Monitoring of Peirson's Milk-vetch in the Imperial Sand Dunes Recreation Area 2014 and 2015

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Cover photograph by Chris Knauf, Bureau of Land Management, Oregon State Office

Preface

The author of this report is John Willoughby, contract botanist, Bureau of Land Management (BLM), California State Office. This report documents 2014 and 2015 monitoring of Peirson's milk-vetch in the Imperial Sand Dunes Recreation Area, as required by the Imperial Sand Dunes Recreation Area Management Plan.

The monitoring study was designed by John Willoughby, Tony McKinney of the Carlsbad Fish and Wildlife Office of the U.S. Fish and Wildlife Service, and Andrew Trouette of the BLM El Centro Field Office. Tony used data from a 2005 dunes-wide survey of Peirson's milk-vetch to select macroplots for monitoring and created waypoints that were downloaded into global positioning system devices for navigating to each macroplot and recording data. Andrew conducted the actual monitoring, assisted by Jeff Sahagun, Lara Kobelt, Vikki Dee Bradshaw, Michelle Pucket, Loren Dunham, and Marcus Lorusso.

Executive Summary

In late winter and spring 2014 and 2015, the Bureau of Land Management (BLM) implemented a monitoring program to monitor the abundance of Peirson's milk-vetch (*Astragalus magdalenae* var. *peirsonii*) in the Imperial Sand Dunes (also called the Algodones Dunes) in southeastern Imperial County, California. Peirson's milk-vetch is a Federally-listed threatened species and a State-listed endangered species.

The Imperial Sand Dunes Recreation Area Management Plan (ISDRAMP) prescribes two levels of monitoring for PMV, a full-scale approach when October-December precipitation at the Dunes is greater than 1.82 inches and a less-intense approach when precipitation during the October-December period is less than 1.82 inches (see Introduction for how this 1.82 inch threshold was derived). Nineteen macroplots, each 50m x 500m in size, were permanently established in areas representing the full range of Peirson's milk-vetch habitat in the Dunes, including areas both open and closed to off-highway vehicles (OHVs). Six of these macroplots are to be monitored in years in which the October-December precipitation is less than 1.82 inches, and all 19 macroplots are to be monitored in years in which the precipitation during that period equals or exceeds 1.82 inches.

Because the October-December precipitation was less than 1.82 inches in both 2013 and 2014, the monitoring effort in 2014 and 2015 was directed toward six macroplots. Seven macroplots were actually monitored in 2014, principally because it was the pilot year of the project, and six macroplots were monitored in 2015.

Because of below-average precipitation in growing seasons 2013-2014 and 2014-2015, the number of Peirson's milk-vetch plants observed in both 2014 and 2015 was substantially fewer than would be expected given an above-average rainfall year (such as growing season 2004-2005). Most of the plants observed in both years were not flowering at the time of the monitoring, likely because the plants represented cohorts of plants that germinated in response to precipitation events that occurred relatively late in the growing season. Few of the plants observed in 2014 appeared to survive the 2014 summer and, based on previous studies, it is unlikely that many of the plants observed in 2015 will survive the 2015 summer and flower in spring 2016. This is consistent with the observations of previous studies in which plants that germinate early in the growing season (e.g., October-December) flower and produce seeds in the same growing season (e.g., in March or April), whereas those that germinate later in the growing season (e.g., January-March) depend upon surviving to the next growing season to produce flowers and seeds. The former strategy likely produces far more seed overall because of the higher numbers of plants, but plants surviving more than one year produce more seed per plant.

Only 1 percent and 0.1 percent, respectively, of the plants observed in 2014 and 2015 were greater than one year old. This is likely reflective of the below-average growing season precipitation in the years preceding 2014 and 2015. The 2013-2014 growing season precipitation was particularly low, probably accounting for the low 0.1 percent of 1-year and older plants in 2015.

Although the 2014 and 2015 monitoring did not show direct impacts from OHV use, the presence of OHV tracks in macroplots 15 and 16 (within Peirson's milk-vetch critical habitat immediately north and south, respectively, of a formerly open vehicle corridor to Patton Valley that was closed in the summer of 2014) may point to the need for additional signage and/or increased ranger patrols along this former corridor.

Introduction

In late winter and spring of 2014 and 2015, the Bureau of Land Management (BLM) implemented a monitoring program to track the abundance of Peirson's milk-vetch (*Astragalus magdalenae* var. *peirsonii*, hereafter referred to as PMV) in the Imperial Sand Dunes Recreation Area,[1] located in southeastern Imperial County, California. PMV is a Federally-listed threatened species and a State-listed endangered species.

The Imperial Sand Dunes Recreation Area Management Plan (ISDRAMP) was approved in June 2013 (BLM 2013). The ISDRAMP closed PMV critical habitat, designated by the U.S. Fish and Wildlife Service (USFWS 2008), to off-highway vehicles (OHVs). It also called for the lifting of interim OHV closures in effect since November 2000 pursuant to a series of lawsuits filed against BLM. These interim OHV closures were not lifted until fall 2014 following a court decision earlier in 2014 (BLM 2014). Thus, the 2014 monitoring was conducted with the interim closure boundaries in effect, and the 2015 monitoring was conducted with the PMV critical habitat closure boundaries in effect.

Appendix D of the ISDRAMP prescribes two levels of monitoring for PMV, a full-scale approach when October-December precipitation at the Dunes is greater than 1.82 inches and a less-intense approach when precipitation during the October-December period is less than 1.82 inches. The 1.82 threshold is the average October-December precipitation between 1964 and 2010 (0.89 inches) plus one standard deviation (0.93 inches; see Figure 1). A spring following this level of October-December precipitation is one in which significant PMV germination, growth, and seed production can be expected (Phillips and Kennedy 2003 and 2006; Willoughby 2001 and 2004). As an example, spring of 2005 was a banner year for PMV plants, as shown by BLM's 2005 monitoring program (Willoughby 2005b). The October-December precipitation for 2004 was well above the 1.82 inch threshold (Figure 1).

[1] The Imperial Sand Dunes are also called the Algodones Dunes. The latter name was used for previous Peirson's milk-vetch monitoring reports, but this report will refer to this large sand dune system as the Imperial Sand Dunes because the applicable management plan refers to them that way.

