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2024 ANNUAL REPORT BIOLOGICAL MONITORING

for Range 48; Unit 25 and Units 13, 20, and 31 Containment Lines

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Prepared for:

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Sacramento District
1325 J Street
Sacramento, CA 95814-2922

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HARRIS ENVIRONMENTAL GROUP INC

Terracon

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2024 ANNUAL REPORT
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SUBMITTED TO:

UNITED STATES ARMY CORPS OF ENGINEERS
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ACRONYMS AND ABBREVIATIONS

ANOVA	Analysis of Variance
Army	United States Army
BRAC	Base Realignment and Closure
BLM	Bureau of Land Management
Burleson	Burleson Consulting Inc., A Terracon Company
CNPS	California Native Plant Society
cm	centimeter (s)
EcoSystems West	EcoSystems West Consulting Group, Inc.
ft	feet
GIS	Geographic Information System
GPS	Global Positioning System
Harris	Harris Environmental Group Inc.
Harris-Terracon	Harris Environmental Group Inc. and Terracon Consultants Inc. Team
HLA	Harding Lawson Associates
HMP	Habitat Management Plan
HMP annuals	Annual Species of Concern
HMP shrub	Shrub Species of Concern
MACTEC	MACTEC Engineering and Consulting, Inc.
MEC	Munitions and Explosives of Concern
m	meter(s)
MRA	Munitions Response Area
NOAA	National Oceanic and Atmospheric Administration
NCEI	National Centers for Environmental Information
NDMC	National Drought Mitigation Center
NPS	Naval Postgraduate School
NMDS	Non-metric Multidimensional Scaling
PERMANOVA	Permutation-Based Multivariate Analysis of Variance
PBO	Programmatic Biological Opinion
Protocol	Protocol for Conducting Vegetation Monitoring in Compliance with the Installation-Wide Multispecies Habitat Management Plan at Former Fort Ord
RAC	Rank Abundance Curve
Revised Protocol	Revisions of Protocol for Conducting Vegetation Monitoring for Compliance with the Installation-Wide Multispecies Habitat Management Plan, Former Fort Ord
RTK	real-time kinematic
Tetra Tech	Tetra Tech Inc.
Terracon	Terracon Consultants, Inc. (formerly Burleson Consulting, Inc.)
USACE	United States Army Corps of Engineers
USACE-Chenega	United States Army Corps of Engineers and Chenega Reliable Services, LLC Team
USDA	United States Department of Agriculture
USFWS	United States Fish and Wildlife Service

1 INTRODUCTION

The United States Army Corps of Engineers (USACE) contracted Harris Environmental Group, Inc. (Harris) and Terracon Consultants, Inc. (Terracon) to conduct biological monitoring at former Fort Ord, Monterey County, California (see Figure 1-1 through Figure 1-3). Monitoring is centered on the biological impacts of environmental cleanup activities associated with munitions and explosives of concern (MEC). Biological monitoring includes rare annual plant species density, annual grass density, invasive and rare species locations, and shrub transects.

This report presents results of follow-up biological monitoring conducted in (a) Range 48 (Year 5 monitoring) and (b) Unit 25 and Units 13, 20, 31 Containment Lines (Year 8 monitoring). Monitoring was conducted during spring, summer, and fall of 2024 to satisfy requirements of the *Installation-wide Multispecies Habitat Management Plan for Former Fort Ord* (HMP) and the reinitiated *Programmatic Biological Opinion for Cleanup and Property Transfer Actions Conducted at the Former Fort Ord* (PBO) issued by the United States Fish and Wildlife Service (USFWS) (USACE, 1997; USFWS, 2017). This annual monitoring report presents results of monitoring for annual species of special concern (HMP annuals), shrubs, non-native annual grasses, and invasive plants. Baseline monitoring is conducted prior to cleanup activities (such as vegetation clearance, MEC removal, and other related operations) to establish the presence, distribution, and abundance of protected species. Vegetation clearance is achieved by burning and/or masticating standing vegetation to allow access to the soil surface for MEC removal and other related operations. Appendices include species acronyms (Appendix A), HMP annuals grid monitoring maps (Appendix B), HMP shrub transect maps (Appendix C), annual grass density maps (Appendix D), invasive and rare species location maps (Appendix E), HMP shrub transect cover data (Appendix F), and non-native species tables (Appendix G).

After completion of cleanup activities, follow-up monitoring of protected species and habitat is conducted to determine whether the species and habitat recovery are meeting success criteria as established in the *Revisions of Protocol for Conducting Vegetation Monitoring for Compliance with the Installation-Wide Multispecies Habitat Management Plan, Former Fort Ord* (Revised Protocol) and the *Protocol for Conducting Vegetation Monitoring in Compliance with the Installation-Wide Multispecies Habitat Management Plan at Former Fort Ord* (Protocol) (Tetra Tech Inc. [Tetra Tech] and EcoSystems West, 2015b; Burleson, 2009a). As part of the development of the Revised Protocol, a series of three major shrub associations were identified based on the dominant species present in the Baseline surveys and their successional patterns described. These associations included: Association A – shaggy-barked manzanita (*Arctostaphylos tomentosa*) dominated, with chamise (*Adenostoma fasciculatum*) sub-dominant; Association B – chamise dominated with shaggy-barked manzanita and sandmat manzanita (*Arctostaphylos pumila*) subdominant; and Association C/D – sandmat manzanita dominated (Tetra Tech and EcoSystems West, 2015b).

Prior to 2015, densities of annual HMP plants had been monitored at Years 1, 3, 5, and 8 following vegetation clearance; shrub communities had been monitored at Years 3, 5, 8, and 13 following vegetation clearance. With the issuance of the 2015 PBO, the USFWS concurred with the United States Army's (Army) recommendation to reduce the duration of monitoring to a maximum of 5 years for HMP annuals and 8 years for shrub communities (USFWS, 2015). This change was based on an analysis of vegetation data collected from over 5,000 acres over a period of up to 10 years that indicated that recovery could be documented based on a reduced time period (Tetra Tech and EcoSystems West, 2015b).

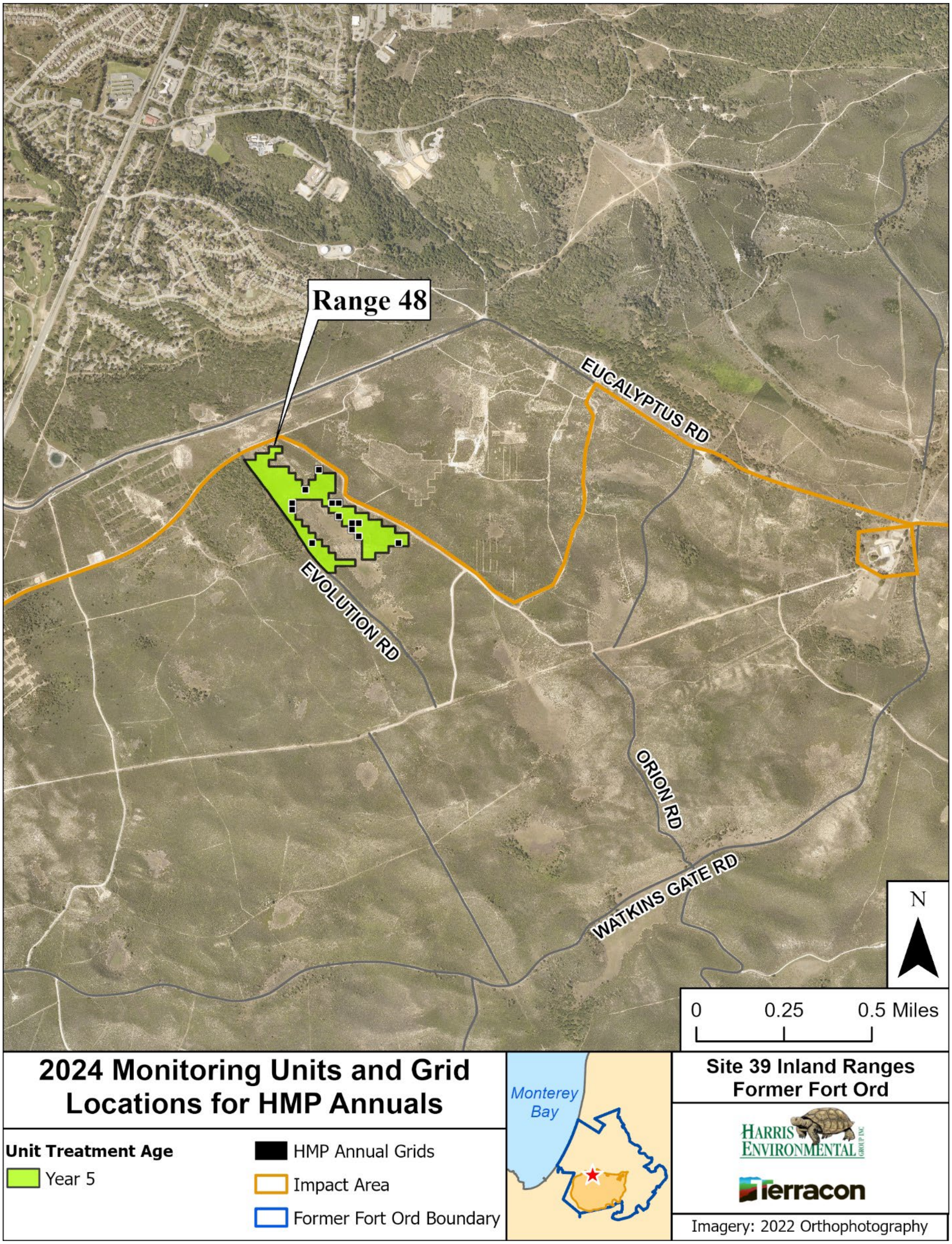

Figure 1-1. Map of Former Fort Ord in Monterey, California, showing location of Units and grids sampled for HMP annual species in 2024.

