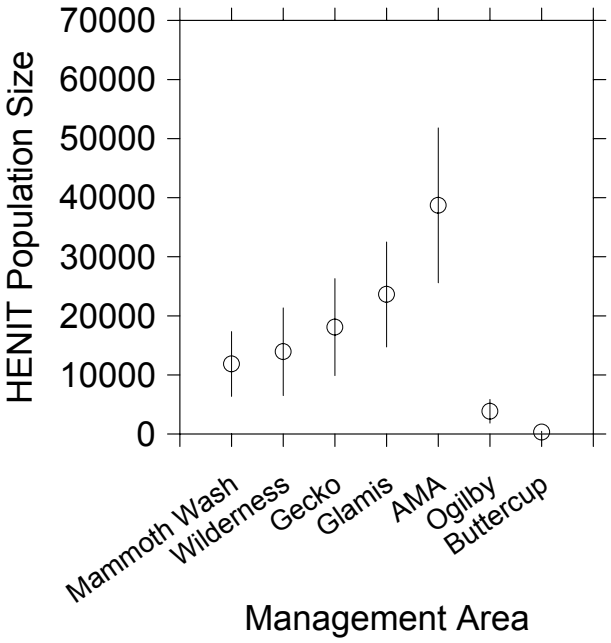


Figure 2-8. Population size of flowering HENIT plants in spring 2004 for each of the management areas. Error bars are 95% confidence intervals.

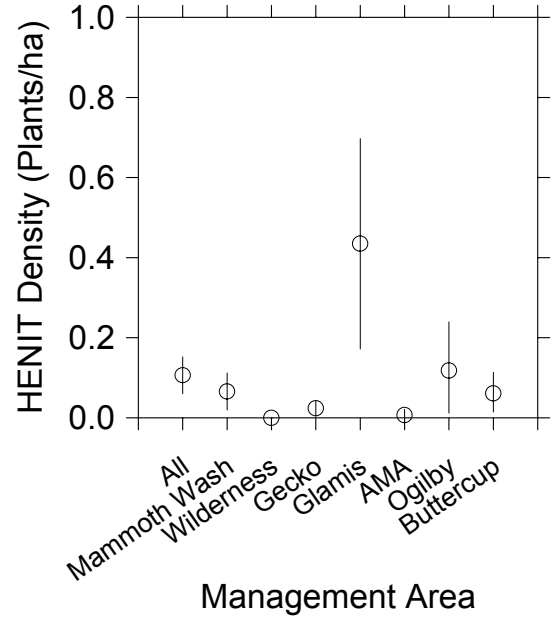


Figure 2-9. Density (plants/ha) of HENIT plants showing OHV damage in spring 2004 for each of the management areas and the Dunes as a whole ("All"). Error bars are 95% confidence intervals.

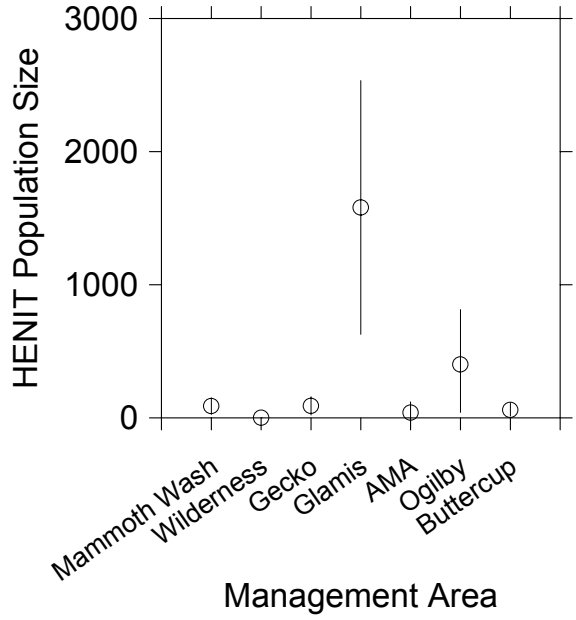


Figure 2-10. Population size of HENIT plants showing OHV damage in spring 2004 for each of the management areas. Error bars are 95% confidence intervals.

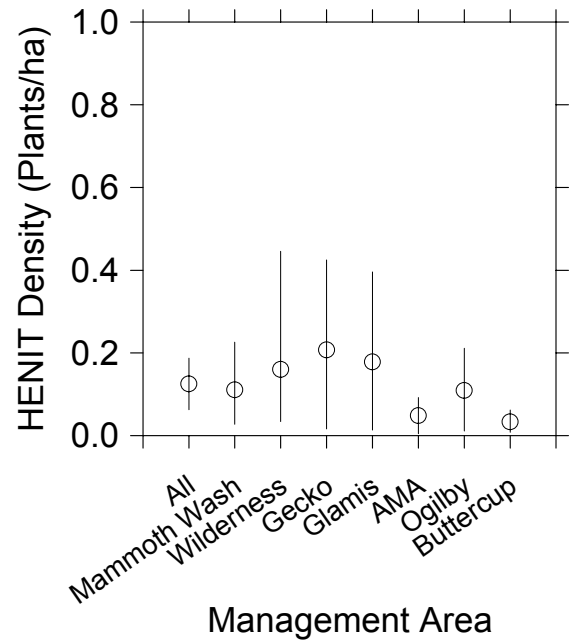


Figure 2-11. Density (plants/ha) of HENIT plants showing non-OHV damage in spring 2004 for each of the management areas and the Dunes as a whole ("All"). Error bars are 95% confidence intervals.