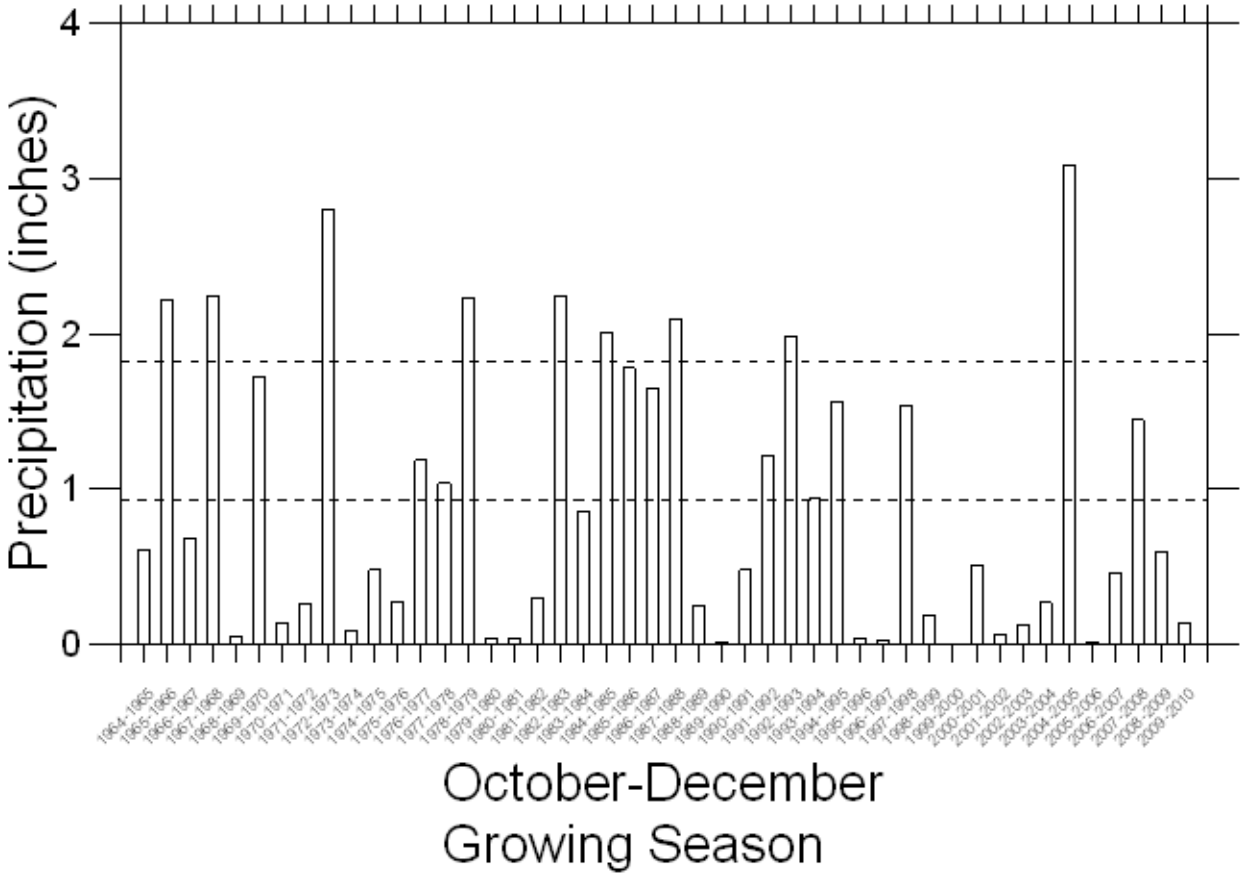

Figure 1. October to December precipitation from growing seasons 1964-1965 to 2009-2010. The full growing season is defined as October 1 to March 30. Thus, the October-December period is the first half of the growing season. Precipitation values for growing seasons 1964-1965 to 2000-2001 are the averages of 7 WRCC weather stations in the vicinity of the Imperial Sand Dunes. The values for growing seasons 2001-2002 to 2009-2010 are the averages of the precipitation recorded for the two Remote Area Weather Stations in the Imperial Sand Dunes (these stations were installed in November 2000). The bottom dashed line is the average October-December growing season precipitation of the 7 WRCC weather stations (0.93 inches). The top dashed line is 1 standard deviation above the average (standard deviation = 0.89 inches). Growing seasons with October-December precipitation higher than the standard deviation line would be expected to be banner years for Peirson's milk-vetch. Monitoring during the spring following the 2004-2005 growing season (Willoughby 2005b) would appear to bear this out.

Methods

In 2014 nineteen permanent macroplots were established in areas representative of good PMV habitat in the Imperial Sand Dunes. Macroplots are 50m x 500m in size and are oriented southwest (SW) to northeast (NE). The macroplots are divided into forty 25x25 meter cells (Figure 2).

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
40	39	38	37	36	35	34	33	32	31	30	29	28	27	26	25	24	23	22	21

Figure 2. 50m x 500m macroplot showing division of macroplot into forty 25m x 25m cells for data recording purposes. Cells are read in the order they are numbered, from Cell 1 to Cell 40.

A cell size of 25m x 25m was chosen to mimic the cell sizes used in the 2003-2007 sampling of Peirson's milk-vetch (Willoughby 2004b, 2005a, 2005b, 2006, 2007). In those studies long, belt transects 25m wide and between 2.35 and 7.73 km long were employed to estimate the population size of PMV in each year. Counts of variables were recorded in 25m segments along each belt transect, resulting in a dataset consisting of more than 339,000 cells in 2005, of which more than 26,116 supported one or more PMV plants. The 2005 data represents both the richest data set (in terms of number of cells read) and the best estimate to date of the abundance and distribution of PMV in the Imperial Sand Dunes (FWS 2008; Willoughby 2006).

The 2005 monitoring project divided the dunes into 16 sampling areas, each of which was sampled using a systematic random sampling scheme (Map 1).[2] Ten of these sampling areas were selected for monitoring in 2014 and beyond based on the number of plants found in the 2005 survey. The chosen sampling areas run the full extent of the dunes from northwest to southeast, but include only the westernmost sampling areas in areas of the dunes south of the North Algodones Dunes Wilderness Area. This is because most PMV plants occupy these westernmost sampling areas, which is also the reason that most of the critical habitat is concentrated in these westernmost sampling areas (Map 1).

Table 1 lists the general locations, number of macroplots, and the criteria used to distribute the nineteen permanent PMV macroplots among the 10 sampling areas in the Imperial Sand Dunes. In years with October-December precipitation above 1.82 inches, all 19 of these macroplots would be monitored.

[2] Note that the numbering system for the 16 sampling areas used in 2005 is missing the numbers 1, 2, 9, and 10. Sampling areas with those numbers were sampled in 2004 and proved to be too variable, so they were divided into smaller sampling areas for the 2015 sampling. New numbers were assigned to these smaller sampling areas.

Table 1. Distribution of 19 Peirson's milk-vetch monitoring macroplots in the Algodones Dunes. The table lists sampling areas from north to south (see map).

Sampling Area	Number of Macroplots	Criteria
13	1	One macroplot in the Mammoth Wash area of the Dunes in critical habitat north of the area that was closed between 2000 and 2013.
14	1	One macroplot in the Mammoth Wash area of the Dunes in critical habitat inside the area closed between 2000 and 2013.
15	1	One macroplot in critical habitat in the northern part of the Wilderness.
16	1	One macroplot in critical habitat in the southern part of the Wilderness.
3	2	One macroplot outside the former closure area and one inside. This is outside of critical habitat but in an area that supported plants in 2005.
4	2	One macroplot outside both former closure areas and one inside the former large central closure. This is outside of critical habitat but in an area that supported plants in 2005.
7	3	As all of this sampling area was closed between 2000 and 2013 the macroplots will be evenly distributed in critical habitat from north to south.
18	3	As all of this sampling area was closed between 2000 and 2013 the macroplots will be evenly distributed in critical habitat from north to south.
19	4	Three macroplots evenly distributed between the north and south parts of the sampling area in the critical habitat area north of the former OHV corridor to Patton Valley (with one just north of the corridor) and one macroplot in the critical habitat area south of the former corridor.
11	1	One macroplot in the critical habitat area in this sampling area.
Total	**19**	

In years with October-December precipitation less than 1.82 inches, 6 of the 19 macroplots will be monitored. Table 2 lists the general locations, number of macroplots, and the criteria used to distribute these 6 PMV macroplots among the 10 sampling areas in the Imperial Sand Dunes.

Table 2. Monitoring macroplots to be censused in low rainfall years.

Sampling Area	Number of Macroplots	Criteria
13	0	
14	0	
15	0	
16	0	
3	1	The macroplot inside the former closure area would be monitored. The reason for this is that the area closed was chosen based on it supporting more plants in the 1998 study (Willoughby 1998).
4	1	The macroplot inside the former central closure area would be monitored. The reason for this is that the area closed was chosen based on it supporting more plants in the 1998 study.
7	1	The middle of the three macroplots in this sampling area will be censused.
18	1	The middle of the three macroplots in this sampling area will be censused.
19	2	Because of potential concerns related to the vehicle corridor to Patton Valley (closed in summer 2014) near the boundary between critical habitat subunits 3A and 3B, the macroplots just north and south of the former corridor will be censused.
11	0	
Total	**6**	

Based on these general criteria, Tony McKinney, GIS expert with the Carlsbad Fish and Wildlife Office of the Fish and Wildlife Service, used the 2005 monitoring data to create specific locations for each of the 19 macroplots. Because the macroplots are intended to represent good PMV habitat, macroplots were chosen that would incorporate areas that had high numbers of plants recorded in 2005. The premise here is that these macroplots would be more likely to have high recruitment and, therefore, high germination in following years. Because plant density increased from north to south based on the 2005 monitoring data, each sampling area was treated independently, according to the following steps:

1. The mean number of plants per sampling area for occupied cells was calculated.
2. Cells greater than or equal to the mean for that sampling area were selected.
3. The selected cells were buffered by 50 meters to create a “blob.” This blob also captures adjacent cells that are less than the mean cell value for the sampling area. Blobs grow in size if the buffer includes additional cells with plant totals equal to or greater than the sampling area mean cell value.

4. Because the 2005 transects were run northwest to southeast in order to capture PMV variability within the transects, the blobs, where they include more than one buffer area, also run northwest to southeast. In order to create macroplots that run southwest to northeast, each sampling area was visually inspected to find blobs that coalesced across transects. Not all of these coalesced blobs formed areas large enough to encompass a 50m x 500m macroplot oriented southwest to northeast.
5. Potential macroplot center points were placed in several areas of cell/blob concentrations.
6. An ArcGIS calculate function was executed to create macroplots normal to the 2005 transects. The number of plants was calculated in cells by macroplot, and the macroplot to be included in the study was selected based on the number of plants and ease of access, the latter of which is especially important for those sampling areas in the Wilderness area where macroplots must be accessed on foot.