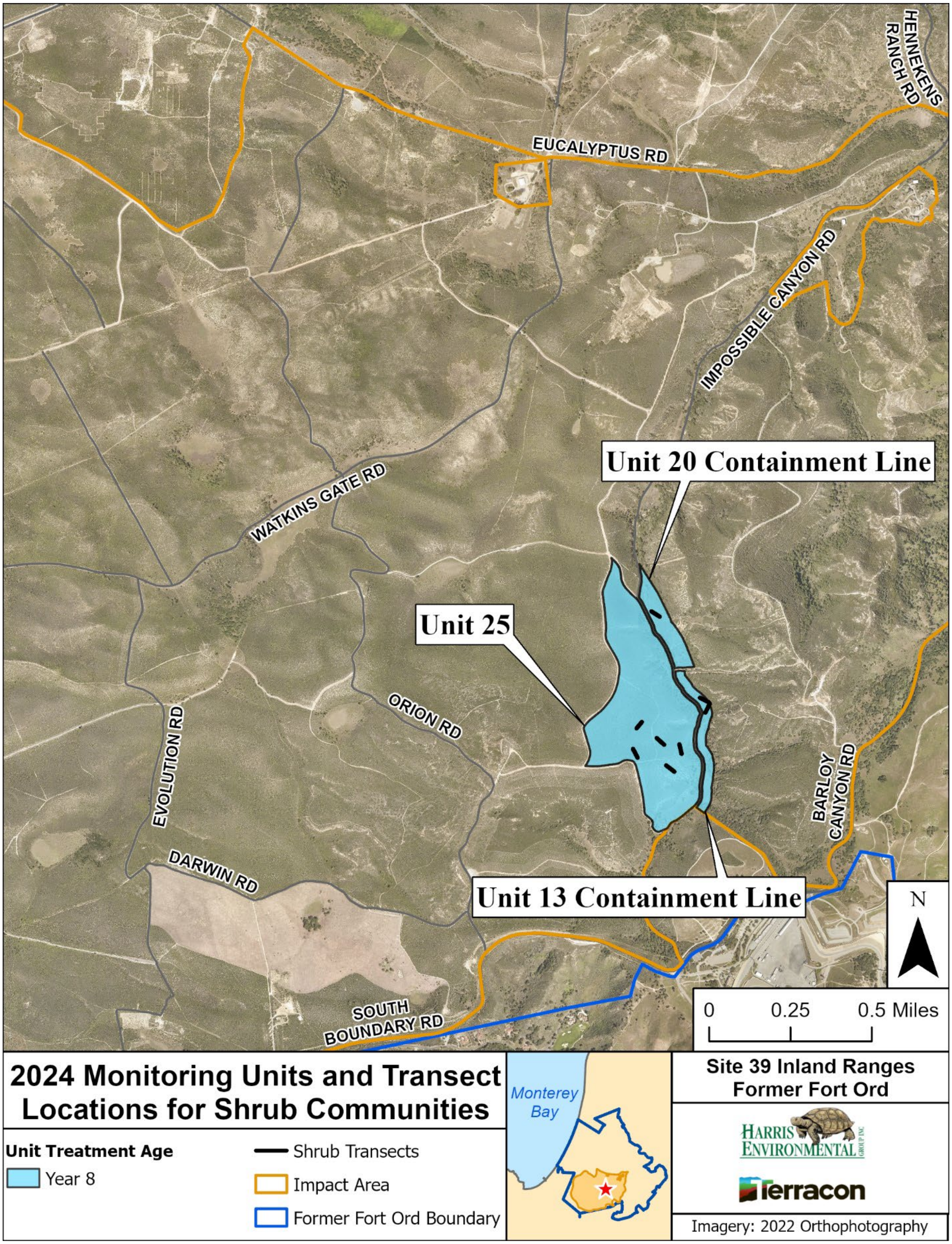

Figure 1-2. Map of Former Fort Ord in Monterey, California, showing locations of Units and transects sampled for shrub community in 2024.

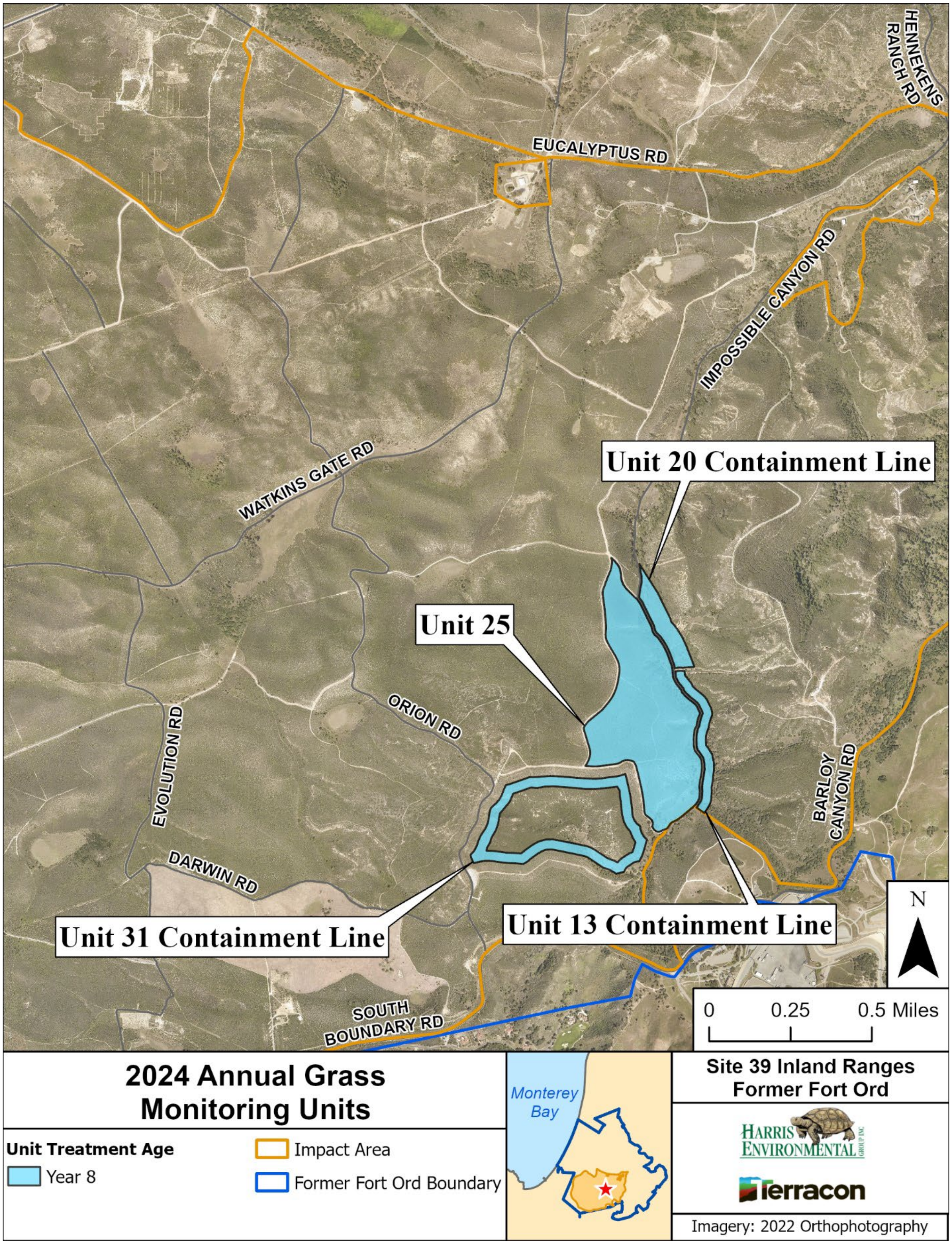

Figure 1-3. Map of Former Fort Ord in Monterey, California, showing locations of Units sampled for annual grasses in 2024.

The terrain in the monitoring Units consists of rolling hills with elevations ranging from 375 to 550 feet (ft). The vegetation type is primarily central maritime chaparral with patches of annual grasslands, vernal pools, wet meadows, and coast live oak (*Quercus agrifolia*) woodlands. Central maritime chaparral is protected under the HMP because of its restricted geographic range and association with significant numbers of rare, threatened, and endangered species. Central maritime chaparral is adapted to periodic fires that remove the dominant shrub species and create open space that can be colonized by annual plants. Van Dyke *et al.* (2001) suggested that prescribed burning, or mechanical disturbance with smoke treatment, may be necessary in central maritime chaparral management. This regime may support the establishment of a more diverse chaparral community by releasing nutrients into the soil through biomass combustion and ash deposition and creating more openings for plants to colonize (Potts *et al.*, 2010).

From 1991 to 2020, the average cumulative precipitation throughout former Fort Ord showed a gradual increase from October through March and generally plateaued at around 40 centimeters (cm) in April. The 2023-2024 water year began with below-average precipitation but saw a significant increase in November and maintained levels close to the 30-year normal for the remainder of the year, whereas the 2022-2023 water year was well above the 30-year normal (Figure 1-4; NPS, 2024; NCEI NOAA, 2024). According to the United States Drought Monitor, the local region began the 2023-2024 water year in non-drought conditions and remained so for most of the year (NDMC *et al.*, 2024).

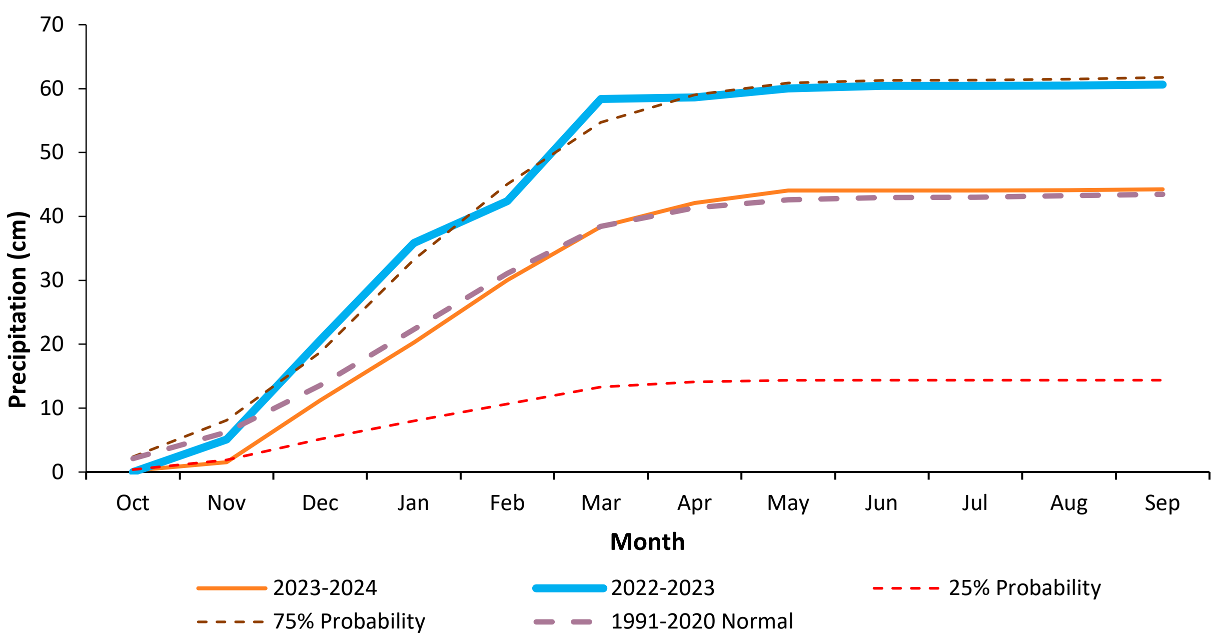

Figure 1-4. Cumulative monthly precipitation for the 2023-2024 water year compared to the 30-Year normal (mean 1991-2020), the 2022-2023 water year, and the 25% and 75% probabilities[1] (NPS 2024; NCEI NOAA, 2024)**.**

[1] The 25% probability indicates that there is a 25% chance that the actual precipitation will fall below that amount; and the 75% probability indicates that there is a 75% chance that the actual precipitation will fall below that amount.

1.1 Species Included in 2024 Habitat and Rare Species Monitoring

Central maritime chaparral habitat is dominated by a variety of shrub and associated herbaceous plants. The focus of the HMP includes five of these shrub species and three annual herbaceous species that are special-status species and, as such, were the focus of the HMP (USACE, 1997). The focus shrub species (HMP shrubs) monitored include:

- California Native Plant Society (CNPS) 1B.2 listed sandmat manzanita (*Arctostaphylos pumila*),
- CNPS 1B.2 listed Toro manzanita (*Arctostaphylos montereyensis*),
- CNPS 1B.2 listed Hooker's manzanita (*Arctostaphylos hookeri* ssp. *hookeri*),
- CNPS 4.2 listed Monterey ceanothus (*Ceanothus rigidus*),
- and CNPS 1B.1 listed Eastwood's goldenbush (*Ericameria fasciculata*).