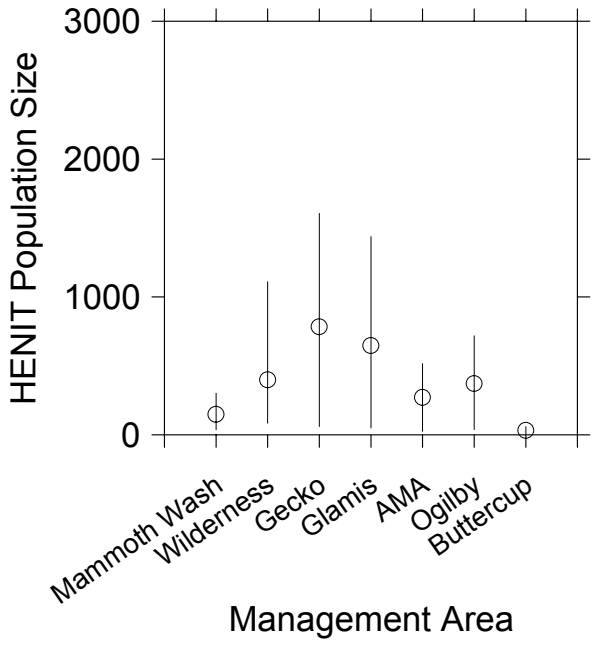


Figure 2-12. Population size of HENIT plants showing non-OHV damage in spring 2004 for each of the management areas. Error bars are 95% confidence intervals.

Table 2-1. Spring 2004 population and density estimates for HENIT in the 7 management areas of the Algodones Dunes and the entire dunes. Data from survey module of Stata release 8.2.

Mammoth Wash

Category	Density Estimate (plants/ha)	95% Confidence Limits		Population Estimate	95% Confidence Limits		Precision (+/- percent of mean)
		Lower	Upper		Lower	Upper	
Seedlings	69.182	40.134	98.230	92,457	53,637	131,278	41.99%
Flowering adults	8.872	4.773	12.971	11,857	6,378	17,335	46.20%
Nonflowering adults	6.390	3.597	9.182	8,539	4,808	12,271	43.70%
Total number of plants	84.443	49.700	119.187	113,090	66,421	159,286	41.14%
Plants with OHV damage	0.066	0.020	0.112	88	27	149	69.77%
Plants with other damage	0.111	0.028	0.226	148	37	302	104.16%

Wilderness

Category	Density Estimate (plants/ha)	95% Confidence Limits		Population Estimate	95% Confidence Limits		Precision (+/- percent of mean)
		Lower	Upper		Lower	Upper	
Seedlings	55.457	25.692	85.222	138,249	64,048	212,450	53.67%
Flowering adults	5.592	2.615	8.568	13,940	6,520	21,360	53.23%
Nonflowering adults	11.545	6.328	16.763	28,781	15,774	41,788	45.19%
Total number of plants	72.594	35.986	109.202	181,369	89,710	272,230	50.43%
Plants with OHV damage	0.000	0.000	0.000	0	0	0	N/A
Plants with other damage	0.160	0.034	0.446	399	85	1,111	178.33%

Gecko

Category	Density Estimate (plants/ha)	95% Confidence Limits		Population Estimate	95% Confidence Limits		Precision (+/- percent of mean)
		Lower	Upper		Lower	Upper	
Seedlings	88.151	47.353	128.949	333,237	179,010	487,464	46.28%
Flowering adults	4.786	2.614	6.958	18,094	9,883	26,304	45.38%
Nonflowering adults	11.866	6.971	16.762	44,858	26,352	63,364	41.25%
Total number of plants	104.804	59.039	150.568	397,062	223,185	569,193	43.67%
Plants with OHV damage	0.024	0.005	0.042	90	21	159	76.93%
Plants with other damage	0.207	0.016	0.425	783	61	1,606	105.00%

Table 2-1. Spring 2004 population and density estimates for HENIT in the 7 management areas of the Algodones Dunes and the entire dunes. Data from survey module of Stata release 8.2.

Glamis

Category	Density Estimate (plants/ha)	95% Confidence Limits		Population Estimate	95% Confidence Limits		Precision (+/- percent of mean)
		Lower	Upper		Lower	Upper	
Seedlings	153.371	109.709	197.032	557,220	398,590	715,850	28.47%
Flowering adults	6.503	4.056	8.951	23,628	14,737	32,519	37.63%
Nonflowering adults	10.667	7.738	13.596	38,757	28,115	49,398	27.46%
Total number of plants	170.488	125.969	215.007	621,832	457,666	781,156	26.11%
Plants with OHV damage	0.435	0.172	0.697	1,580	627	2,533	60.33%
Plants with other damage	0.178	0.014	0.396	647	50	1,438	122.06%

Adaptive Management Area

Category	Density Estimate (plants/ha)	95% Confidence Limits		Population Estimate	95% Confidence Limits		Precision (+/- percent of mean)
		Lower	Upper		Lower	Upper	
Seedlings	65.140	23.487	106.792	364,441	131,406	597,477	63.94%
Flowering adults	6.917	4.575	9.259	38,698	25,596	51,800	33.86%
Nonflowering adults	5.625	3.574	7.676	31,470	19,995	42,946	36.46%
Total number of plants	77.682	33.998	121.365	434,920	190,212	679,008	56.23%
Plants with OHV damage	0.007	0.000	0.021	39	2	120	206.49%
Plants with other damage	0.049	0.005	0.092	271	26	517	90.34%

Ogilby

Category	Density Estimate (plants/ha)	95% Confidence Limits		Population Estimate	95% Confidence Limits		Precision (+/- percent of mean)
		Lower	Upper		Lower	Upper	
Seedlings	56.555	38.014	75.096	192,117	129,133	255,101	32.78%
Flowering adults	1.133	0.540	1.726	3,850	1,836	5,865	52.33%
Nonflowering adults	4.257	3.244	5.271	14,463	11,019	17,906	23.81%
Total number of plants	61.946	42.419	81.473	211,202	144,097	276,762	31.52%
Plants with OHV damage	0.118	0.012	0.239	401	41	813	103.01%
Plants with other damage	0.109	0.011	0.211	371	38	718	93.41%

Table 2-1. Spring 2004 population and density estimates for HENIT in the 7 management areas of the Algodones Dunes and the entire dunes. Data from survey module of Stata release 8.2.