An example of the above process as applied to Sampling Area 14 is provided in Map 2. The nineteen macroplots selected using this procedure are shown in Map 6, along with their positions relative to PMV critical habitat, the 2000-2014 OHV closures, and the 2005 sampling areas. Table 3 lists the macroplots, their locations and which ones are to be monitored in springs following October-December precipitation below and above the threshold of 1.82 inches.

Table 3. Macroplots and their positions in the Imperial Sand Dunes. X's show the macroplots to be monitored according to the October-December precipitation threshold.

Macroplot	Sampling Area	October-December Precipitation		Location
		< 1.82 inches	> 1.82 inches	
1	13		X	In critical habitat
2	14		X	In critical habitat
3	15		X	In North Algodones Wilderness Area
4	16		X	In North Algodones Wilderness Area
5	3		X	In area never closed to OHV use
6	3	X	X	In area closed to OHV use 2000-2014
7	4		X	In area never closed to OHV use
8	4	X	X	In area closed to OHV use 2000-2014
9	7		X	In critical habitat in northern part of sampling area
10	7	X	X	In critical habitat in middle part of sampling area
11	7		X	In critical habitat in southern part of sampling area

Macroplot	Sampling Area	October-December Precipitation		Location
		< 1.82 inches	> 1.82 inches	
12	18		X	In critical habitat in northern part of sampling area
13	18	X	X	In critical habitat in middle part of sampling area
14	18		X	In critical habitat in southern part of sampling area
15	19	X	X	In critical habitat just north of former vehicle corridor to Patton Valley (north part of sampling area)
16	19	X	X	In critical habitat just south of former vehicle corridor to Patton Valley (north part of sampling area)
17	19		X	In critical habitat in middle part of sampling area
18	19		X	In critical habitat in southern part of sampling area
19	11		X	In critical habitat in southern part of sampling area

Peirson's milk-vetch was completely censused in each macroplot for the following variables: (1) seedlings and young, nonflowering plants, (2) flowering plants, (3) total number of plants (this is the total of categories 1 and 2), (4) number of plants greater than 1-year old, (5) number of plants showing damage from OHVs, and (6) number of plants showing damage from sources other than OHVs. In addition to these PMV variables, the number of OHV tracks was also recorded. These seven variables were recorded separately for each 25m x 25m cell, which was the same protocol used in the 2003-2007 monitoring. Macroplots are located using a global positioning system (GPS) with waypoints entered into each GPS unit corresponding to the beginning and end of each 25m x 25m cell. Figure 3 shows the numbering system used in 2015.[3]

[3] A different numbering system was used in 2014, the pilot year, but the cells were traversed in the same way as described for 2015.

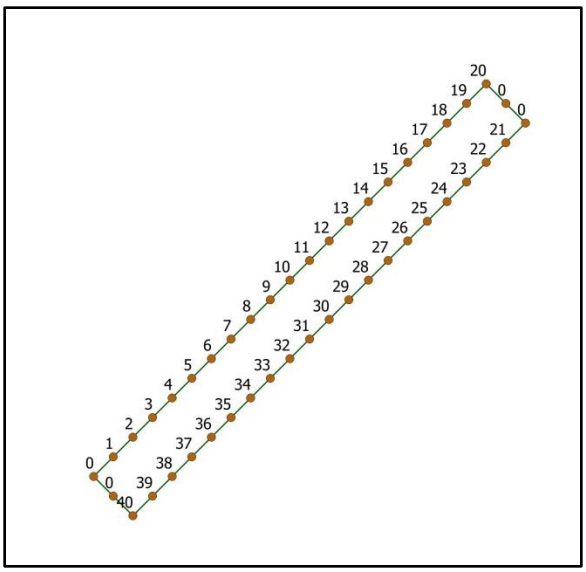

Figure 3. Waypoint numbering system used in 2015 for monitoring each macroplot.

The following describes the system used to collect monitoring data in 2015. The waypoints numbered 0 are for navigation purposes only and have no data recorded for them. The observers begin the monitoring at the 0 point at the southwest point along the upper edge of the macroplot. They then set the GPS unit to navigate toward waypoint 1. Observer 1 (with the GPS) stays on the top (left edge) of the belt transect, while the second observer stays 25m away from Observer 1 on the right edge of the transect (if there is a third observer, that observer traverses the center of the belt). These observers then count and record the number of plants/tracks in each of the seven categories for the cell ending at waypoint 1 (this is Cell 1; see Figure 2). Those values are recorded in the GPS unit under waypoint 1. The observers then continue recording data for cells 2-20 (the top row of cells) and navigate down to the waypoint 0 at the southeast corner of the lower edge of the macroplot. Observer 1 continues down the lower (left) edge of the macroplot while Observer 2 stays 25m away on the right edge of the transect (which is the middle of the macroplot). This continues until the data for the last cell is recorded under waypoint 40 (this is Cell 40; see Figure 2).

Total values are then computed for each macroplot by summing the values recorded for cells 1-40.

Weather Data. Precipitation data were obtained from two remote area weather stations (RAWS) in the Imperial Sand Dunes, 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. The locations of these stations are shown in Willoughby (2004a, Map 6). During the 2013-2014 and 2014-2015

growing seasons (October-March) both of these stations malfunctioned during some months. Fortunately, the station malfunctions did not overlap. The Cahuilla RAWS is missing data for most of December 2014, all of January and February 2014, and the first half of April 2014. The Buttercup RAWS is missing data for several days at the end of December 2014 and for ten days during the first part of January 2015. The monthly precipitation shown in the results section is the average of the two RAWS stations for a particular month, except for those months in which one of the stations is missing data, in which case the "average" precipitation is the precipitation from the weather station with a full month of data.

Results

The October-December precipitation in both 2014 and 2015 was below the threshold of 1.82 inches. Therefore, monitoring was to consist of monitoring only the six plots as shown in Table 3. Because of the confusion associated with implementing a new monitoring procedure, an additional macroplot, Macroplot 5, was monitored in 2014, the pilot year. Also, Macroplot 7 was monitored instead of the target Macroplot 8.

Macroplots were monitored between March 5 and 13 in 2014 and between February 24 and March 25 in 2015 (Tables 4 and 5).

Table 4. Monitoring dates and observers in 2014.

Macroplot	Date Monitored	Observers
5	3/7/2014	Jeff Sahagun and Vikki Dee Bradshaw
6	3/7/2014	Jeff Sahagun and Vikki Dee Bradshaw
7	3/5 and 3/12/2014	Jeff Sahagun, Marcus Lorusso and Loren Dunham
10	3/12/2014	Jeff Sahagun, Marcus Lorusso and Loren Dunham
13	3/6 and 3/13/2014	Jeff Sahagun, Marcus Lorusso and Loren Dunham
15	3/13/2014	Jeff Sahagun, Marcus Lorusso and Loren Dunham
16	3/5/2014	Andrew Trouette, Jeff Sahagun and Michelle Pucket

Table 5. Monitoring dates and observers in 2015.

Macroplot	Date Monitored	Observers
6	3/25/2015	Andrew Trouette and Lara Kobelt
8	3/23/2015	Andrew Trouette and Jeff Sahagun
10	3/24/2015	Andrew Trouette and Lara Kobelt
13	3/24/2015	Andrew Trouette and Lara Kobelt
15	3/24/2015	Andrew Trouette and Lara Kobelt
16	2/24/2015	Andrew Trouette and Lara Kobelt

Monitoring results. Table 6 shows the number of plants observed in each of the seven categories for each macroplot in each of 2014 and 2015. It also shows the number of vehicle tracks observed, the number of cells in which PMV plants were found, and the number of cells in which OHV tracks were observed (there are 40 cells in each macoplot, a total of 280 cells for all macroplots combined in 2014, and a total of 240 cells for all macroplots combined in 2015).

Table 6. Number of PMV plants counted in six categories, the number of OHV tracks, the number of cells occupied by PMV, and the number of cells with OHV tracks for macroplots in 2014 and 2015.