The focus annual species (HMP annuals) monitored include:

- state threatened, federally endangered, and CNPS 1B.2 listed Monterey gilia (*Gilia tenuiflora* ssp. *arenaria*),
- federally threatened and CNPS 1B.2 listed Monterey spineflower (*Chorizanthe pungens* var. *pungens*),
- and state endangered and CNPS 1B.1 listed seaside bird's-beak (*Cordylanthus rigidus* ssp. *littoralis*).

Survey teams also report the locations of federally endangered and CNPS 1B.1 listed Yadon's piperia (*Piperia yadonii*) when encountered incidentally during monitoring efforts.

Some changes in species taxonomy were made to conform to current taxonomic treatments (Baldwin *et al.*, 2012). Specifically, the acronym for the Monterey ceanothus (*Ceanothus cuneatus* var. *rigidus*) was changed from CERI to CECUR in 2010 to reflect the sub-specific designation of this plant at that time. However, prior to the 2013 survey, the accepted species designation was changed back to *Ceanothus rigidus* (Baldwin *et al.*, 2012). Therefore, the code has been changed back to CERI to remain consistent with historical data. See Appendix A for a representative list of central maritime chaparral plant species found on Fort Ord, and their associated acronyms.

1.2 Previous Surveys Conducted on the Sites

Previous surveys conducted at specific former Fort Ord Units monitored in 2024 are referenced in Table 1-1. Data from previous surveys for HMP annuals and shrub transects were obtained from results from previous surveys and Geographic Information System (GIS) shapefiles and associated metadata provided by the Base Realignment and Closure (BRAC) office (HLA, 1999 and 2001; MACTEC, 2004; Tetra Tech and EcoSystems West, 2011 – 2015b; Burleson, 2016 – 2023).

When appropriate and available, shrub transect data were transcribed from the electronic versions of previous monitoring reports. In addition to incorporating past shrub transect data into the database, adjustments were made to the "density" class field in the HMP annuals data table to correspond to the density classes defined by Burleson (Burleson, 2009a), while maintaining the original data. If only count data were provided in previous reports or the database, then an entry was provided in the "density" class field. If the database contained only qualitative estimates of HMP annuals densities (e.g., high, medium, low), then an appropriate density class was determined.

Three treatment classes were identified as follows:

- Masticate – Vegetation was cut in place;
- Masticate & Burn – Vegetation was cut and then burned in place, or was cut and inadvertently burned;
- Burn – Vegetation was burned in place without being cut first. This method most closely mimics a natural fire.

In addition, another treatment class was identified for grids and transects which could not be assigned to one of the three primary treatment classes:

- Mixed – A portion of the grid cell was masticated and a portion was burned. These grids are generally located on the border between two treatments.

Treatments were identified based on the activities reported in previous reports and using data from the "flora_fire_area" shapefile obtained from USACE (USACE, 2022).

Table 1-1. Previous Monitoring Surveys at 2024 Study Units on Former Fort Ord.

Survey Year	Survey
2000	Harding Lawson Associates (2001) performed Baseline surveys on Range 48.
2013	Tetra Tech and EcoSystems West (2014) performed Year 10 (Pre-treatment) surveys in Range 48.
2014	Tetra Tech and EcoSystems West (2015a) performed Baseline surveys on Units 25 and 31 Containment Lines.
2015	Burleson (2016) performed Baseline surveys in Units 13 and 20 Containment Lines.
2017	Burleson (2018) performed Year 1 surveys in Unit 25; shrub transect monitoring and annual grasses monitoring on Unit 25, and Units 13, 20, and 31 Containment Lines.
2019	Burleson (2019b) performed Year 1 shrub transect monitoring and HMP annual surveys in Units 25 and 31 Containment Lines; Year 3 shrub transect monitoring of Unit 25 and Units 13, 20, and 31 Containment Lines.
2020	Burleson (2021) performed Year 1 surveys in Range 48.
2021	Burleson (2022) performed Year 3 HMP annual surveys in Units 25 and 31 Containment Line; Year 5 shrub transect monitoring of Unit 25 and Units 13, 20, and 31 Containment Lines.

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2 METHODS

This section describes the standard monitoring methods used during the 2024 vegetation monitoring program. Monitoring was completed based on methodology presented in the HMP, Protocol, and Revised Protocol (USACE, 1997; Burleson, 2009a; Tetra Tech and EcoSystems West, 2015b). Unit-specific modifications to methods are identified in the relevant results sections of the report, as needed.

2.1 Soils

The United States Department of Agriculture (USDA) mapped three soil types occurring in Units monitored in 2024, shown in Table 2-1 (USDA NRCS, 2024). Arnold-Santa Ynez complex is a large portion of the munitions remediation area (MRA) and occurs in Range 48 and Unit 31 Containment Line. Baywood sand with 2 to 15 percent slopes, occurs in Range 48. Xerorthents, dissected, occurs in Unit 25 and Units 13, 20, and 31 Containment Lines. However, the soils mapped by the USDA (2024) in the MRA may be too coarsely mapped to reflect soil variability at a relatively fine scale.

Table 2-1. Distribution of Soil Types in Former Fort Ord Biological Monitoring Areas of 2024 (USDA NRCS, 2024).

Soil Type	Description	Units Where Found
Ar, Arnold-Santa Ynez complex	**Arnold**: Loamy fine sand; somewhat excessively drained; derived from residuum weathered from sandstone **Santa Ynez**: Fine sandy loam; moderately well drained; derived from residuum weathered from sandstone	Range 48, Unit 31 Containment Line
BbC, Baywood sand, 2 to 15 percent slopes	Sand; somewhat excessively drained; derived from stabilized sandy aeolian sands	Range 48
Xd, Xerorthents, dissected	Loam, clay loam; well drained; derived from mixed unconsolidated alluvium	Unit 25, Units 13, 20, 31 Containment Lines

2.2 HMP Annuals Grids Methods

2.2.1 Field Methods

The Harris-Terracon team conducted density monitoring for three HMP annual species (Monterey spineflower, Monterey gilia, and seaside bird's-beak) during the 2024 monitoring season. These surveys occurred in Range 48. Yadon's piperia was not monitored for density as individual plants are often widely scattered and difficult to locate. Instead, individuals were mapped using ArcGIS Field Maps with a Juniper Systems Geode GNS3S Receiver with sub-meter accuracy and RTK (real-time kinematic) corrections; occurrences were noted for comparison with future monitoring efforts. Piperia individuals were recorded to genus due to the difficulty of identifying to species when not in flower. If observed, locations are reported to the BRAC office for possible avoidance during future remediation work and to allow a BRAC biologist to return during the appropriate bloom period to identify the species.

The predefined base-wide 100×100-ft grids were used as sample grids for density monitoring. In the Baseline Units, a stratified random sample of 100×100-ft grids were selected for sampling, consisting of grids identified during meandering transect surveys as occupied by one or more herbaceous HMP species. The monitoring protocol indicates that 20% of occupied grids or 38 total grids, whichever is greater, be selected for HMP annual density monitoring (Burleson, 2009a). Sampling was stratified by species to ensure adequate representation of Monterey spineflower, Monterey gilia, and seaside bird's-beak, and by containment area versus interior. Boundaries of sampled grids were located in the field using ArcGIS Field Maps with a Juniper Systems Geode GNS3S Receiver. Grid corners were temporarily marked in the field using pink flagging tape tied to the tallest point of vegetation to assist with navigation during HMP annual species monitoring.

Methods specified in the monitoring protocols were followed for all Units monitored in 2024 (Burleson, 2009a; Tetra Tech and EcoSystems West, 2015b). Monitoring for HMP annual species density is conducted at Baseline and follow-up monitoring is conducted at 1, 3, and 5-year intervals following treatment and MEC clearance. For all 2024 HMP annuals density surveys, each 100x100-ft sample grid was censused by counting all individuals of a given HMP annual species within the grid using a hand counter. When more than 500 individuals of any species were recorded, surveyors stopped counting individuals since this is the maximum density class.

For each HMP annual species in a 100×100-ft sample grid, surveyors estimated the percent suitable habitat within the grid. In practice, "suitable habitat" was treated as any "occupied habitat" or habitat that was suitable for HMP annuals (e.g., bare ground). Percent suitable habitat was historically used to calculate the estimated number of individuals present within a 100×100-ft sample grid when a circular subsample plot was used. The 2024 monitoring effort was based on the more recent protocols which eliminated the need for circular plots (Tetra Tech and EcoSystems West, 2015b).

For each HMP annual species, the 100×100-ft sample grid was assigned to one of five density classes based on the number of individuals counted or subsampled to be present. The density classes are as follows when the entire 100×100-ft sample grid is sampled:

0 = 0 plants,
1 = 1 to 50 plants,
2 = 51 to 100 plants,
3 = 101 to 500 plants,
4 = >500 plants.

When only a portion of the grid was sampled due to recent disturbance or interception by roads, the density classes were scaled proportionally to the percentage of the total grid sampled. In some cases, where it was evident that a given sample grid should be assigned to density class 4 (i.e., more than 500 plants), based on experience, the survey team assigned the grid to this density class without attempting to count or estimate the numbers of plants. In some cases, grids were assigned to density class 4 after a partial census indicated that considerably more than 500 plants were present in a 100×100-ft sample grid. Density class 4 was the only class assigned in this manner. The general steps taken by field surveyors when monitoring HMP annual grids were as follows:

- Located grid using ArcGIS Field Maps with a Juniper Systems Geode GNS3S Receiver.
- Marked the staked corners with flagging tape, or re-staked if necessary.
- Each grid was monitored by one surveyor, starting at one corner and walking the length of the grid and back, maintaining a 2-3 ft buffer from the last lane surveyed.
- Used hand counters, one for each HMP species, to count the number of individuals.
- Marked areas that had been counted to reduce double counting.
- Stopped counting a species once the entire grid was surveyed, or after 501 individuals were counted.
- Estimated percent occupied habitat.

- Recorded counts of individuals in each grid for Monterey spineflower, seaside bird's-beak, and Monterey gilia and the percent occupied on the field data sheet.

2.2.2 Statistical Methods

HMP annual grid density classes were calculated for Monterey spineflower, seaside bird's-beak, and Monterey gilia based on individual plant counts and grid area using ArcGIS Pro (ESRI, 2024). Density classes were assessed by unit by plotting counts of each density class for each HMP annual species. These are visually displayed using bar plots, and trends between Baseline, intervening survey years, and the current monitoring year are evaluated.

When possible, the effects due to treatment type (burned, masticated, or mixed) were evaluated. Treatment types were allocated by examining shapefiles of the HMP annual monitoring grids against the FODIS shapefiles "flora_pres_burn_area" and "flora_fire_area" using ArcGIS Pro (ESRI, 2024; USACE, 2022). Treatment types were allocated based on the following rules:

- Masticated – Greater than 90% of the grid was only masticated.
- Burned – Greater than 90% of the grid was only burned.
- Mixed – A portion of the grid was masticated and burned, and a portion was only burned or a portion was only masticated. Neither treatment was greater than 90%, but the sum was greater than 90%.
- Masticated and Burned – Greater than 90% of the grid was masticated and then subsequently burned.

All Units surveyed in 2024 were masticated only, so no further analysis was needed.

2.3 HMP Shrub Transects Methods

2.3.1 Field Methods

The Harris-Terracon team conducted shrub transect monitoring in maritime chaparral in Unit 25 and Units 13 and 20 Containment Lines during the 2024 monitoring season. For previously sampled transects, including follow-up monitoring at 3, 5, and 8 years post-treatment, the surveyors used ArcGIS Field Maps with an external Trimble® R1 GNSS receiver (sub-meter accuracy) to locate the previously recorded start points of each transect sampled. In the Baseline year, one transect was allocated for every 11 acres (approximately) within a Unit. Transects were allocated separately within the masticated primary Containment Lines or the interior of the Units. This is done to evaluate effects due to treatment type when different treatments are employed between the Containment Lines and the Unit interiors.