Buttercup

Category	Density Estimate (plants/ha)	95% Confidence Limits		Population Estimate	95% Confidence Limits		Precision (+/- percent of mean)
		Lower	Upper		Lower	Upper	
Seedlings	10.019	0.693	19.345	9,747	674	18,820	93.08%
Flowering adults	0.330	0.175	0.486	321	170	473	47.16%
Nonflowering adults	0.718	0.515	0.921	699	501	896	28.26%
Total number of plants	11.067	1.663	20.472	10,859	1,617	19,917	84.98%
Plants with OHV damage	0.061	0.014	0.114	59	14	111	86.47%
Plants with other damage	0.033	0.008	0.062	33	8	60	84.86%

Entire Dunes

Category	Density Estimate (plants/ha)	95% Confidence Limits		Population Estimate	95% Confidence Limits		Precision (+/- percent of mean)
		Lower	Upper		Lower	Upper	
Seedlings	79.564	64.685	94.443	1,687,343	1,371,799	2,002,887	18.70%
Flowering adults	5.205	4.319	6.092	110,388	91,589	129,187	17.03%
Nonflowering adults	7.901	6.673	9.130	167,567	141,518	193,616	15.55%
Total number of plants	92.667	76.756	108.578	1,970,208	1,627,793	2,302,667	17.17%
Plants with OHV damage	0.106	0.060	0.153	2,257	1,278	3,235	43.36%
Plants with other damage	0.125	0.063	0.187	2,653	1,332	3,974	49.79%

Appendix 3 –PHSO density and total population size.

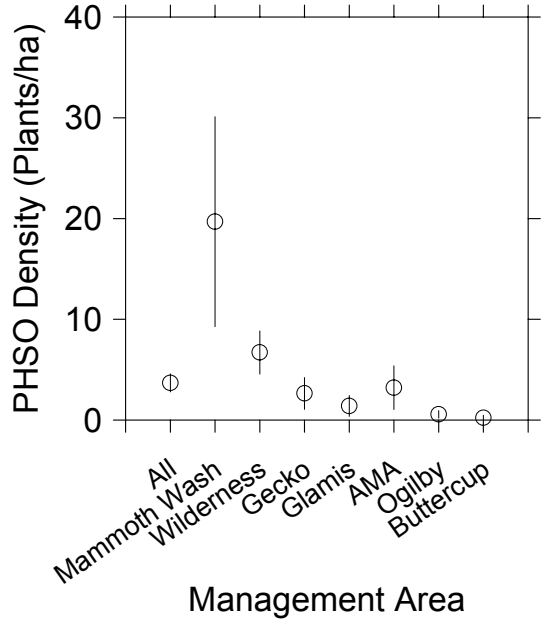


Figure 3-1. Density (inflorescenses/ha) of all PHSO inflorescences in spring 2004 for each of the management areas and the Dunes as a whole ("All"). Error bars are 95% confidence intervals.

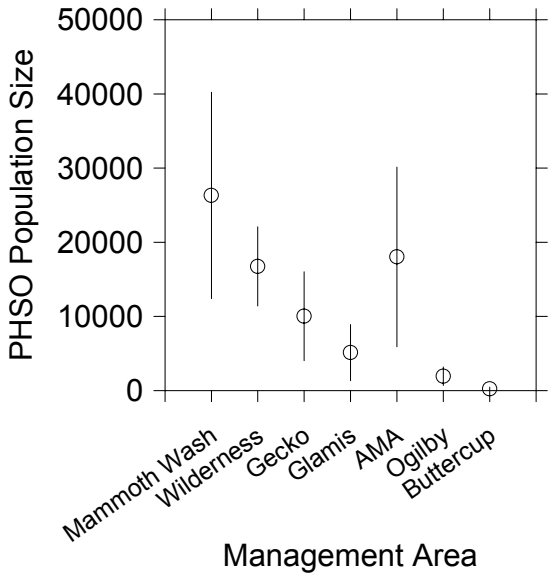


Figure 3-2. Population size of all PHSO inflorescences in spring 2004 for each of the management areas. Error bars are 95% confidence intervals.

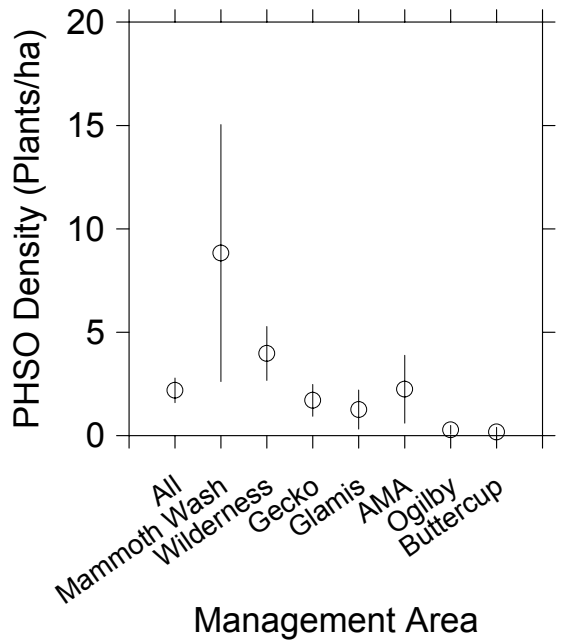


Figure 3-3. Density (inflorescences/ha) of live PHSO inflorescences in spring 2004 for each of the management areas and the Dunes as a whole ("All"). Error bars are 95% confidence intervals.