Macro plot	Year	Num Seed-lings	Num Flower-ing	Total	Num > 1 yr	Num w OHV Damage	Num w Other Damage	Num OHV Tracks	Num Cells Occupied by PMV	Num Cells w OHV Tracks
5	2014	3	0	3	0	0	0	50	3	30
	2015	NA	NA	NA	NA	NA	NA	NA	NA	NA
6	2014	0	0	0	0	0	0	12	0	8
	2015	0	0	0	0	0	0	0	0	0
7	2014	7	2	9	0	0	0	66	5	35
	2015	NA	NA	NA	NA	NA	NA	NA	NA	NA
8	2014	NA	NA	NA	NA	NA	NA	NA	NA	NA
	2015	554	0	554	0	1	0	43	16	20
10	2014	268	10	278	4	0	0	0	7	0
	2015	770	0	770	0	0	0	6	11	2
13	2014	1133	65	1198	19	0	0	0	17	0
	2015	1374	11	1385	3	0	0	6	15	6
15	2014	683	3	686	2	0	0	11	20	9
	2015	10	0	10	0	0	0	12	3	5
16	2014	144	1	145	1	0	0	3	12	1
	2015	0	0	0	0	0	0	18	0	11
Total	2014	2238	81	2319	26	0	0	142	64	83
	2015	2708	11	2719	3	1	0	85	45	44

The macroplots used for the 2014-2015 monitoring were chosen based on the fact that they encompassed rather high numbers of plants during the 2005 surveys. The total number of plants that would have been observed in the macroplots had they existed in 2005 has been estimated. Table 7 shows the total number of PMV individuals observed by macroplot in 2014 and 2015 compared to the estimated number of individuals per macroplot based on the data from the 2005 sampling. The 2005 estimated number is based on the numbers of plants in the 2005 sampled cells that overlapped the macroplot. Because not all of the macroplots' cells

were sampled in 2005, the actual number of plants in each macroplot in 2005 was likely higher than the number shown in Table 7.

Table 7. Total number of PMV plants observed by macroplot in 2014 and 2015 compared to the estimated number of plants per macroplot based on 2005 sampling.

Macroplot	Total 2014 Plants	Total 2015 Plants	Estimated Total 2005 Plants
5	3	NA	257
6	0	0	387
7	9	NA	212
8	NA	554	473
10	278	770	673
13	1198	1385	3159
15	686	10	8732
16	145	0	4646
Total	2319	2719	18539

Weather Data. Table 8 shows the weather data collected at the two RAWS for growing seasons 2013-2014 and 2014-2015. The 50-year growing season average of the WRCC stations in the vicinity of the dunes and the RAWS is given for comparison (the average of 7 weather stations are used for averages between growing seasons 1965-1966 to 1999-2000; the RAWS data are used after that).

Table 8. Growing season precipitation at the Imperial Sand Dunes for growing seasons 2013-2014 and 2014-2015. The 50-year growing season average of the WRCC stations in the vicinity of the dunes and the RAWS is given for comparison. All units are in inches.

Growing Season	Oct-Dec ppt.	Jan-Mar ppt.	Total Growing Season ppt.	Long-term Growing Season Average ppt. of all WRCC Stations
2013-2014	0.43	0.06	0.49	2.00
2014-2015	0.33	1.01	1.34	2.00

Figure 4 shows the monthly distribution of rainfall for growing seasons 2013-2014 and 2014-2015. Note that precipitation was relatively low in all months except March 2015 and that some months (October, January, and February in growing season 2013-2014 and November and February in growing season 2014-2015) had no rainfall at all.

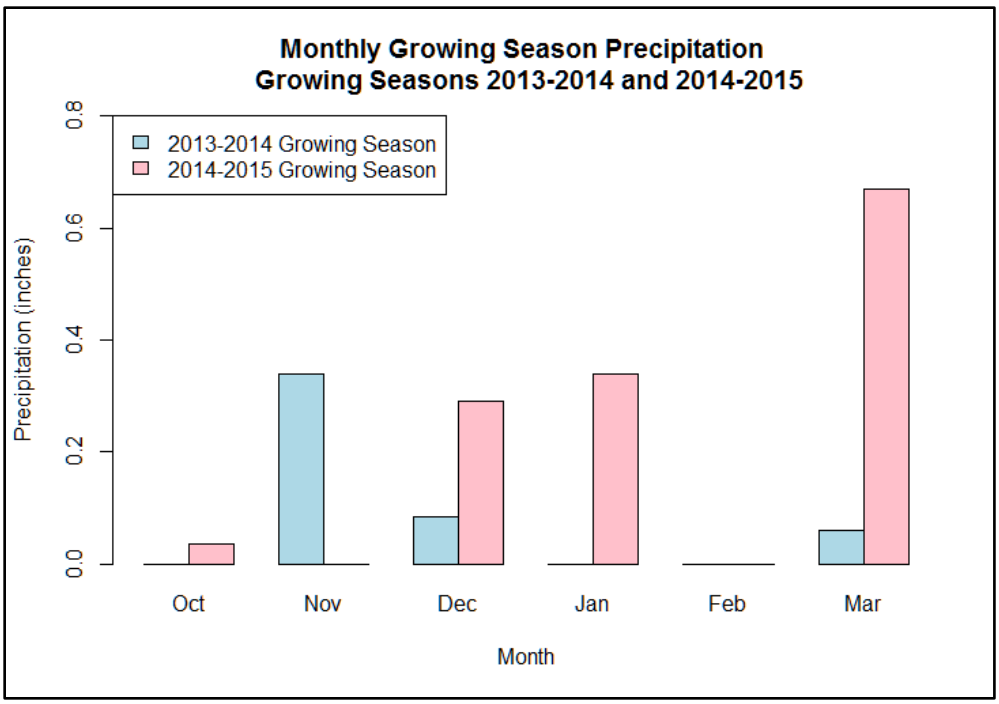

Figure 4. Monthly growing season precipitation for the 2013-2014 and 2014-2015 growing seasons. Monthly values are the average of the two RAWS for months in which both RAWS were operable, or the precipitation recorded at the single operable RAWS for months in which one of the RAWS was offline.

OHV Impacts and Tracks. As Table 6 shows, none of the PMV plants counted in the 2014 survey showed evidence of OHV damage.[4] One of the plants counted in the 2015 survey showed damage from OHVs; this plant was found in Macroplot 8 in an area that has been open to OHV use since fall 2014.

OHV tracks totaled 142 in 2014 throughout the 7 macroplots surveyed and 85 in 2015 in the 6 macroplots surveyed. In 2014, 128 (90%) of these tracks were in macroplots in areas open to OHV use (macroplots 5, 6, and 7). The other 14 were encountered in macroplots 15 (11 tracks) and 16 (3 tracks); although these macroplots were in areas closed to OHVs, they are close to an OHV corridor to Patton Valley that was still open in 2014 to allow riders to access the main dunes on the east from the sand highway and camping areas to the west (this corridor was closed in the summer of 2015).

In 2015, 43 (51%) of the 85 OHV tracks counted were in Macroplot 8, which is open to OHV use. Interestingly, no OHV tracks were encountered in Macroplot 6, which is also open to OHV use. The remaining 42 OHV tracks (49%) were in macroplots closed to OHV use by virtue of being

[4] A determination of OHV damage is made when a plant shows damage (e.g., a broken stem) and a vehicle track crosses the area where the plant occurs.

inside PMV critical habitat. As in 2014, most of these OHV tracks (29) were in macroplots 15 and 16, adjacent to the formerly open vehicle corridor to Patton Valley.

Impacts from sources other than OHV use. No damage was observed in either year from sources other than OHV use, such as those that might occur from animal (e.g., insects and small mammals) or disease.

Discussion

Distribution and abundance. Neither the 2013-2014 nor the 2014-2015 growing seasons appeared to be favorable to the germination and growth of Peirson's milk-vetch. As Table 7 illustrates, the number of individuals observed in 2014 and 2015 was far fewer than would be expected during a very favorable growing season like that experienced in 2004-2005. Both growing seasons 2013-2014 and 2014-2015 experienced less rainfall than the average, but the latter growing season had significantly more rainfall than the former (1.34 inches for 2015 compared to only 0.49 inches for 2014). Based on this fact, one would expect the number of plants to be greater in 2015 than in 2014. This is largely the case except for macroplots 15 and 16. Macroplot 15 curiously supported 686 plants in 2014 but only 10 plants in 2015. In Macroplot 16, a total of 145 plants were observed in 2014 compared to 0 in 2015. The reason for this is unclear, but does not appear to be related to OHV use, since the number of OHV tracks observed in 2015 in these two macroplots (30) was not much higher than the number observed in 2014 (14), and no plants were found with OHV damage in either year (although the total number of plants counted in 2015 was only 10 for both macroplots). Perhaps the portion of the Dunes in which macroplots 15 and 16 are located (they are very near to each other) did not benefit from as much rain in 2015 as the RAWS stations would indicate.