Shrub transect sampling was conducted using the line intercept method along transects 50 meters (m) in length (Tetra Tech and EcoSystems West, 2015b; Burleson, 2009a). The general line intercept methodology included:

- Navigating to the transect start point using ArcGIS Field Maps with an external Trimble® R1 GNSS receiver and following line shapefiles of transects from the FODIS database.
- Laying out a 50-m transect tape along the line, repeating direction from previous sampling year.
- Recording plants greater than or equal to 0.1 m contiguous cover directly beneath the transect.
- Identifying shrubs to species and recording start/end points on the transect. Bare ground was also recorded.

- Recording herbaceous cover collectively when its cover was less than 20% of the transect line, and all species present recorded without cover quantification for each.
    - Herbaceous cover only included individuals that appeared to be from this growing season. Herbaceous cover that appeared dead from the previous growing season was considered thatch and not quantified along the transect line.
    - When herbaceous cover was greater than 20%, quadrat sampling was conducted to describe the species composition and abundance (cover) of herbaceous vegetation at that location. These quadrats alternated from right to left on either side of the transect placed every 10 m (6 quadrats total).
- Recording transect direction, clarifying species codes for uncommon species, and noting areas of new mastication or fuel breaks that may have reduced the effective length of a transect since the Baseline sampling year.
- When transects were less than 50 m (i.e., intersected by a road), calculating cover values with the new transect length. The shortened transects were then analyzed as if they were 50 m. This was deemed appropriate since the differences in length occurred on few transects and was a small portion of the total transect length.

2.3.2 Statistical Methods

Treatment Units were initially separated by the age of treatment at the point when 2024 shrub transect monitoring was conducted (e.g., 5-year-old vs 3-year-old). Within these groups, the Harris-Terracon team conducted either one-way, two-way, or three-way permutational analysis of variance (PERMANOVA) testing to detect differences in community composition between Unit, Age, or Treatment (Anderson, 2001; McArdle and Anderson, 2001). Community composition is defined by the structural patterns of the community (e.g., abundance, richness, evenness, and diversity; Smith and Smith, 2001). Treatment age, Unit, and treatment type are grouping factors that will be referred to as *age*, *unit*, and *treatment*. These tests were conducted using the *adonis* function in the vegan package in R Statistical Software (Oksanen, 2021; R Core Team, 2023). The Harris-Terracon team used Bray-Curtis dissimilarity matrices to measure community composition, and partitioned between factors. The function *adonis* uses permutation testing to detect the potential influence of those partitions. Two-way PERMANOVA testing was conducted on Units that contained more than one treatment to examine the influence of *treatment* on community composition. PERMANOVA testing is a robust alternative to other analyses (e.g., Kruskal-Wallis or ANOVA). While the test has the potential to increase the Type II error (false positive) rate compared to other tests, PERMANOVA reduces the need to conduct separate tests for each community structure parameter and eliminates the normality assumption required from ANOVA (i.e., some community structure data do not meet normality assumption).

Following Legendre and Legendre (1998), the Harris-Terracon team conducted nonmetric multidimensional scaling (NMDS) ordinations. These allowed qualitative visualizations of the differences detected in PERMANOVA testing. NMDS is a reduced-space ordination method that begins with full dimensional space and attempts to represent groups in as few dimensions as possible while retaining the distance relationships between groups. Vegetation transect data was grouped by *treatment* or *age*. The matrices analyzed were *transect* by *species* and are sometimes longer in the *species* dimension than in the *transect* dimension. Differences between these grouping factors are illustrated by differing locations of ellipsoids that surround grouped transect points in ordination space. These analyses were conducted utilizing the *metaMDS* function in the vegan package, using Bray-Curtis dissimilarity distances (Oksanen, 2021).

Four community metrics were calculated and grouped by *treatment* or *age* within Units to assess community structure. Community metrics calculated were total cover (%), Shannon-Wiener diversity index, species richness, and species evenness index. All community metrics calculations exclude bare ground and herbaceous cover. Total cover is sometimes greater than 100% due to overlapping growth of some species (e.g., a coast live oak tree growing within a sandmat manzanita individual). Cover (%) is identified as:

c = vegetative cover

Species diversity was measured by the Shannon-Weiner *H'* metric (Pielou, 1974). This metric expresses diversity as a combination of the number of species present in the association and their relative abundance (or cover) in the sample. Diversity increases with both increasing number of species and increasing equitability of species abundance. For a given number of species, diversity is highest when all species are present in equal abundance. Diversity index is calculated as:

$$H' = -\sum_{i=1}^{S} p_i * \ln(p_i)$$

where,

p_i = proportion of the i^{th} species = $\frac{n_i}{N}$

Species richness is the number of species present, including native and non-native species. Evenness is a measure of the equability of the relative contribution of species to the total cover in the association (Pielou, 1974). Evenness is the ratio of the observed diversity to the maximum diversity possible for a sample with the same number of species. Maximum evenness (value = 1) is achieved when all species are present in equal abundance in the sample. Evenness is calculated as:

$$J' = \frac{H'}{\ln(S)}$$

where,

S = species richness

These statistics were calculated using the functions *rowSums*, *diversity*, and *specnumber* in the *vegan* package (Oksanen, 2021). Community metrics data were displayed via scatterplots and the *jitter* function was used to add random noise to better visualize overlapping data points.

One-way, two-way, or mixed-design ANOVA were conducted to detect differences of community metrics between *Units* within age classes, and *treatment* groups within Units when more than one treatment was applied to any Unit. Bare ground cover and herbaceous cover were evaluated using the same methods that were used for community metrics. These methods are also utilized to evaluate HMP species cover differences between *treatment* types in the Year 8 Units.

When conducting two- or three-way ANOVA tests, the *F*-statistic and *p*-value were used to assess potential differences. The *F*-statistic is defined as:

$$F = \frac{variation\ between\ sample\ means}{variation\ among\ individuals\ within\ the\ same\ sample}$$

The *F*-statistic can only be zero or positive in value and is only zero when all sample means are identical (Moore *et al.*, 2013). The *F*-statistic gets larger as the sample means move further apart. Large values provide evidence against the null hypothesis that the means are the same.

The *p*-value is a means to assess the strength of evidence against a claim (the null hypothesis) (Moore *et al*., 2013). It follows the reasoning that an outcome that would rarely happen if a claim were true is good evidence against that claim. The *p*-value represents the probability of how infrequently an outcome like this would happen if the null hypothesis were true. Small *p*-values are evidence against the null hypothesis because they show that the observed result would be unlikely if the null were true.

In former Fort Ord Biomonitoring Annual Reports issued prior to 2020, statistical differences were considered significant when the *p*-value was less than a 0.05 significance level and when the *F*-statistic was considerably greater than one. Starting with the 2020 Annual Report, less emphasis was placed on the *p*-value and *F*-statistic in comparison to a significance level. This shift is based on a statement by the American Statistical Association (Wasserstein and Lazar, 2016) that discussed potential misinterpretation of the *p*-value and the "bright line" created between significant and not significant when compared against a predetermined significance level (Wasserstein and Lazar, 2016; Wasserstein *et al.*, 2019). Instead, while the *F*-statistic and *p*-value are reported, no significance level is identified and interpretation of the factors affecting recovery is based on an overall assessment of the data and descriptive statistics.

When two- or three-way ANOVAs were conducted, *F*-statistic and *p*-value were reported for interaction terms. Interaction terms may suggest if unique responses to particular treatment combinations (e.g., *Burned* transects at the *Age* level of Year 8 only) exist (Gotelli and Ellison, 2004).

When appropriate, Mauchly's test was utilized to test that the sphericity assumption was met, which evaluates the equal variance among the differences between all possible combinations of groups. When community metrics did not meet parametric assumptions of one-way ANOVA testing, either Greenhouse-Geisler sphericity corrections or nonparametric Kruskall-Wallis tests were used. In cases where community metrics did not meet parametric assumptions of two-way ANOVA testing, we made inferences using the PERMANOVA results, as there is no nonparametric version of a two-way ANOVA. Descriptive statistics were used to examine differences in communities over time and between treatments.

Rank abundance curves (RACs) were generated to illustrate the important community relationships and show species-level responses to differences in *treatment* or *age* (Molles, 2010). RACs were plotted with species rank on the x-axis and the $\log_{10}$ proportional abundance on the y-axis, with species identified using their species code (see Appendix A for Fort Ord species code list). The distribution of the species in these Units can characterize the species composition further than the community metrics such as the Shannon-Wiener diversity index or the species evenness index (Calow, 1999). Rank abundance curves were created using the *rankabundance* function in the BiodiversityR package (Kindt, 2019; R Core Team, 2023).

2.4 Non-Native Annual Grasses Methods

2.4.1 Field Methods

Non-native annual grasses were mapped within Unit 25 and Units 13, 20, and 31 Containment Lines, as well as in roadside fuel breaks adjacent to each Unit, during the 2024 monitoring season. Areas directly adjacent to the roads were mapped from the vehicle. Areas further than 25-50 ft from the vehicle, or where direct line-of-sight was impeded, were mapped on foot. All maps of annual grass polygons were mapped using ArcGIS Field Maps with a Trimble® R1 GNSS receiver or a Juniper Systems Geode GNS3S Receiver; the acreage occupied was calculated using ArcGIS Pro. Density classes for each polygon were visually estimated and recorded.

2.4.2 Reporting Methods

Non-native annual grasses are presented on maps derived in ArcGIS Pro (ESRI, 2024). Additionally, the estimated area occupied by annual grasses was quantified for all areas where surveys occurred and reported by density class. The density classes are as follows:

1 (low)	= 1-5%
2 (medium)	= 6-25%
3 (high)	= >25%

2.5 Invasive Species Methods

2.5.1 Field Methods

Invasive species were monitored along shrub transects and when encountered incidentally during HMP annuals and annual grass monitoring, or while traversing the Units to reach sampling locations. Emphasis was placed on iceplant (*Carpobrotus edulis*), pampas grass (*Cortaderia* sp.), and French broom (*Genista monspessulana*). Iceplant locations were only recorded when the occurrence was larger than about 100 square feet (ft^2) or in areas clustered with smaller individuals that collectively indicated a recent and/or potentially problematic infestation. Locations were recorded using ArcGIS Field Maps with a Trimble® R1 GNSS receiver or a Juniper Systems Geode GNS3S Receiver.

2.5.2 Reporting Methods

Invasive species are presented on maps developed in ArcGIS Pro (ESRI, 2024). These surveys were not intended to be comprehensive. The intent is to document occurrences to support invasive species management through the Service Agreement with the BLM.

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3 YEAR 5 VEGETATION SURVEYS: Range 48

3.1 Introduction

Year 5 surveys were completed at Range 48 (Figure 3-1). The area was masticated in 2019 as part of environmental cleanup operations involving MEC removal activities. Prior to mastication efforts in 2019, Range 48 vegetation was monitored over thirteen years (2000-2013), including after a controlled burn in 2003. Baseline monitoring for Range 48 was conducted in 2000 following previous HMP Annual monitoring protocols (HLA, 2001). The Baseline data from 2000 were documented by mapping patches of HMP Annual species instead of recording numbers of individuals by grid. Results from 2013 HMP Annual grid surveys (Year 10 post-burn) are considered to be Baseline for the 2024 analysis, as the 2013 results were collected using the current protocol and the data represent pre-mastication conditions (Tetra Tech and Ecosystems West, 2014). No shrub transects, or annual grass monitoring was conducted during Year 5 surveys of Range 48.