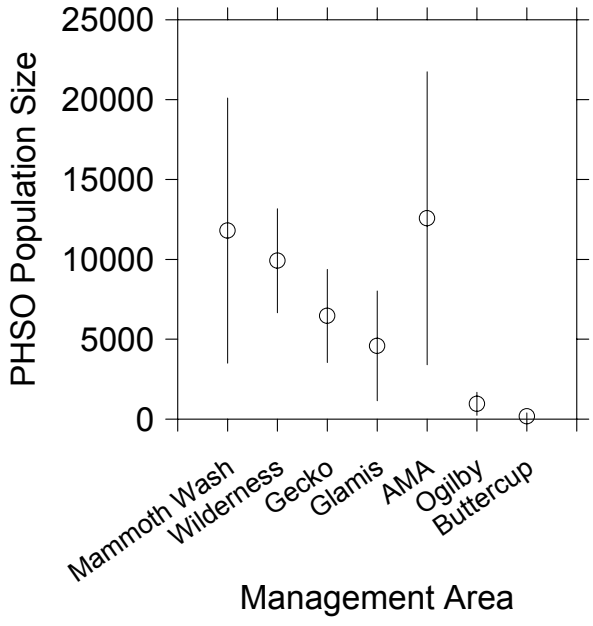


Figure 3-4. Population size of live PHSO inflorescences in spring 2004 for each of the management areas. Error bars are 95% confidence intervals.

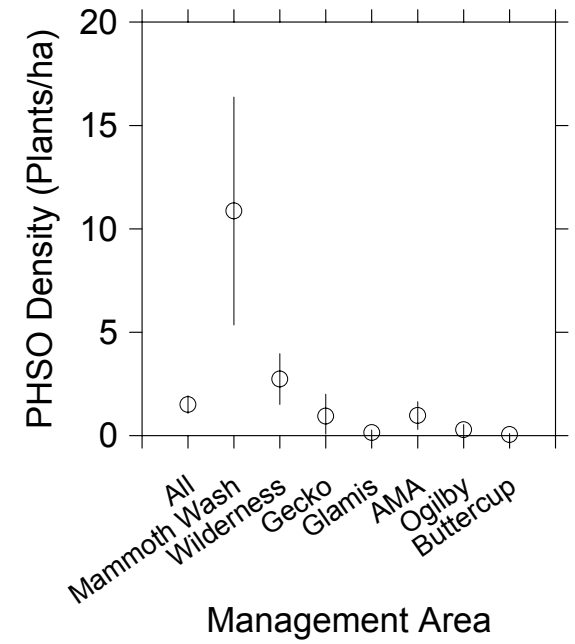


Figure 3-5. Density (inflorescences/ha) of dead PHSO inflorescences in spring 2004 for each of the management areas and the Dunes as a whole ("All"). Error bars are 95% confidence intervals.

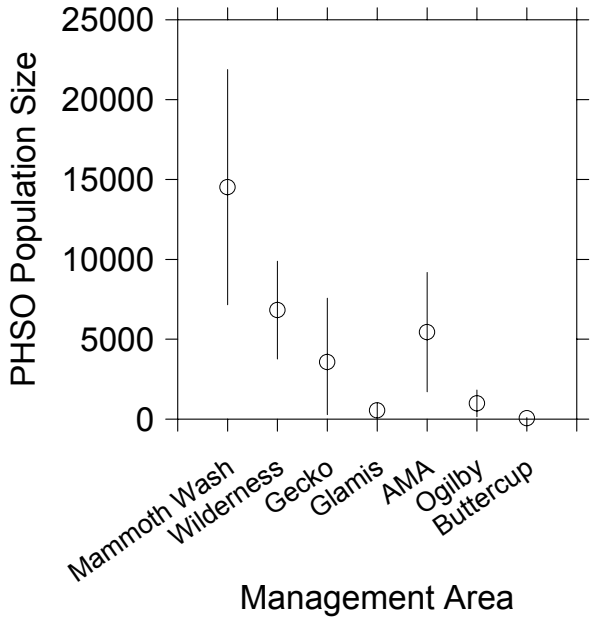


Figure 3-6. Population size of dead PHSO inflorescences in spring 2004 for each of the management areas. Error bars are 95% confidence intervals.

Table 3-1. Spring 2004 population and density estimates for PHSO in the 7 management areas of the Algodones Dunes and the entire dunes. Data from survey module of Stata release 8.2.

Mammoth Wash

Category		95% Confidence Limits		Population Estimate	95% Confidence Limits		Precision (+/- percent of mean)
		Lower	Upper		Lower	Upper	
Live inflorescences	8.830002	2.619	15.041	11,801	3,501	20,101	70.33%
Dead inflorescences	10.86608	5.359	16.373	14,522	7,162	21,882	50.68%
Total inflorescences	19.69609	9.282	30.111	26,323	12,404	40,241	52.88%

Wilderness

Category	Density Estimate (infl/ha)	95% Confidence Limits		Population Estimate	95% Confidence Limits		Precision (+/- percent of mean)
		Lower	Upper		Lower	Upper	
Live inflorescences	3.977749	2.674	5.282	9,916	6,666	13,166	32.78%
Dead inflorescences	2.738469	1.511	3.966	6,827	3,766	9,888	44.84%
Total inflorescences	6.716218	4.575	8.858	16,743	11,405	22,081	31.88%

Gecko

Category	Density Estimate (infl/ha)	95% Confidence Limits		Population Estimate	95% Confidence Limits		Precision (+/- percent of mean)
		Lower	Upper		Lower	Upper	
Live inflorescences	1.70916	0.938	2.480	6,461	3,546	9,377	45.12%
Dead inflorescences	0.9438496	0.074	2.004	3,568	278	7,576	112.34%
Total inflorescences	2.653009	1.067	4.239	10,029	4,034	16,024	59.78%

Glamis

Category	Density Estimate (infl/ha)	95% Confidence Limits		Population Estimate	95% Confidence Limits		Precision (+/- percent of mean)
		Lower	Upper		Lower	Upper	
Live inflorescences	1.261583	0.316	2.207	4,584	1,148	8,019	74.95%
Dead inflorescences	0.1497027	0.022	0.277	544	82	1,006	84.99%
Total inflorescences	1.411286	0.368	2.454	5,127	1,337	8,917	73.92%

Table 3-1. Spring 2004 population and density estimates for PHSO in the 7 management areas of the Algodones Dunes and the entire dunes. Data from survey module of Stata release 8.2.