Stage-class composition. Neither the 2013-2014 nor the 2014-2015 growing seasons appeared to be favorable to the germination and growth of Peirson's milk-vetch. The total precipitation for both growing seasons was well below the long-term average. Very few flowering plants were found in either growing season, 81 (out of 2,319 total plants or 3.5%) in 2014 and 11 (out of a total 2,719 plants or 0.4%) in 2015. Thus, 96.5% and 99.6%, respectively, of the plants observed in 2014 were seedlings and young, nonflowering plants. This contrasts with the findings of 2005 (Willoughby 2005), in which 25% of the plants observed were seedlings and young, nonflowering plants and 75% were flowering and past flowering. These differences are likely the result of the timing of the rainfall. In the 2004-2005 growing season, October precipitation alone was 1.1 inches (the average of the two RAWS). Precipitation continued in November and December (the October-December precipitation total was 2.3 inches). Plants

germinating in October 2004 thus survived until spring 2005, providing sufficient time to flower and produce seed.

The large percent of seedlings and young, nonflowering plants observed in 2014 and 2015 is similar to the stage class distributions observed in the 2003 and 2004 monitoring (Willoughby 2004b, 2005a). In 2003, only 2.3% of the plants that germinated in fall/winter 2003-2004 were flowering at the time of the 2003 survey. In 2004, 5.7% of the plants counted in spring 2004 were flowering, but more than half of these were plants greater than 1-year old (i.e., they had germinated in a previous year, likely 2003); only 2.3% of plants that germinated in fall/winter 2003-2004 were flowering at the time of the spring 2004 survey.

The only precipitation events during the 2002-2003 growing season (October – March) occurred on February 13, February 25, and March 16, 2003. The consequence of this is that most plants observed did not have time to reach the flowering stage. In 2004, most of the seedling/juvenile plants likely represented a cohort that germinated in response to February 2004 rains and thus did not have time to reach the flowering stage. The few flowering plants that germinated in fall/winter 2003-2004 may represent a cohort that germinated in response to a small rainfall event in November 2003.

The plants observed in spring 2014 likely represented a cohort of plants that germinated in response to a rainfall event that occurred on November 21-23, 2013, during which 0.11 inches of rain was recorded at the Cahuilla RAWS and 0.57 inches was recorded at the Buttercup RAWS. An additional rainfall event of 0.17 inches was recorded on December 19, 2013, at the Buttercup RAWS. The Cahuilla RAWS was inoperative at that time. The 2,319 seedlings and juvenile plants observed in spring 2014 were likely the result of germination that occurred in response to the late November rainfall event. Only a few of the plants of this cohort had sufficient time to flower. The timing of the survey also likely played a role in these observations: most of the flowering plants were recorded on the last two days of the 2014 survey (March 12 and 13, 2014) in Macroplots 10 and 13 (Macroplot 10 was surveyed on March 12; Macroplot 13 was surveyed on March 6 and 13; the survey on March 13 yielded the highest numbers of flowering plants).

The plants observed in spring 2015 likely resulted from rainfall events that took place December 3-4, 2014, December 16-17, 2014, and January 11-12, 2015. None of these rainfall events were very large (ranging from 0.16 to 0.25 inches). Few plants germinating in response to these rainfall events had time to develop into flowering plants by the time of the surveys.

Only 26 (1%) of the 2,319 plants observed in 2014 were greater than 1 year old. Although the 2012-2013 growing season precipitation of 1.39 inches was less than the long-term average of 2.0 inches, this was apparently enough to allow 1% of the plants that germinated in growing

season 2012-2013 or earlier to survive into 2014. In 2015, there was an order of magnitude decrease in the percentage of plants greater than 1 year old: only three plants (0.1%) greater than one year old were observed out of the total of 2719 plants. This low percentage is likely a reflection of the low rainfall (only 0.49 inches) experienced during the 2013-2014 growing season: there was insufficient rainfall to carry any but a very few plants through summer 2014.

Porter et al. (2005) and Phillips and Kennedy (2005) noted that PMV possesses two different strategies for seed production. Plants that flower early in the growing season have time to flower and set seed during the same season. Porter et al. state there is approximately 90 days between germination and flowering. Plants that germinate later in the growing season do not flower in that growing season. Rather, they depend upon surviving through the summer to flower and produce seeds in the subsequent growing season. The former strategy appears to produce the largest quantity of seed simply because the numbers of same-season flowering plants are much higher (Phillips and Kennedy 2005 and 2006; Willoughby 2005 and 2006), but the latter strategy certainly also works to put seeds into the seed bank. Although 1-year old and older plants are far fewer, they produce much more seed than same-season flowering plants (Porter et al. 2005, Phillips and Kennedy 2005). Although the numbers of plants observed in 2006, following a dismal growing season, were low, Willoughby (2006) concluded that all of the plants must have been one or more years old: there simply was not enough rain to stimulate any germination of PMV in the 2005-2006 growing season.

OHV impacts and tracks. Only one plant over the two years of monitoring showed evidence of damage from OHV use, and this was in an area open to OHV use in 2015. The study did find, however, that OHVs are intruding on areas within PMV critical habitat that are closed to OHV use. This unauthorized use is particularly obvious in macroplots 15 and 16, which are adjacent to the vehicle corridor to Patton Valley that was open in 2014 but closed in the summer of 2015. This may indicate the need for additional signage and/or increased ranger patrols along the former corridor.