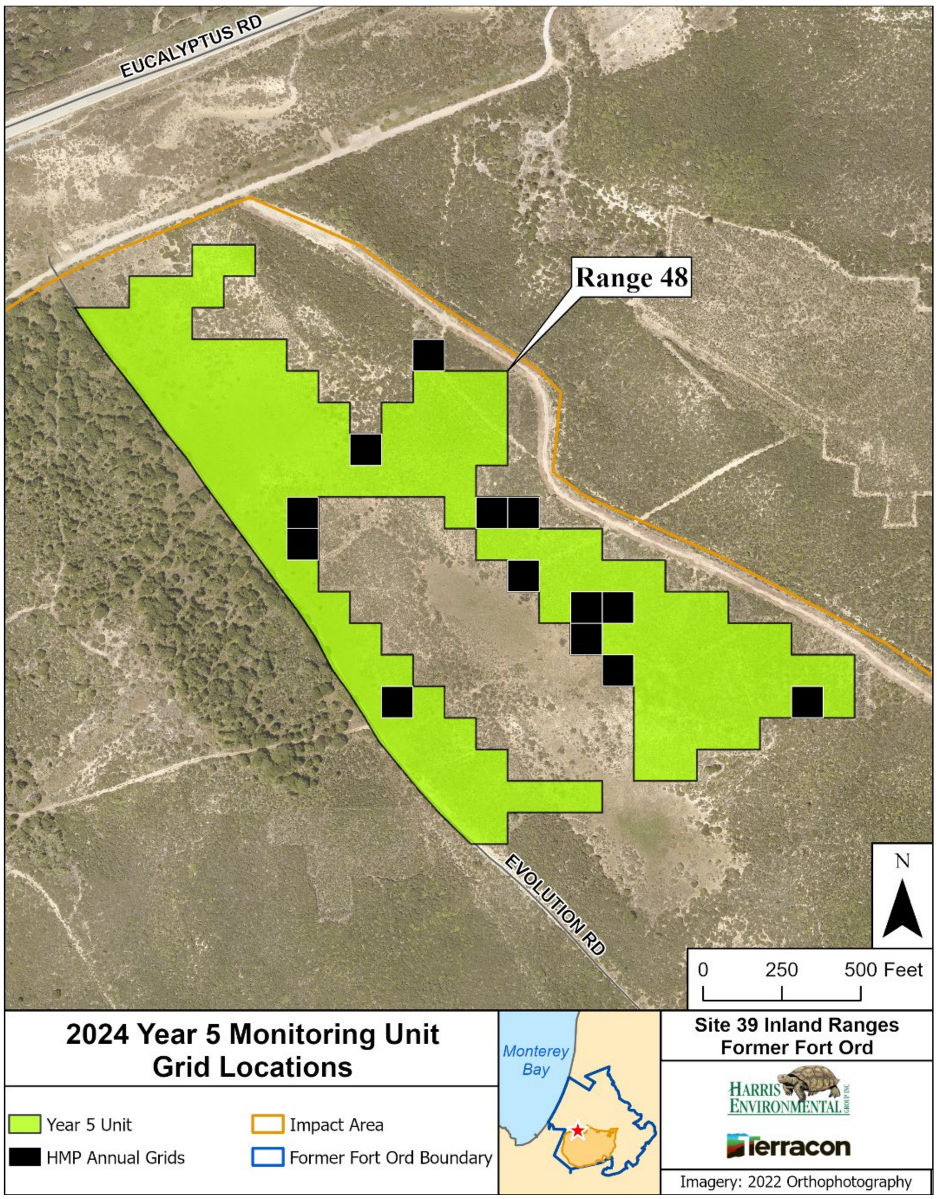


Figure 3-1. Year 5 HMP annuals grids surveyed in 2024.

3.2 Range 48: Setting

Range 48 encompasses approximately 30 acres of generally rolling terrain that was masticated in 2019. Range 48 is treated as the area west and northwest of the intersection of Orion Road and Broadway Avenue and south of Eucalyptus Road. Two major vegetation types predominate in the area: maritime chaparral and areas dominated by grasses and herbs with only scattered shrubs.

3.3 Range 48: Methods

In accordance with methods outlined in the Revised Protocol and Section 2 in this report, the 2024 Year 5 vegetation monitoring surveys in Range 48 comprised the following components:

- Density monitoring for three HMP annual species: Monterey gilia, seaside bird's-beak, and Monterey spineflower. This survey effort was conducted to evaluate how the density of these species responded to treatment within the monitored grids. Surveys occurred on May 6, 7, and 16, 2024.
- Mapping of invasive species including iceplant, pampas grass, and French broom, where encountered. This survey effort was conducted to support ongoing management.

3.4 Range 48: Results and Discussion

Year 5 surveys included 13 HMP monitoring grids in Range 48 in 2024. Maps of survey grids for the sampled Units are provided in Appendix B (Figures B-1 through B-3).

3.4.1 Monterey gilia

Monterey gilia was observed in Range 48 in all survey years. In Baseline (2013), Monterey gilia had a frequency of occurrence of 46% (6 of 13 grids). Monterey gilia increased in both frequency and density in Year 1, with a frequency of occurrence of 85% (11 of 13 grids), with 6 of those grids containing 101-500 plants. The frequency of occurrence in Years 3 and 5 returned to near-Baseline conditions, with frequency of occurrences of 46% and 54%, respectively (Figure 3-2; Appendix B, Figures B-1). The grids occupied by Monterey gilia were generally consistent year to year, with minimal spatial variation. Five of the six grids occupied in Baseline were still occupied in Year 5; and the same six grids in the 101-500 plant density class in Year 1 persisted into Years 3 and 5, shifting to the 1-50 plant density class.

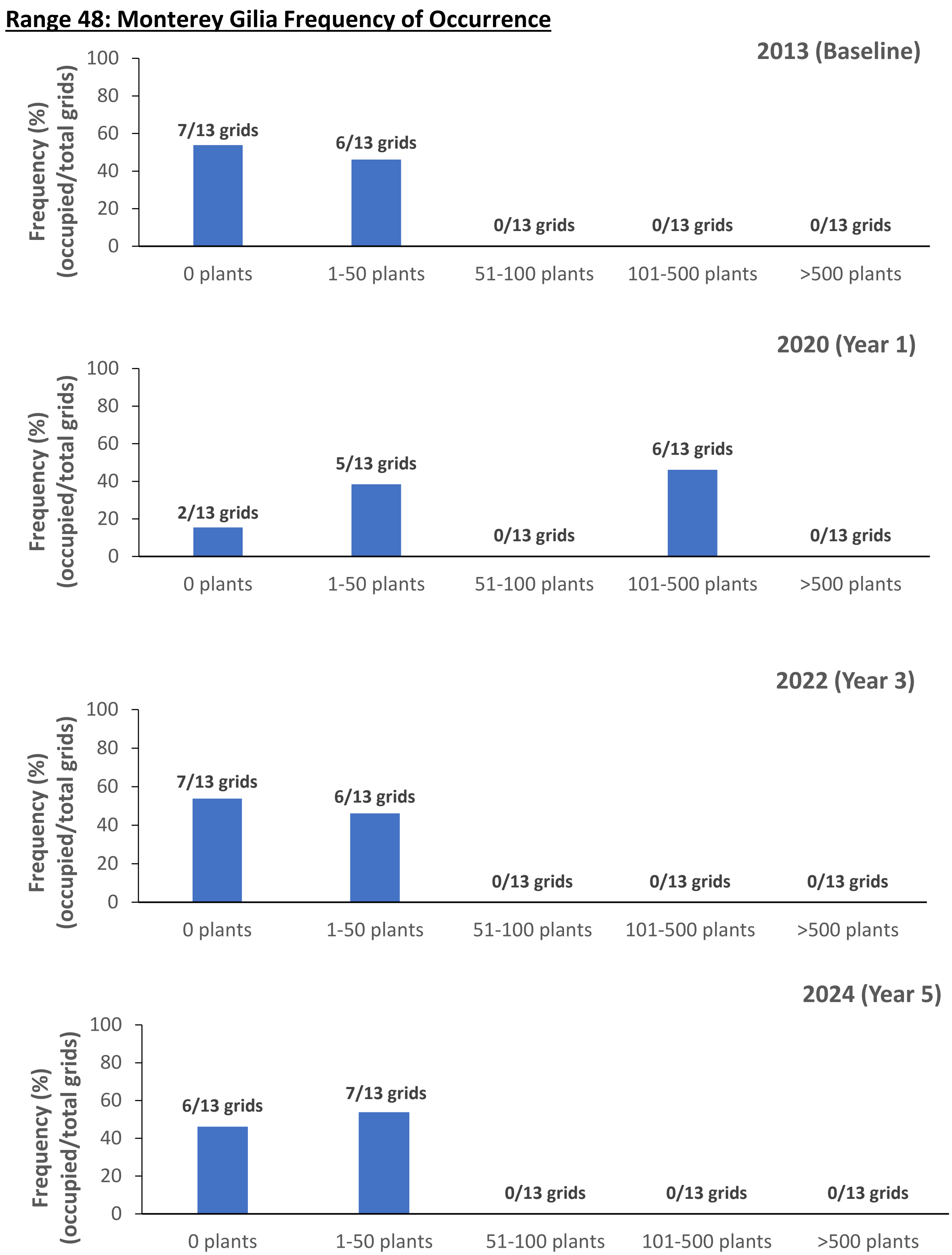
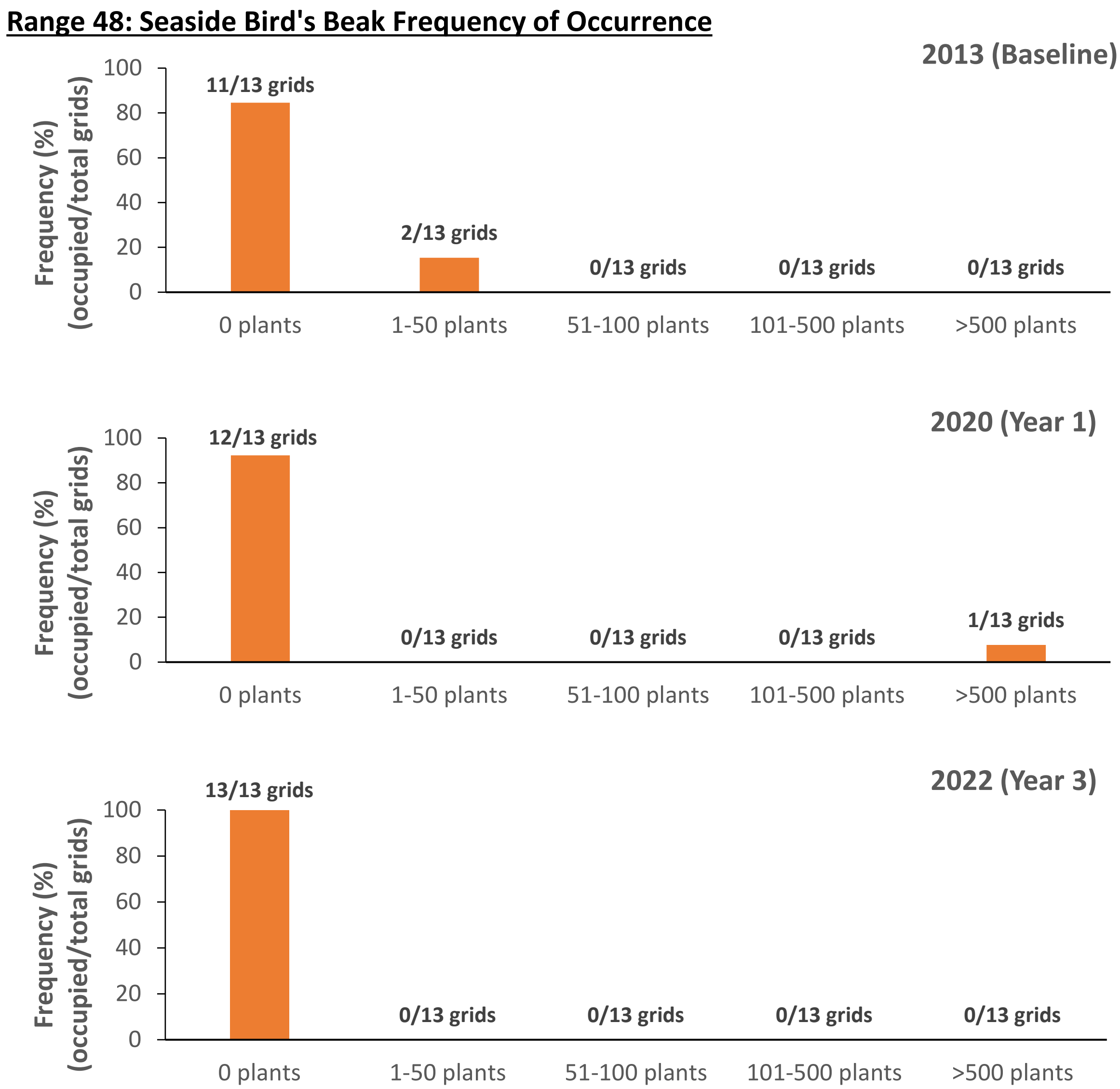