Adaptive Management Area

Category	Density Estimate (infl/ha)	95% Confidence Limits		Population Estimate	95% Confidence Limits		Precision (+/- percent of mean)
		Lower	Upper		Lower	Upper	
Live inflorescences	2.247726	0.609	3.886	12,575	3,409	21,742	72.89%
Dead inflorescences	0.97342	0.305	1.642	5,446	1,708	9,184	68.64%
Total inflorescences	3.221146	1.057	5.385	18,022	5,914	30,129	67.18%

Ogilby

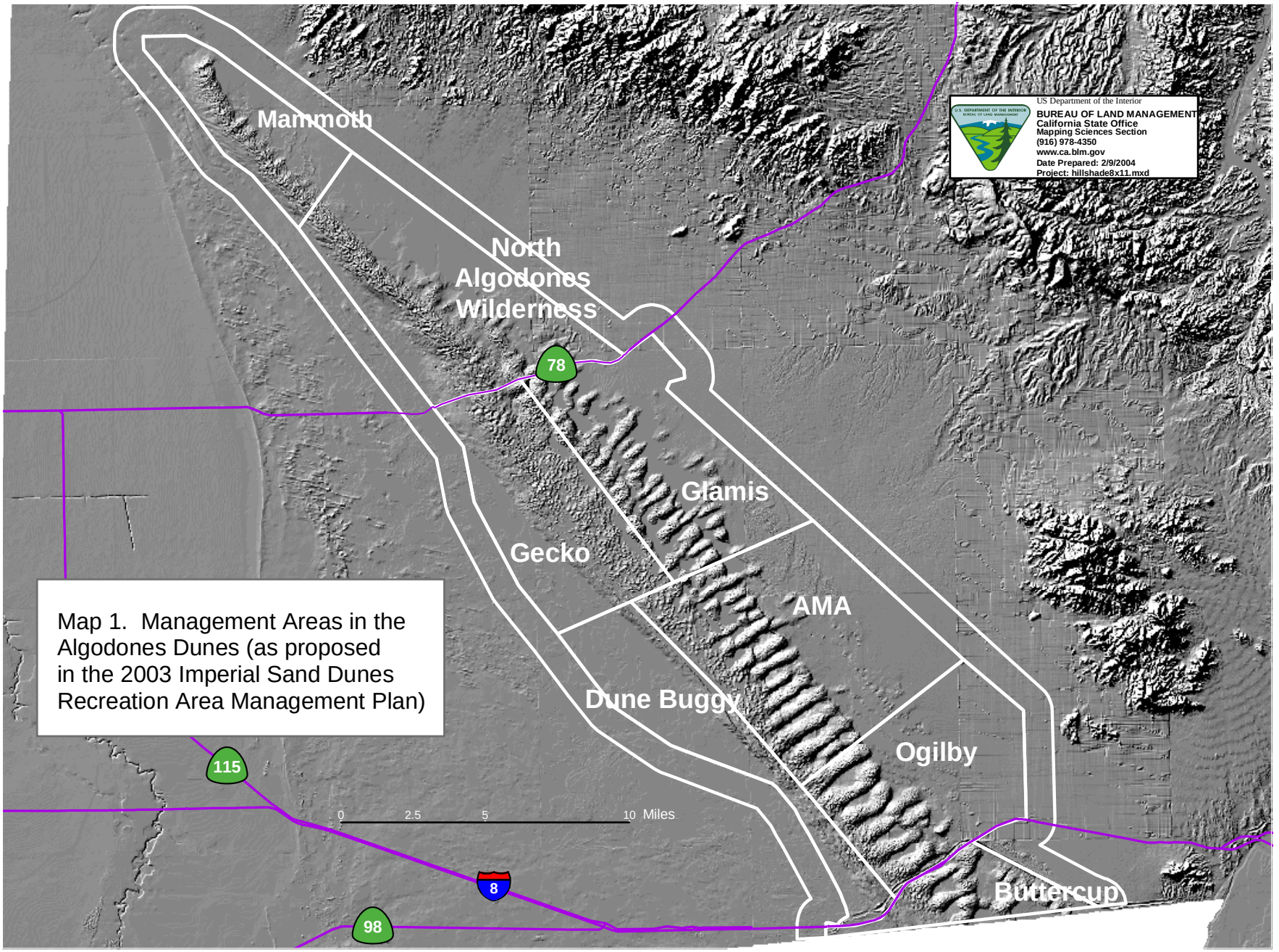
Category	Density Estimate (infl/ha)	95% Confidence Limits		Population Estimate	95% Confidence Limits		Precision (+/- percent of mean)
		Lower	Upper		Lower	Upper	
Live inflorescences	0.281913	0.070	0.494	958	237	1678	75.22%
Dead inflorescences	0.290543	0.045	0.536	987	153	1821	84.47%
Total inflorescences	0.572456	0.205	0.940	1,945	696	3193	64.21%