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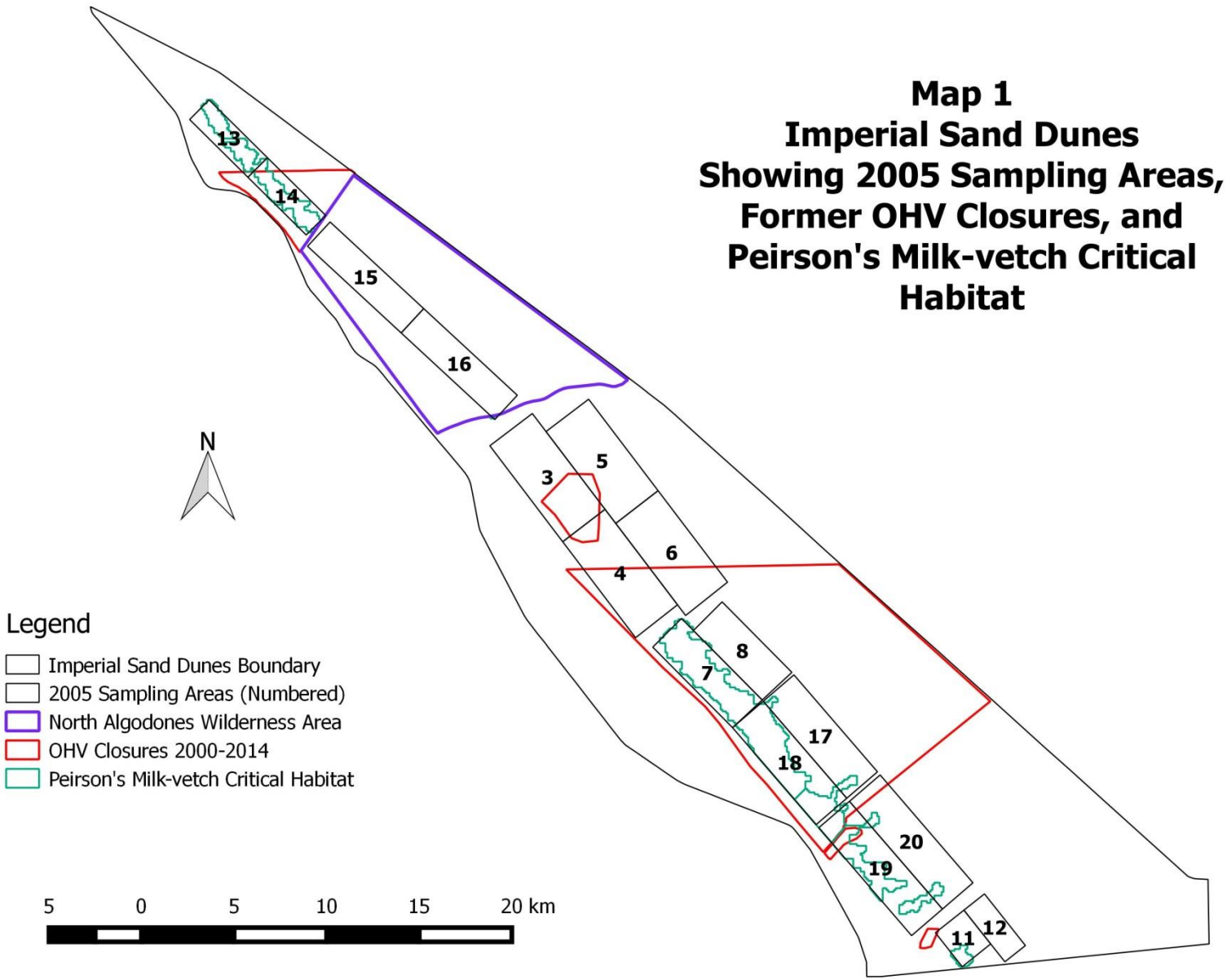
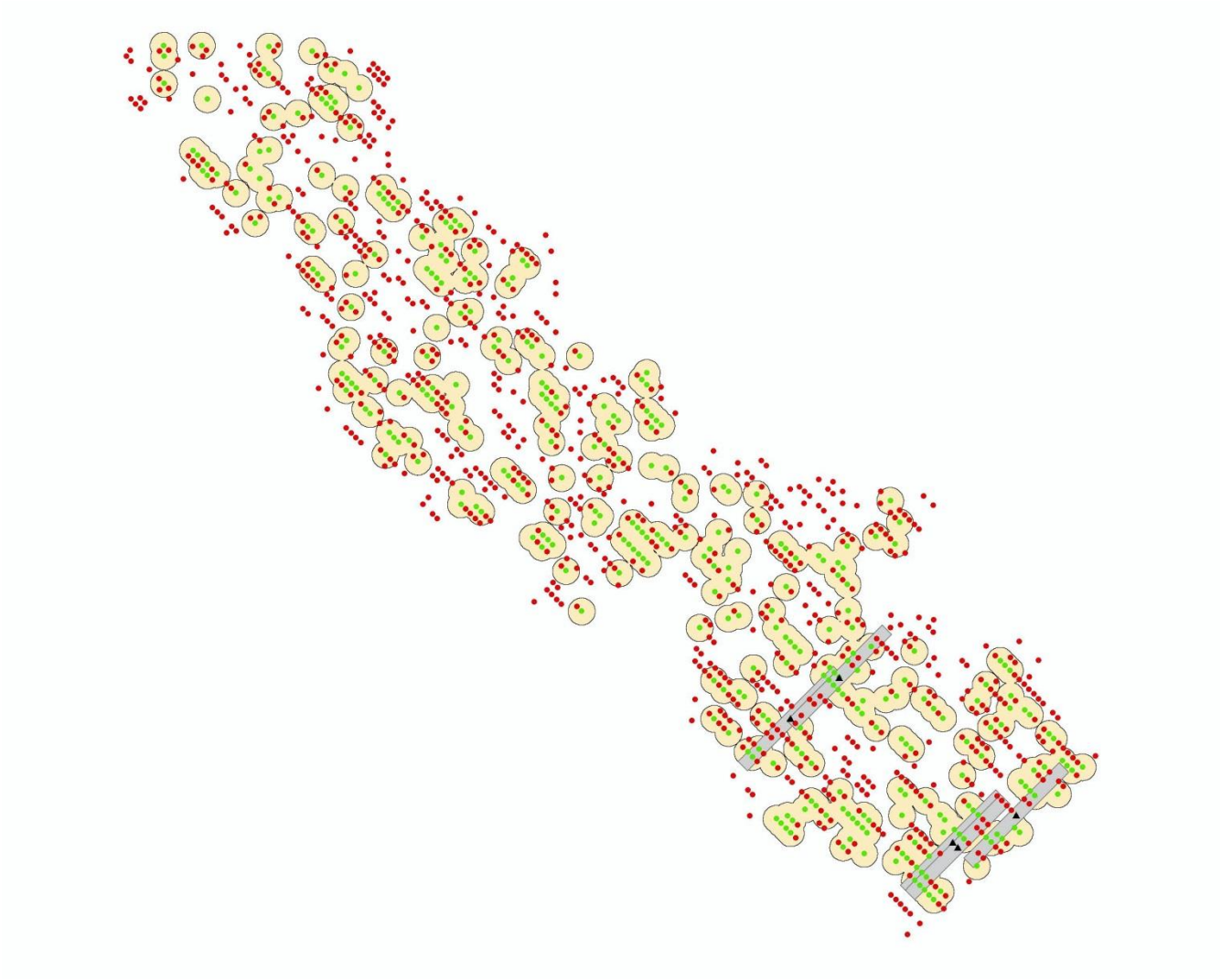
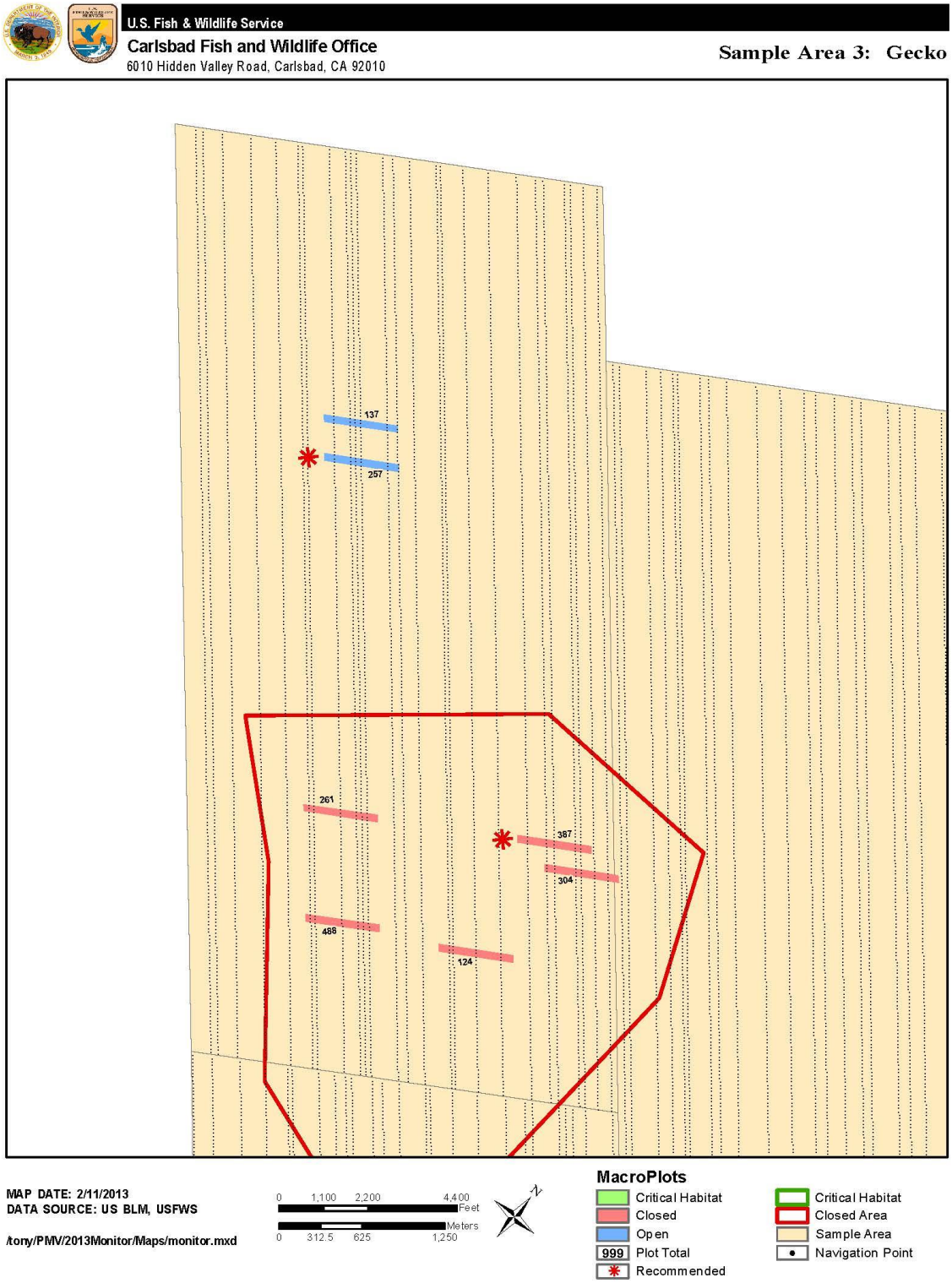
Map 1
Imperial Sand Dunes Showing 2005 Sampling Areas, Former OHV Closures, and Peirson's Milk-vetch Critical Habitat