Figure 3-2. Range 48 Monterey gilia occurrence in surveyed grids (n=13) for Baseline (2013), Year 1 (2020), Year 3 (2022), and Year 5 (2024).

3.4.2 Seaside Bird's-Beak

Seaside bird's-beak was observed in Range 48 in Baseline (2013) and Year 1 (2020) but was not observed in Year 3 (2022) or Year 5 (2024) (Figure 3-3; Appendix B, Figure B-2). Seaside bird's-beak had a frequency of occurrence of 15% (2 of 13 grids) in Baseline, 8% (1 of 13 grids) in Year 1, and 0% in Years 3 and 5.



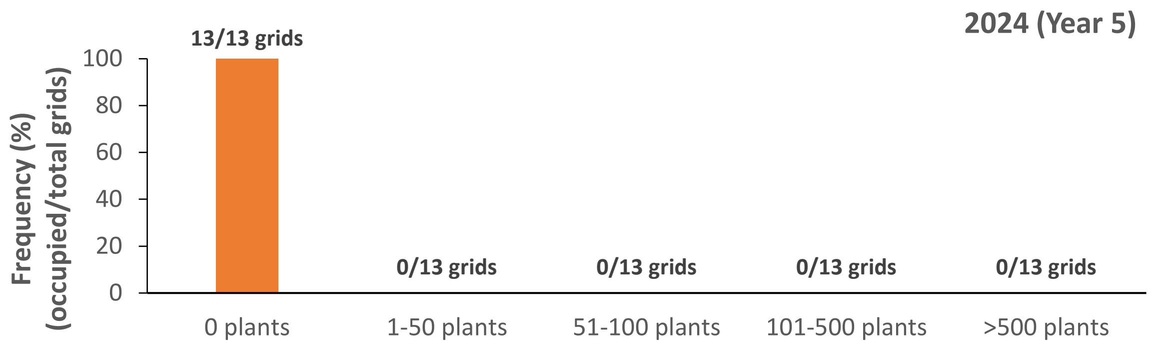
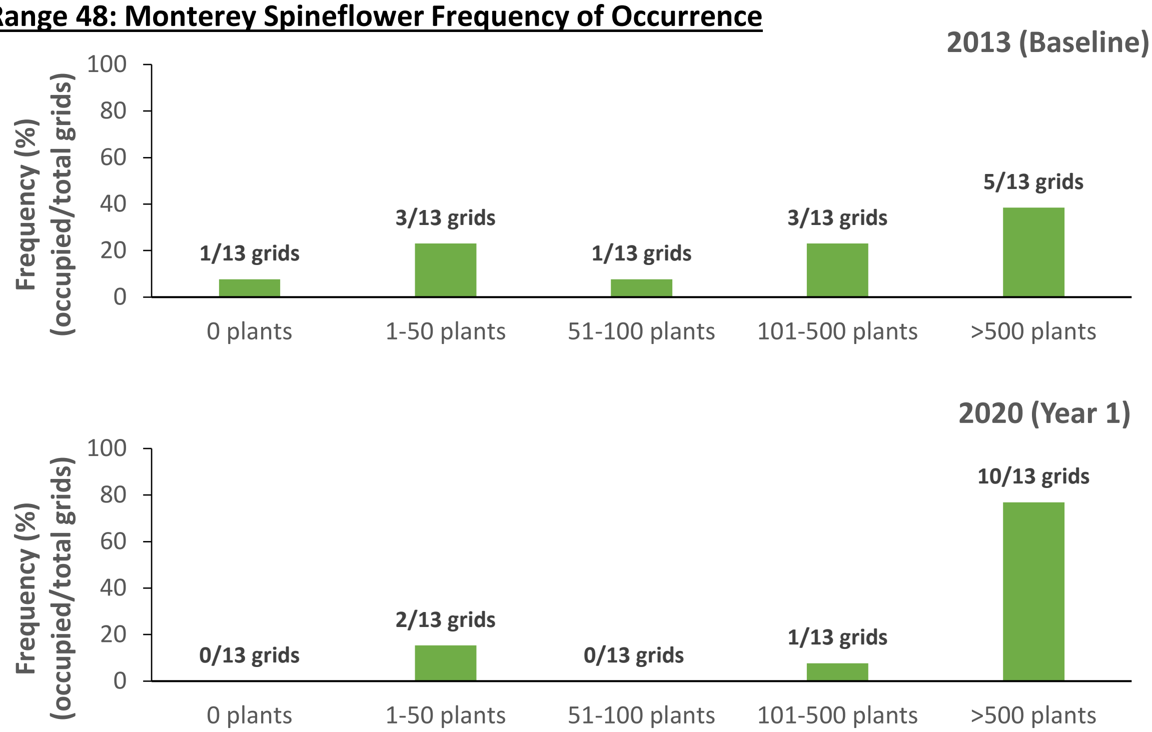


Figure 3-3. Range 48 Line seaside bird's beak occurrence in surveyed grids (n=13) for Baseline (2013), Year 1 (2020), Year 3 (2022), and Year 5 (2024).

3.4.3 Monterey Spineflower

Monterey spineflower was observed in Range 48 in all survey years and has increased in density since Baseline (Figure 3-4). In Baseline, Monterey spineflower was observed with a frequency of occurrence of 92% (12 of 13 grids). The frequency of occurrence increased to 100% (13 of 13 grids) by Year 1 and remained at 100% in Years 3 and 5, with most grids falling within the highest density class (Figure 3-4; Appendix B, Figure B-3). The grids occupied by Monterey spineflower were generally consistent year to year, with minimal spatial variation.

Range 48: Monterey Spineflower Frequency of Occurrence



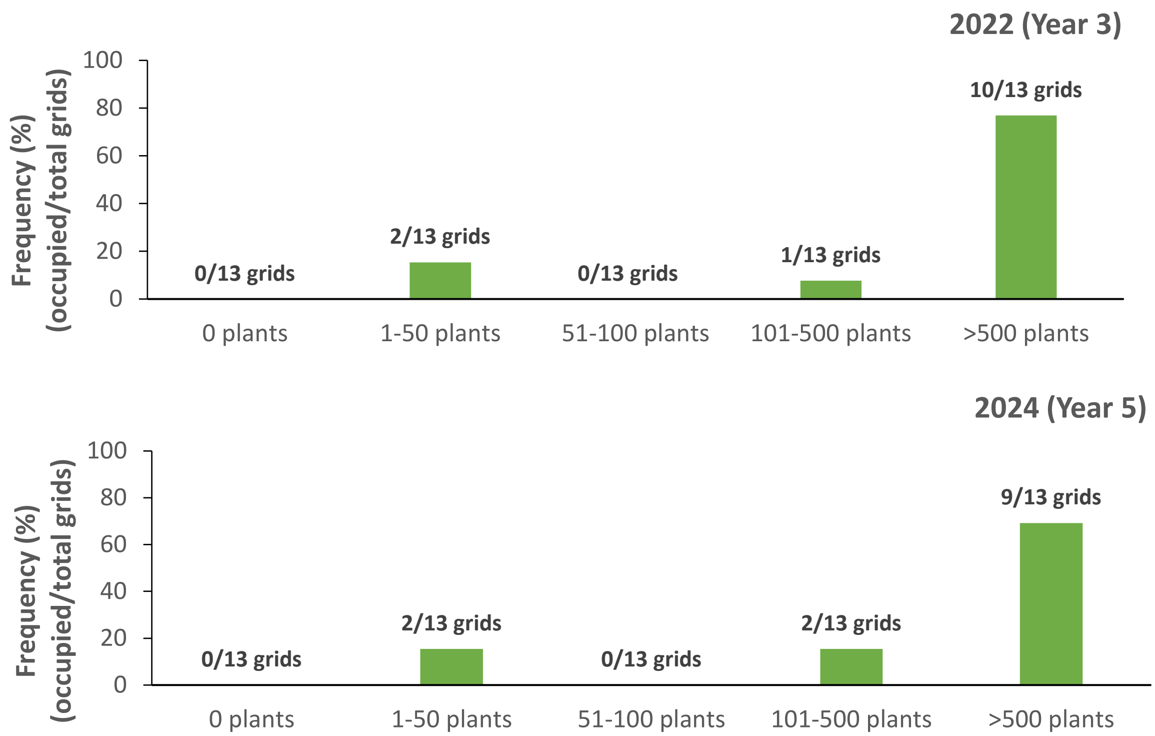


Figure 3-4. Range 48 Monterey spineflower occurrence in surveyed grids (n=13) for Baseline (2013), Year 1 (2020), Year 3 (2022), and Year 5 (2024).

3.4.4 Yadon's Piperia

No piperia were observed at Range 48.

3.4.5 Effect of Treatment on HMP Density

The effect of different treatment types on HMP annuals density could not be evaluated at Range 48 since this area was masticated only, with no prescribed burns.

3.4.6 Invasive and Non-Native Species Monitoring

None of the target invasive species (iceplant, pampas grass, and French broom) were observed during Year 5 of monitoring at Range 48.