Buttercup

Category	Density Estimate (infl/ha)	95% Confidence Limits		Population Estimate	95% Confidence Limits		Precision (+/- percent of mean)
		Lower	Upper		Lower	Upper	
Live inflorescences	0.1802224	0.043	0.404	175	42	393	124.14%
Dead inflorescences	0.0551289	0.012	0.104	54	12	101	88.59%
Total inflorescences	0.2353514	0.056	0.482	229	54	469	104.81%

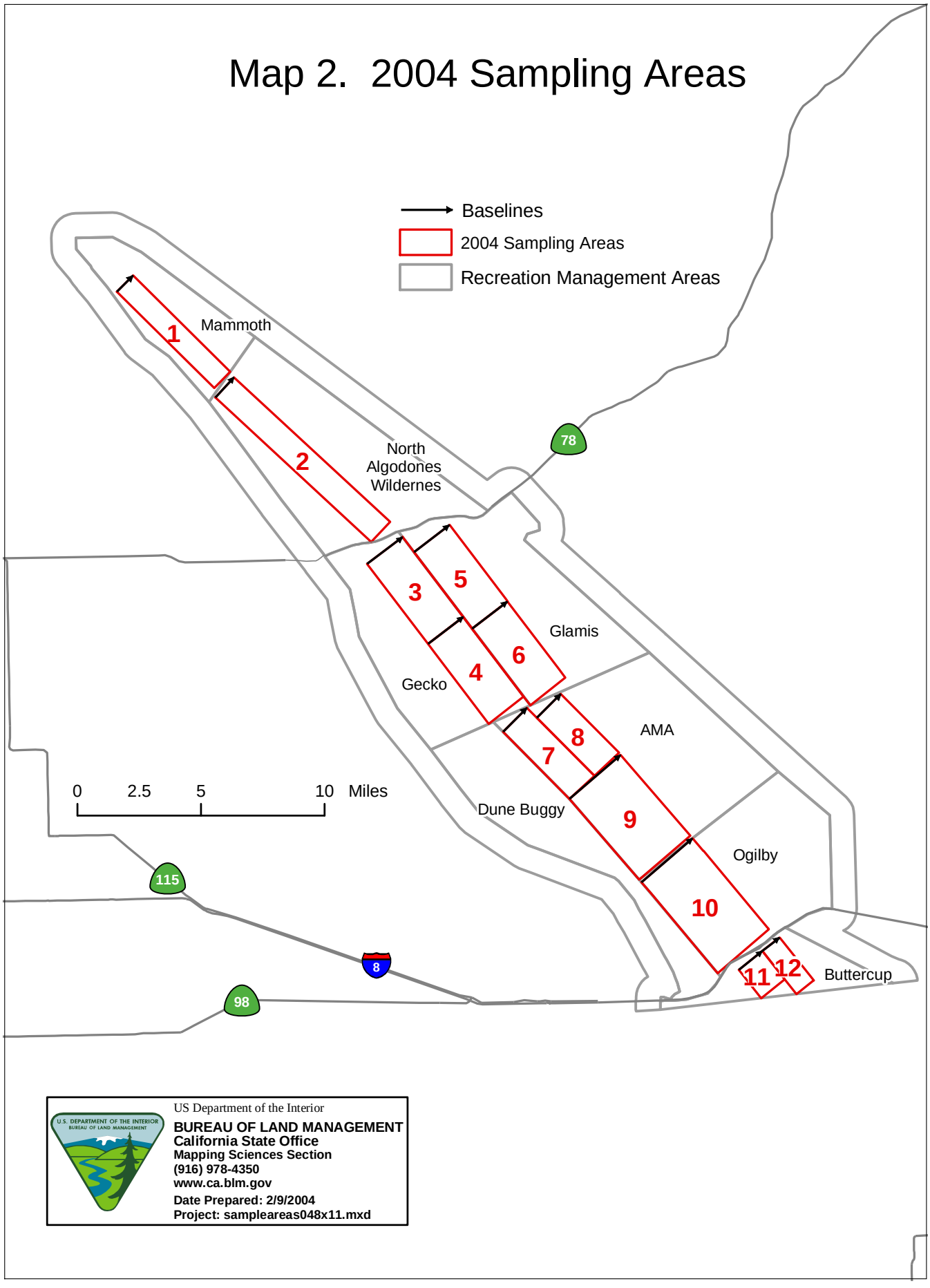
Entire Dunes

Category	Density Estimate (infl/ha)	95% Confidence Limits		Population Estimate	95% Confidence Limits		Precision (+/- percent of mean)
		Lower	Upper		Lower	Upper	
Live inflorescences	2.191219	1.596	2.786	46,470	33,855	59,085	27.15%
Dead inflorescences	1.506417	1.082	1.931	31,947	22,941	40,953	28.19%
Total inflorescences	3.697636	2.800	4.595	78,417	59,381	97,453	24.28%



Map 1. Management Areas in the Algodones Dunes (as proposed in the 2003 Imperial Sand Dunes Recreation Area Management Plan)