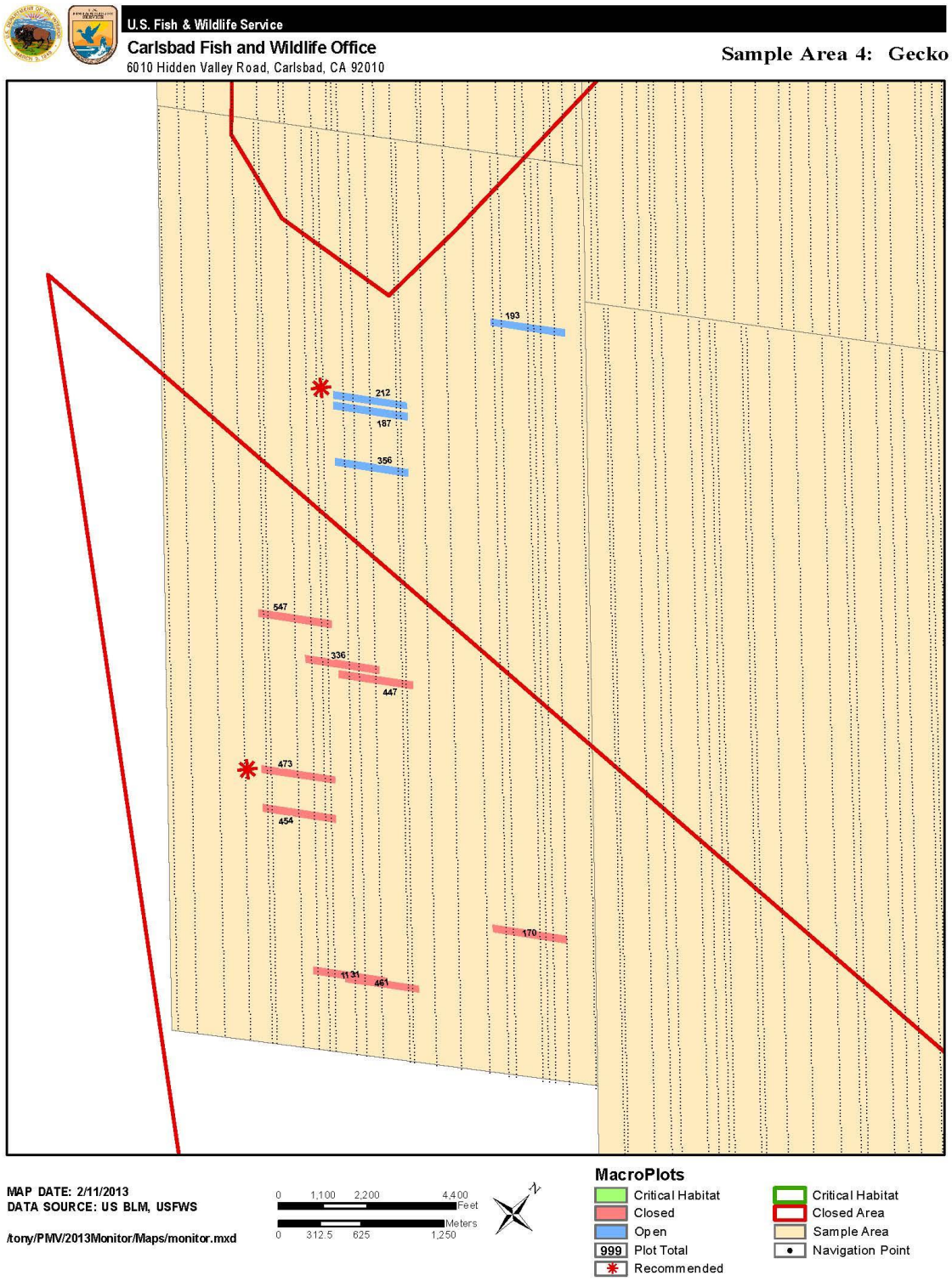




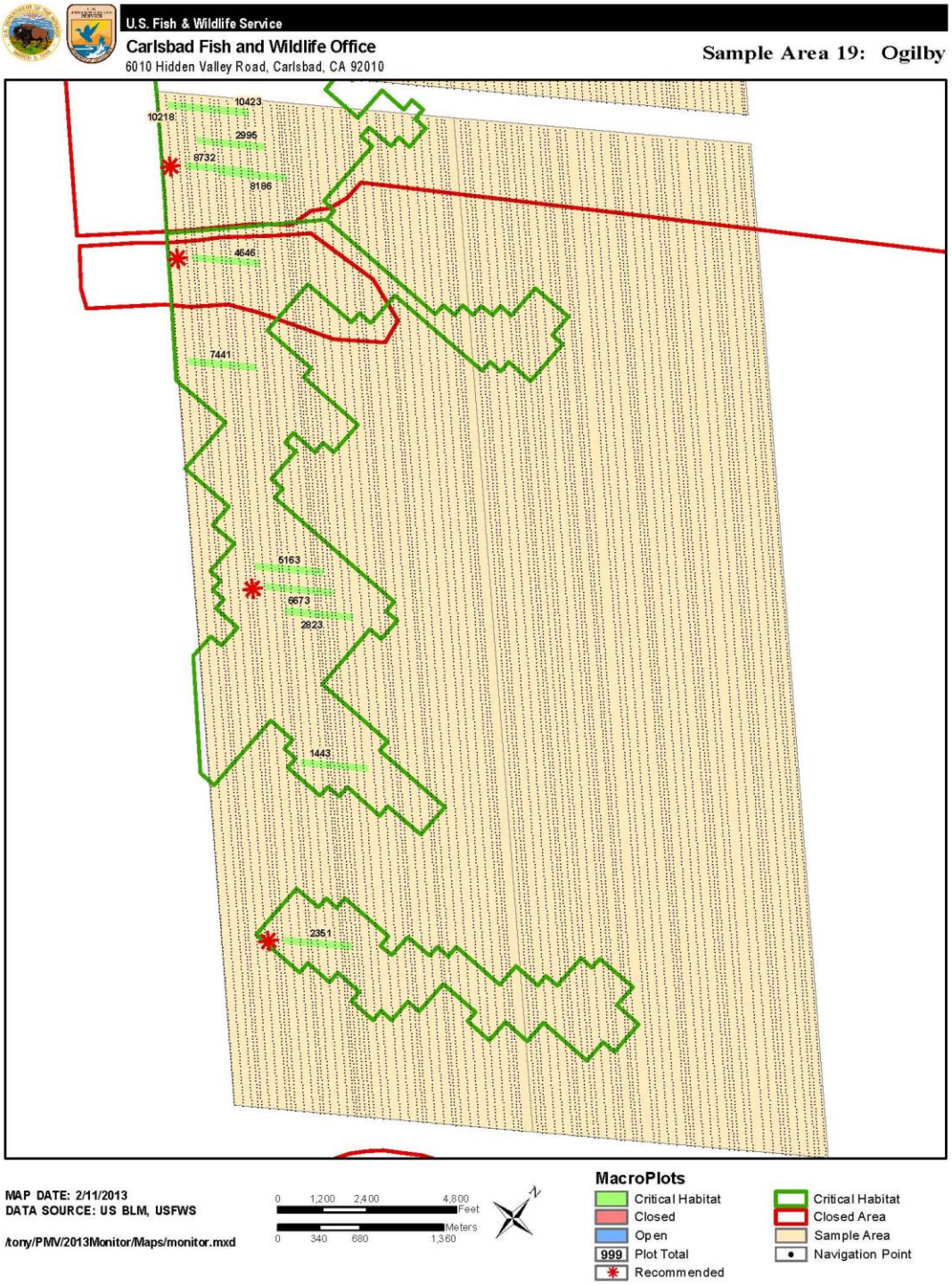
Map 2. Sampling Area 14, illustrating the process used to create macroplots. Green dots are 25m x 25m cells from 2005 monitoring that have cells with numbers of plants greater than or equal to the mean cell value for the sampling area. Red dots are cells with numbers of plants less than the sampling area mean. Tan polygons represent 50m buffers around cells. Black triangles are centerpoints for potential macroplots. Grey polygons are the macroplot selection set.



Map 3. Potential and selected macroplots in Sampling Area 3. One out of two potential macroplots (blue) selected in area that has always been open to OHV use and one out of five potential macroplots (red) in area that was closed to OHV use from 2000 to early 2014.