4 YEAR 8 VEGETATION SURVEYS: UNIT 25 AND UNITS 13, 20, AND 31 CONTAINMENT LINES

4.1 Introduction

Year 8 Units included Unit 25 and the Containment Lines of Units 13, 20, and 31 (Figure 4-1). These Units were masticated in 2016 as part of environmental cleanup operations involving preparations for prescribed burns and MEC removal. The Containment Lines of Units 25 and 31 were partially re-masticated in 2018 as part of environmental cleanup operations involving preparations for prescribed burns and MEC removal. Baseline surveys occurred in 2014 for Units 25 and 31, and 2015 for the Containment Lines of Units 13 and 20 (Tetra Tech and EcoSystems West, 2015a; Burleson, 2016). These surveys included meandering transects to map areas of occurrence of HMP herbaceous species; density monitoring for the HMP annual species Monterey gilia, seaside bird's-beak, and Monterey spineflower; transects to sample shrub composition in the maritime chaparral (Unit 25 and Units 13 and 20 Containment Lines); and annual grass monitoring. Year 1 surveys occurred in 2017, Year 3 surveys occurred in 2019, and Year 5 surveys occurred in 2021 for all Year 8 Units. Years 1, 3, and 5 surveys included density surveys for the HMP annual species Monterey gilia, seaside bird's-beak, and Monterey spineflower; and annual grass surveys (Terracon, 2022). In 2024, shrub transect monitoring occurred in Unit 25 and Units 13 and 20 Containment Lines; and annual grass monitoring occurred in Unit 25 and Units 13, 20, and 31 Containment Lines.

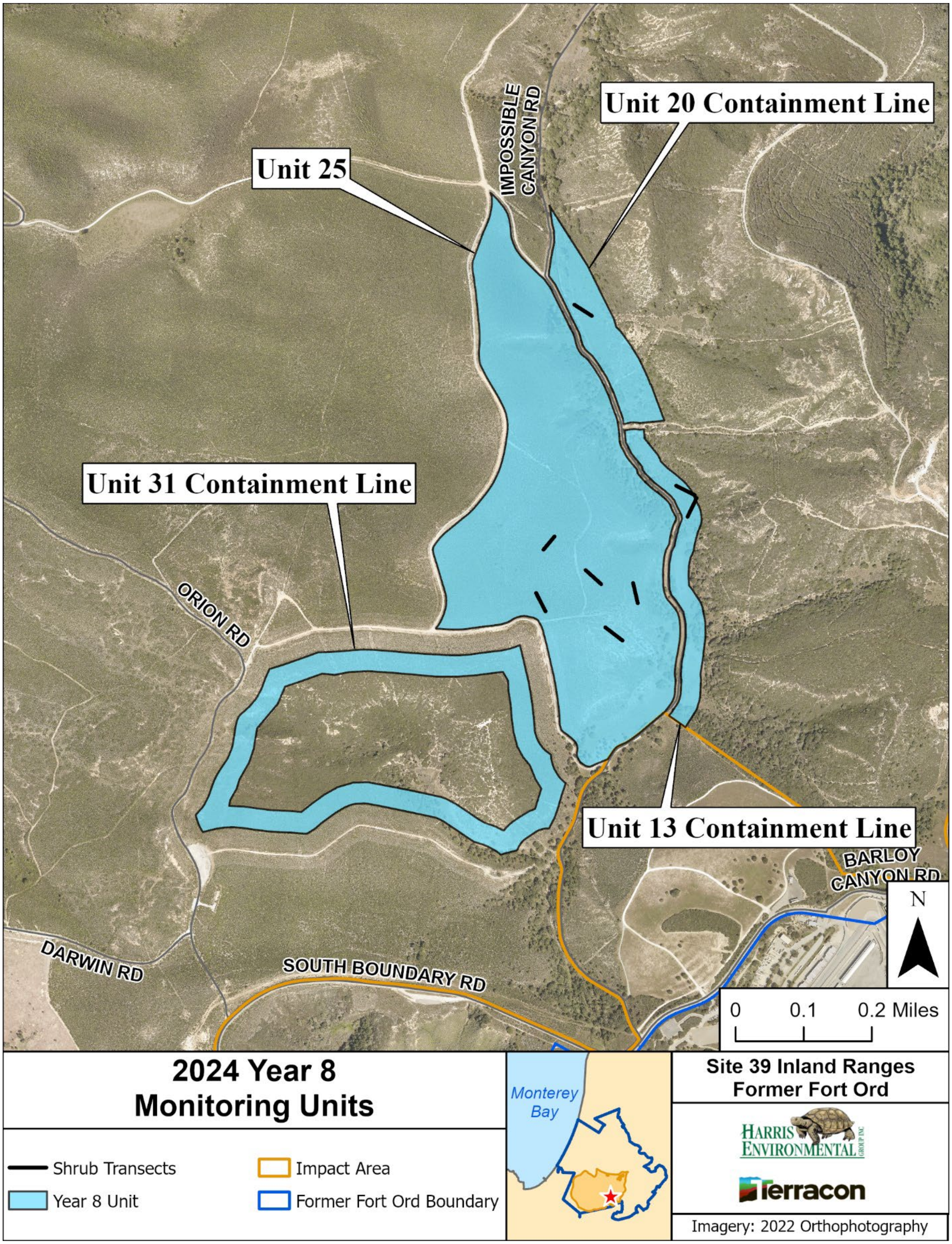


Figure 4-1. Year 8 Monitoring Units for shrub transect and annual grass monitoring. All Units were surveyed for annual grasses; Unit 25 and Units 13 and 20 Containment Lines were surveyed for HMP shrub transects in 2024.

4.2 Unit 25 and Units 13, 20, and 31 Containment Lines: Setting

Unit 25 encompasses a 95-acre area. This Unit was initially slated for a prescribed burn, but due to significant risk of an escaped wildfire (difficult terrain and proximity to residential areas), the Army decided to masticate the entire Unit. This action was coordinated with USFWS which affirmed that it was within the allowed activities described in the PBO (USFWS, 2019). The Unit is located east of Riso Ridge Road and west of Impossible Canyon Road in the southeast portion of former Fort Ord. Unit 25 has gently rolling topography in the western portion, with a steep, east-facing slope dominated by coast live oak woodland in the eastern portion bordering Impossible Canyon Road. Abandoned roads with varying amounts of vegetative overgrowth across the Unit and along ridgelines provide some degree of unobstructed access to the interior portions of the Unit. Prior to mastication, Unit 25 was dominated by mature maritime chaparral vegetation. Non-meadow annual grassland and disturbed areas occur in the southeast portion of the Unit along Impossible Canyon Road. Relatively open chaparral is most extensive on south and east facing slopes in areas that appeared more recently disturbed.

The Containment Lines of Units 13 and 20 encompass 9 acres and 10 acres, respectively. These areas will serve as the primary containment (mastication only) areas for prescribed burns planned for Unit 31 immediately to the west. The Units are bordered to the west by Impossible Canyon Road and situated in the southeast portion of the former Fort Ord Impact Area and immediately northwest of the Laguna Seca Raceway. Unit 13 is dominated by mature maritime chaparral to the north and coast live oak woodland and disturbed non-native grassland to the south. The Unit is situated along the lower half of a steep west facing slope forming Impossible Canyon. A sizable vernal pool (Pond 16) containing emergent vegetation and known to support federally threatened California tiger salamander (*Ambystoma californiense*) and fairy shrimp (*Linderiella occidentalis*) is located in the western portion of Unit 13 and is surrounded by annual grassland and coyote brush scrub. Unit 20 is contiguous with Unit 13 to the south and is more heavily dominated by maritime chaparral. There are scattered areas of oak woodland in the southernmost and northernmost section and a large area of past disturbance with non-native fill material in the south-central portion of the Unit. Several old north-south trending roads bisect the Unit providing some degree of unobstructed access to the interior portions of the Unit.

Unit 31 Containment Line was masticated in 2016 and a portion was re-masticated in 2018 in preparation for prescribed burns. The area surveyed for annual grasses in 2024 included the 34 acres of containment line that was masticated in 2016 but not re-masticated in 2018. A prescribed burn without mastication is planned for the interior of the Unit (47 acres). The Unit is located east of Riso Ridge Road and west of Impossible Canyon Road in the southeast portion of the area of former Fort Ord. Unit 31 is dominated by mature maritime chaparral, coast live oak woodland, and disturbed non-native grassland. The Unit is located in a southeast facing bowl which slopes down to a narrow valley that was evidenced to have been heavily used for infantry training when the base was active. The relatively flat valley is bordered by dense coast live oak woodland on a steep north facing slope immediately to the south and comprises patchy non-native grassland with sparse to locally dense coyote brush (*Baccharis pilularis*).

4.3 Unit 25 and Units 13, 20, and 31 Containment Lines: Methods

In accordance with methods outlined in the Revised Protocol (Tetra Tech and EcoSystems West, 2015b) and Section 2 of this report, the 2024 Year 8 follow-up shrub transect monitoring and annual grass surveys occurred in Units 25 and Units 13, 20, and 31 Containment Lines consisted of the following activities:

- Mapping of non-native annual grasses within the primary containment areas. This survey effort was conducted to assess expansion or contraction of these populations over time after disturbance. Surveys occurred on June 11, 12, 13, 17, 20, and July 15, 2024.
- Repeated sampling of transects that were monitored in 2014, 2015, and 2019 surveys (Tetra Tech and EcoSystems West, 2015a; Burleson, 2016; Burleson, 2019b). This survey effort was conducted to assess shrub species composition of the sensitive maritime chaparral community after treatment. Surveys occurred on June 11, 12, 17, and 18, 2024.
- Mapping of invasive species, including iceplant, pampas grass, and French broom, where encountered. This survey effort was conducted to support ongoing management.

4.4 Unit 25 and Units 13, 20, and 31 Containment Lines: Results and Discussion

A total of eight shrub transects were monitored in Year 8 Units, with five in Unit 25, two in Unit 13, and one in Unit 20. Maps of monitored transects are provided in Appendix C.

4.4.1 Yadon's Piperia

No piperia were observed in any Year 8 Units (Appendix E).

4.4.2 Shrub Transect Monitoring

Shrub transects were sampled in Units 25 (*n*=5) and Units 13 (*n*=2) and Unit 20 (*n*=1) Containment Lines in 2024 (Appendix C, Figures C-1 through C-3). Baseline transects were collected in 2014 for Unit 25 and in 2015 for Units 13 and 20 Containment Lines (Tetra Tech and EcoSystems West, 2015a; MACTEC, 2004).

The temporal patterns of broad scale community response to mastication were generally congruent with past observations of the neighboring Units in the MRA (Tetra Tech and EcoSystems West, 2011 through 2015b; Burleson, 2016 through 2022). Community structure parameters in all Year 8 Units changed similarly through time in most cases.

Mixed-design ANOVAs were conducted to examine the effects of Unit and age on mean percent cover, species richness, species evenness, and species diversity for Year 8 Units. Unit did not appear to influence any community structure parameters, whereas age of the Unit (Baseline vs. Year 8) appeared to influence mean percent cover, species richness, and species diversity (Figure 4-1). There was no evidence of an interaction between Unit and age affecting community composition.

Table 4-1. Mixed-design ANOVA Results for Unit 25 and Units 13 and 20 Containment Lines.

Factor	Total Mean Cover		Species Richness		Species Evenness		Species Diversity	
	F	*P*	*F*	*P*	*F*	*P*	*F*	*P*
Unit	0.5731	0.5969	1.250	0.3629	0.0823	0.9222	0.0501	0.9517
Age	16.51	5.11E-05	11.03	0.0050	0.5851	0.6340	5.116	0.0336
Unit*Age	0.4600	0.827	0.5494	0.6830	0.3884	0.8751	0.0660	0.9879

Mean shrub cover in all Year 8 Units responded similarly to mastication between Baseline and Year 8 (Figures 4-2, 4-3, and 4-4). Mean cover decreased for all Year 8 Units between Baseline ($C_{13,\ Baseline}$ = 109%; $C_{20,\ Baseline}$ = 108%; $C_{25,\ Baseline}$ = 106%) and Year 3 ($C_{13,\ Year\ 3}$ = 79%; $C_{20,\ Year\ 3}$ = 66%; $C_{25,\ Year\ 3}$ = 65%). However, shrub cover in all Units began recovering in Year 5 and continued to increase in Year 8 ($C_{13,\ Year\ 8}$ = 112%; $C_{20,\ Year\ 8}$ = 90%; $C_{25,\ Year\ 8}$ = 91%). Overall, Unit 13 Containment Line slightly increased, while Unit 20 Containment Line and Unit 25 decreased in mean shrub cover from Baseline to Year 8.