Map 2. 2004 Sampling Areas



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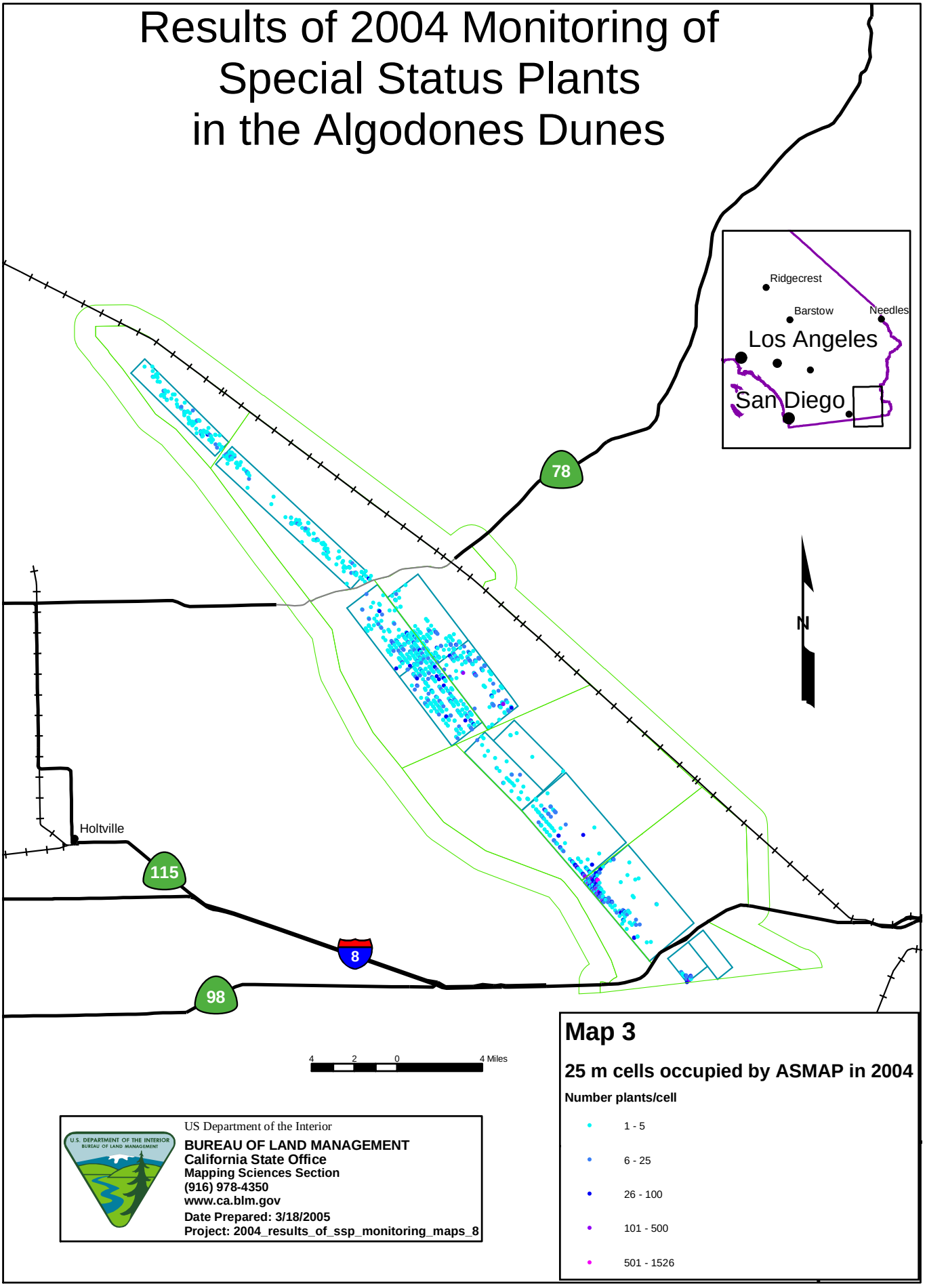
Project: sampleareas048x11.mxd

Results of 2004 Monitoring of Special Status Plants in the Algodones Dunes



Map 3

25 m cells occupied by ASMAP in 2004

Number plants/cell

- 1 - 5
- 6 - 25
- 26 - 100
- 101 - 500
- 501 - 1526

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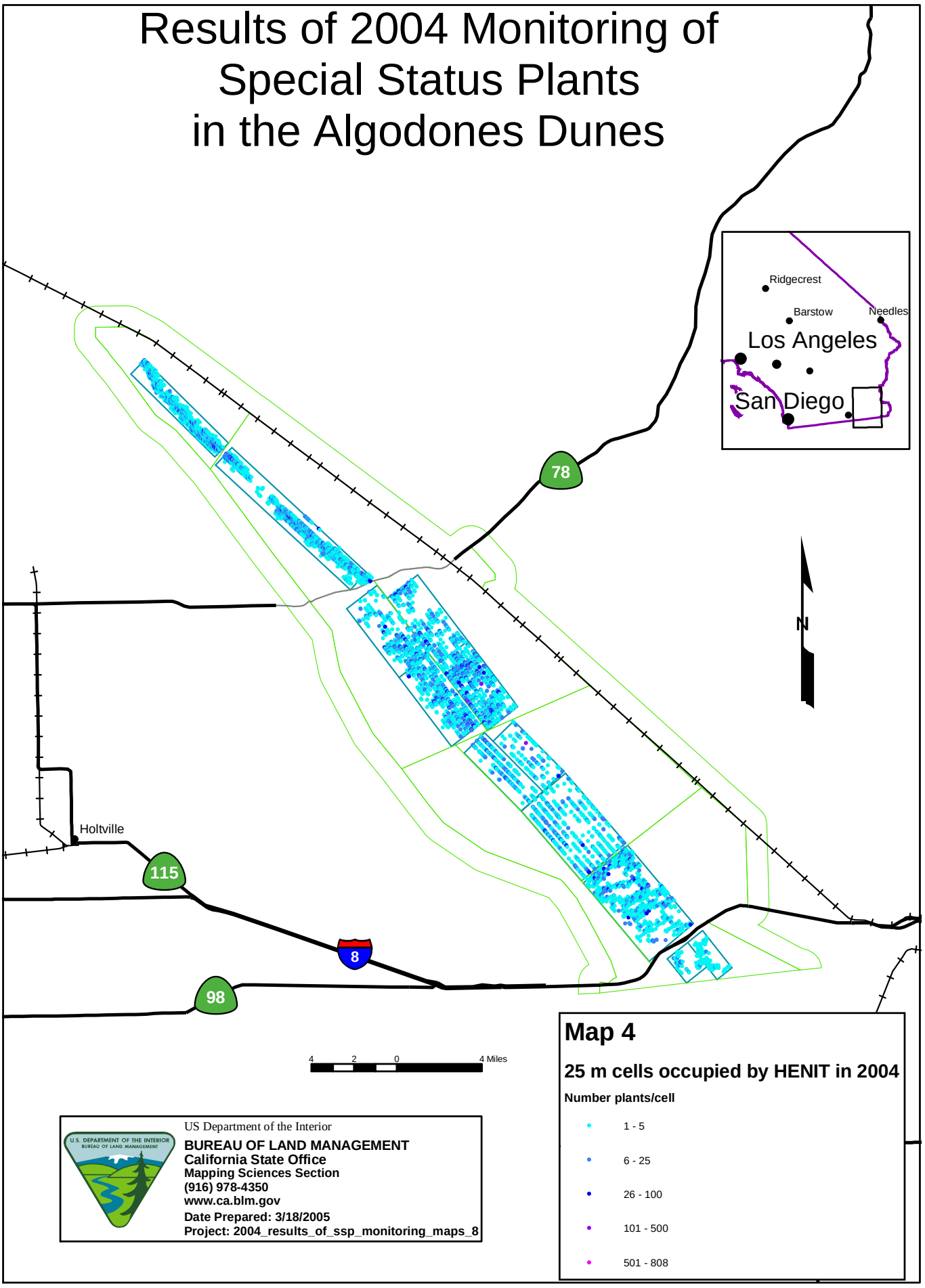