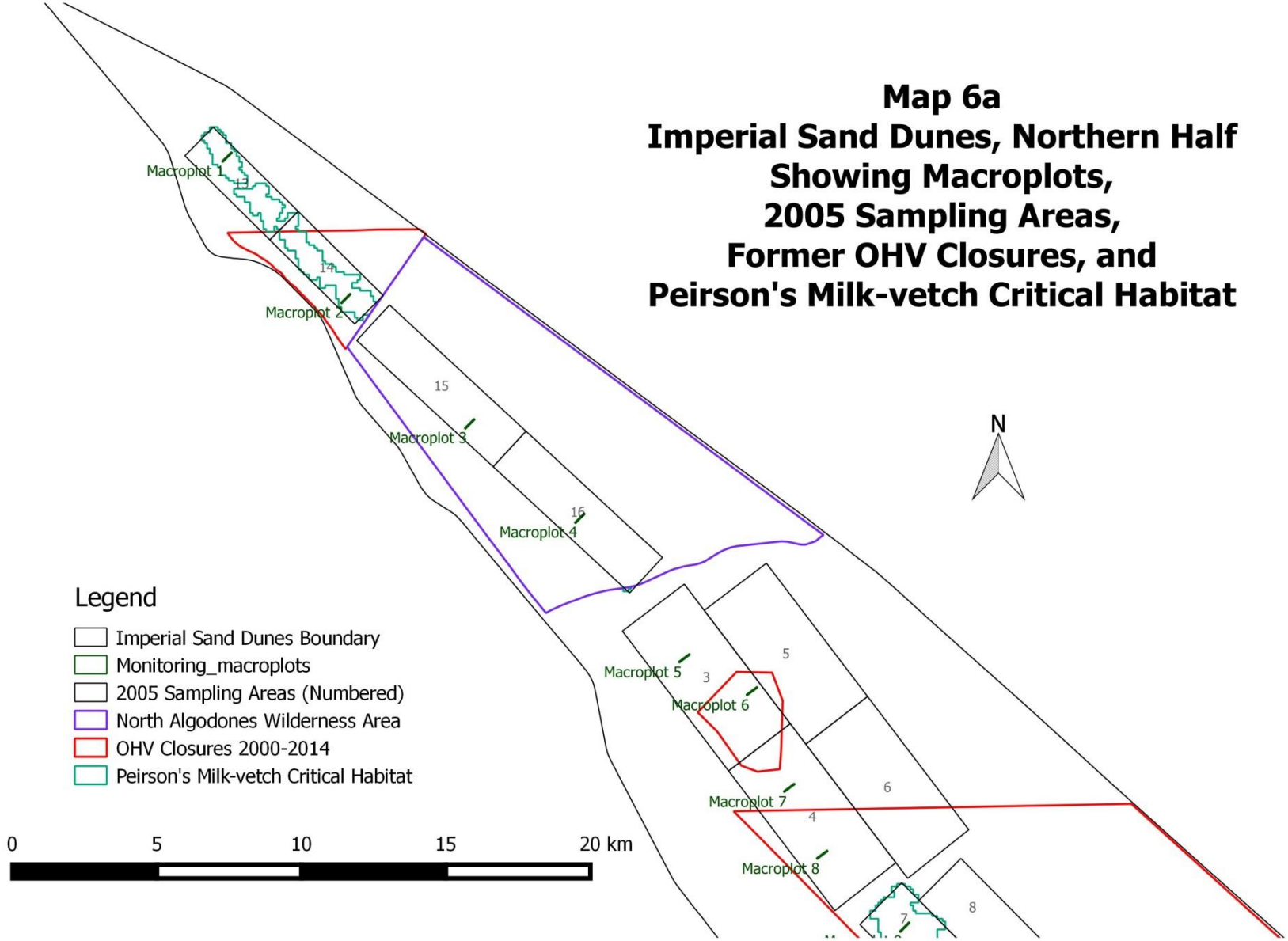
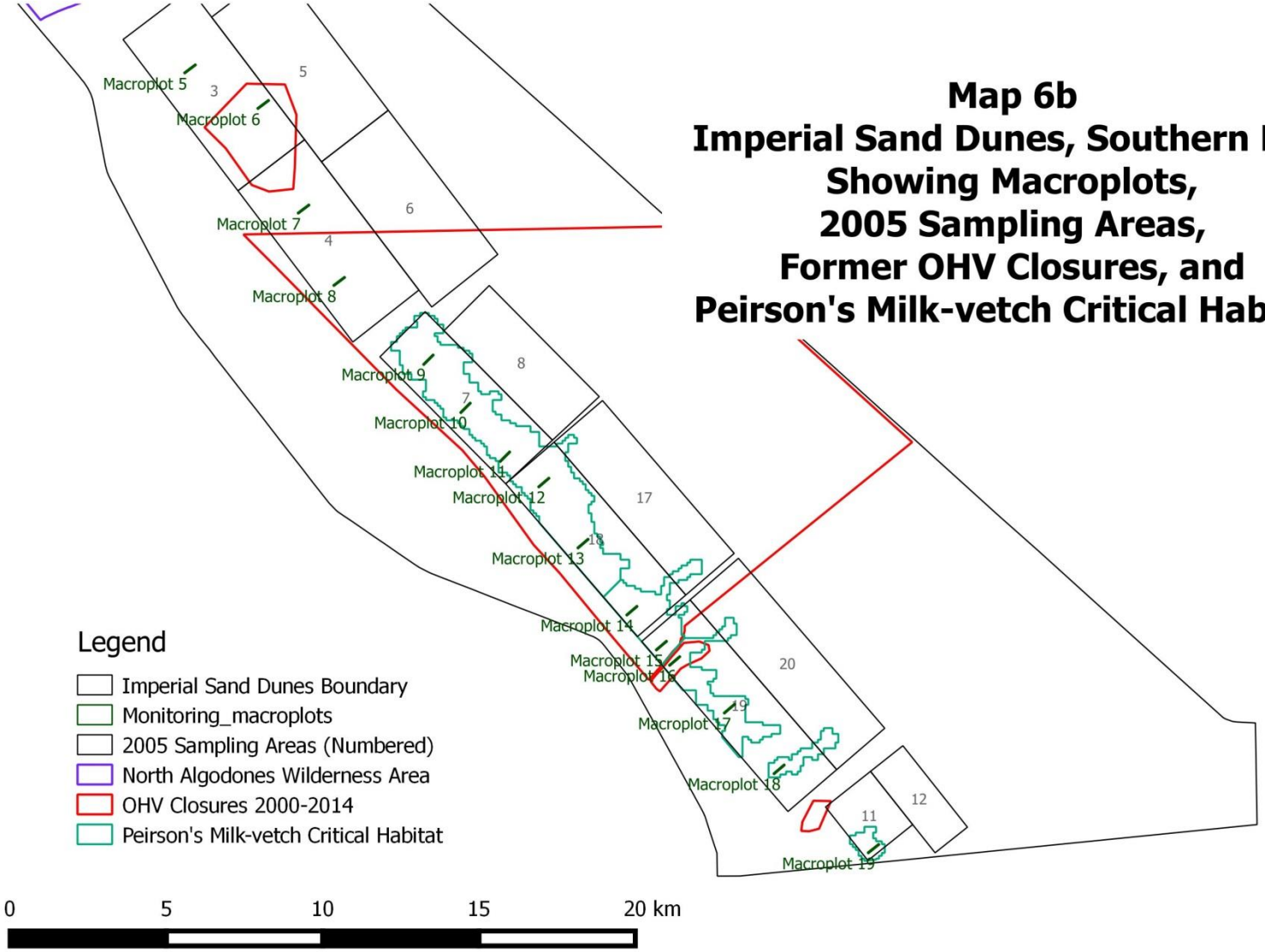


Map 4. Potential and selected macroplots in Sampling Area 4. One out of four potential macroplots (blue) selected in area that has always been open to OHV use and one out of four potential macroplots (red) in area that was closed to OHV use from 2000 to early 2014.



Map 5. Potential and selected macroplots in Sampling Area 19. One out of three potential macroplots selected within Critical Habitat north of the former OHV corridor to Patton Valley (the one closest to the corridor was chosen), two out of six potential macroplots in the Critical Habitat south of the corridor (the northernmost of these chosen because it was closest to the corridor) and one out of one potential macroplot in the separate Critical Habitat area in the south part of the sampling area.

Map 6a
Imperial Sand Dunes, Northern Half Showing Macroplots, 2005 Sampling Areas, Former OHV Closures, and Peirson's Milk-vetch Critical Habitat



Map 6b
Imperial Sand Dunes, Southern Half Showing Macroplots, 2005 Sampling Areas, Former OHV Closures, and Peirson's Milk-vetch Critical Habitat