Map 4

25 m cells occupied by HENIT in 2004

Number plants/cell

- 1 - 5
- 6 - 25
- 26 - 100
- 101 - 500
- 501 - 808

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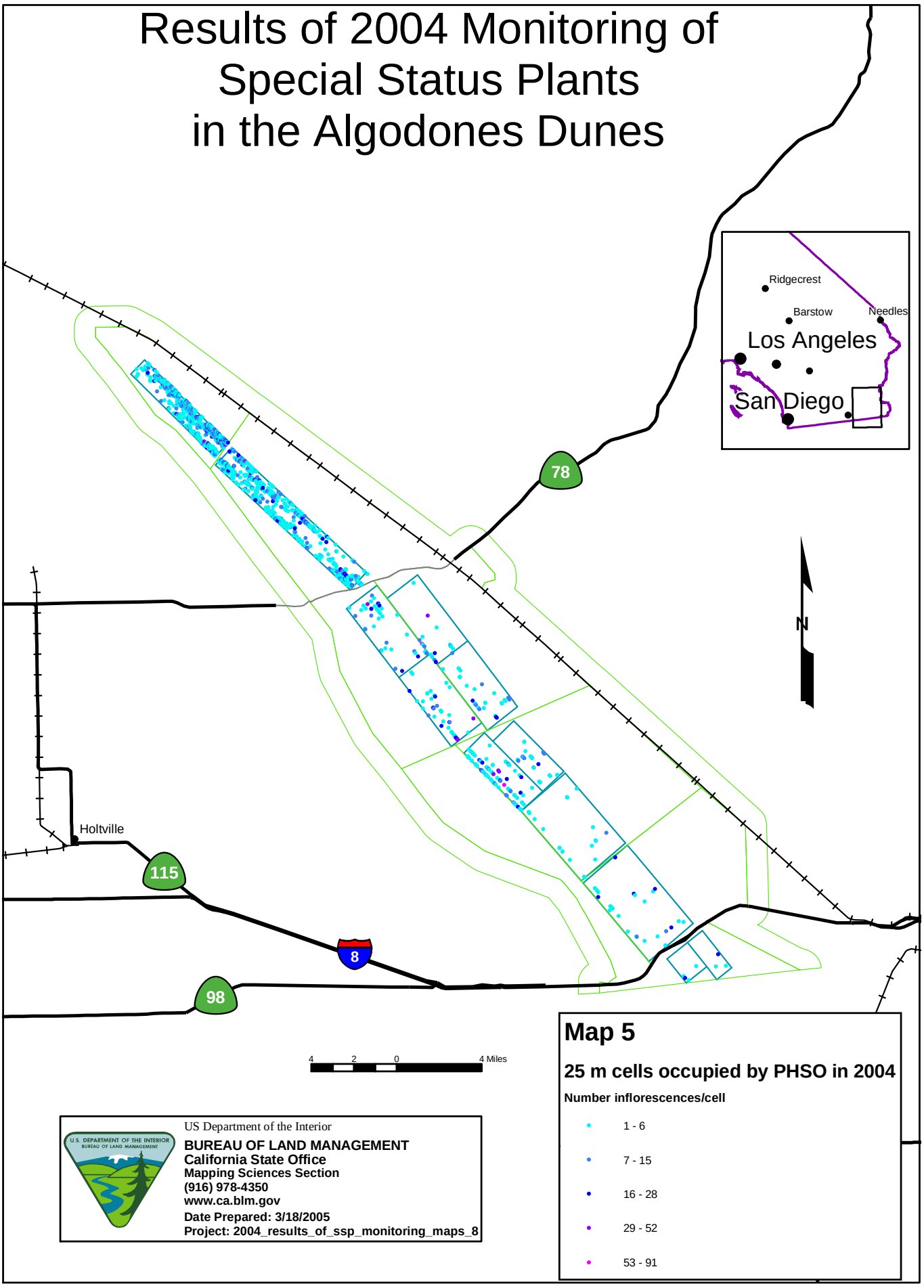

Map 5

25 m cells occupied by PHSO in 2004

Number inflorescences/cell

- 1 - 6
- 7 - 15
- 16 - 28
- 29 - 52
- 53 - 91

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