Species richness in Year 8 Units responded variably to mastication (Figures 4-2, 4-3, and 4-4). Species richness in all Year 8 Units increased from Baseline ($S_{13,\ Baseline}$ = 4.5; $S_{20,\ Baseline}$ = 6.0; $S_{25,\ Baseline}$ = 5.0) to Year 3 ($S_{13,\ Year\ 3}$ = 7.5; $S_{20,\ Year\ 3}$ = 10.0; $S_{25,\ Year\ 3}$ = 8.2), either increased slightly or remained stable in Year 5, and either decreased or remained stable in Year 8 ($S_{13,\ Year\ 8}$ = 8.5; $S_{20,\ Year\ 8}$ = 8.0; $S_{25,\ Year\ 8}$ = 9.6). Overall, all Year 8 Units increased in species richness from Baseline to Year 8.

Species diversity between Year 8 Units generally responded similarly over time (Figures 4-2, 4-3, and 4-4). Unit 20 Containment Line and Unit 25 species diversity increased from Baseline ($H_{20,\ Baseline}$ = 0.96, $H_{25,\ Baseline}$ = 0.92) to Year 3 ($H_{20,\ Year\ 3}$ = 1.4, $H_{25,\ Year\ 3}$ = 1.4), and remained stable in Year 5 and Year 8. Species diversity in Unit 13 Containment Line increased from Baseline ($H_{13,\ Baseline}$ = 0.98) to Year 3 ($H_{13,\ Year\ 3}$ = 1.3), and remained relatively stable in Year 5 ($H_{13,\ Year\ 5}$ = 1.4) and Year 8 ($H_{13,\ Year\ 8}$ = 1.3). Overall, all Year 8 Units increased in species diversity from Baseline to Year 8.

Species evenness in Year 8 Units responded variably to mastication but remained relatively stable between years (Figures 4-2, 4-3, and 4-4). Unit 20 Containment Line and Unit 25 increased from Baseline ($J_{20,\ Baseline}$ = 0.54, $J_{25,\ Baseline}$ = 0.58) to Year 3 ($J_{20,\ Year\ 3}$ = 0.62, $J_{25,\ Year\ 3}$ = 0.64), decreased or remained stable in Year 5 ($J_{20,\ Year\ 5}$ = 0.62, $J_{25,\ Year\ 5}$ = 0.62), and increased in Year 8 ($J_{20,\ Year\ 8}$ = 0.70, $J_{25,\ Year\ 8}$ = 0.63). Unit 13 Containment Line slightly decreased from Baseline ($J_{13,\ Baseline}$ = 0.65) to Year 3 ($J_{13,\ Year\ 3}$ = 0.64), increased by 0.01 in Year 5, and decreased slightly in Year 8 ($J_{13,\ Year\ 8}$ = 0.63). Overall, Unit 20 Containment Line and Unit 25 increased in species evenness, while Unit 13 Containment Line decreased slightly from Baseline to Year 8.

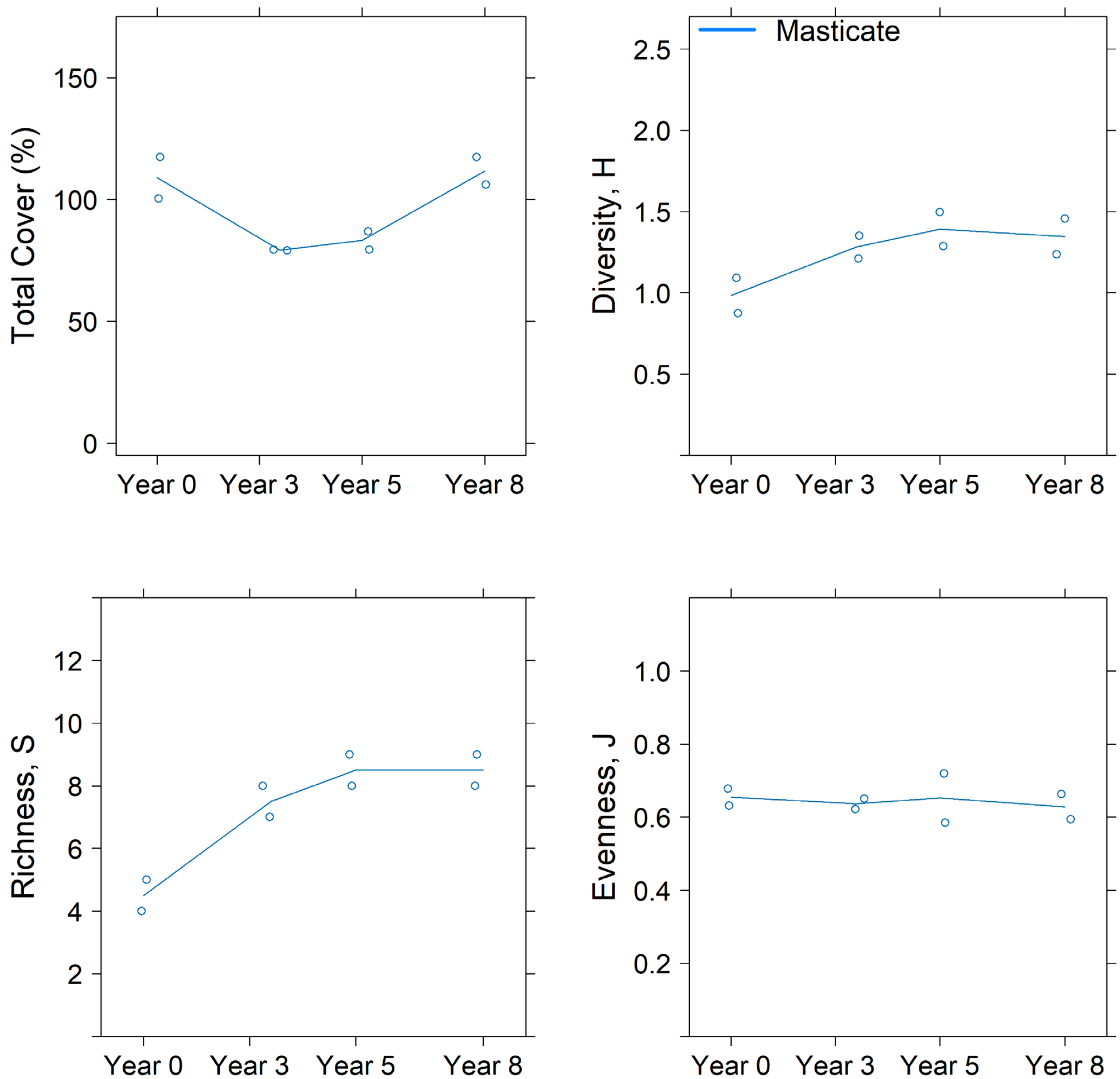


Figure 4-2. Unit 13 Containment Line community structure from Baseline (Year 0) (2015) to eight years after mastication (2024). Two masticated transects were analyzed in Unit 13 Containment Line.

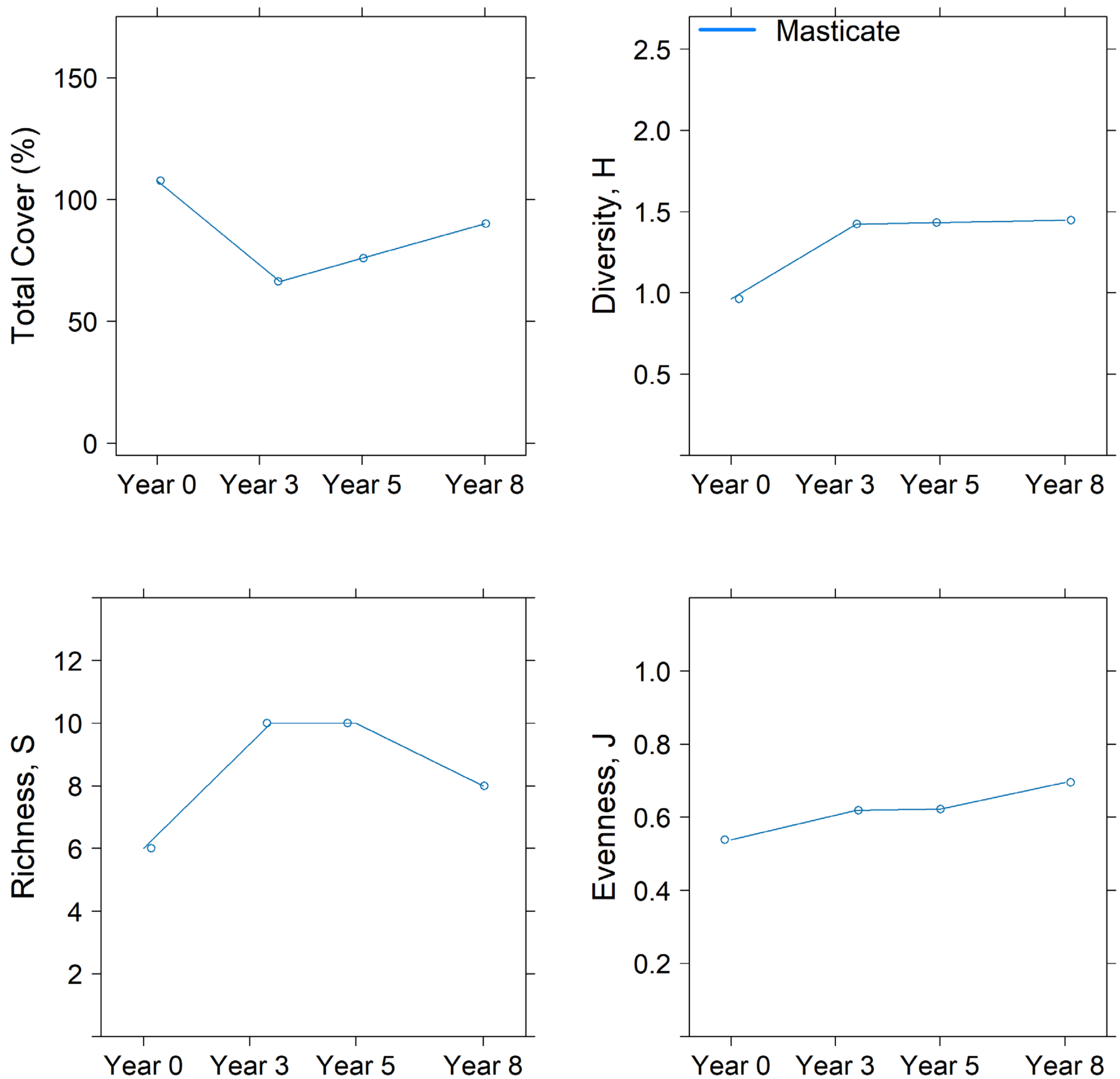


Figure 4-3. Unit 20 Containment Line community structure from Baseline (Year 0) (2015) to eight years after mastication (2023). One masticated transect was analyzed in Unit 20 Containment Line.

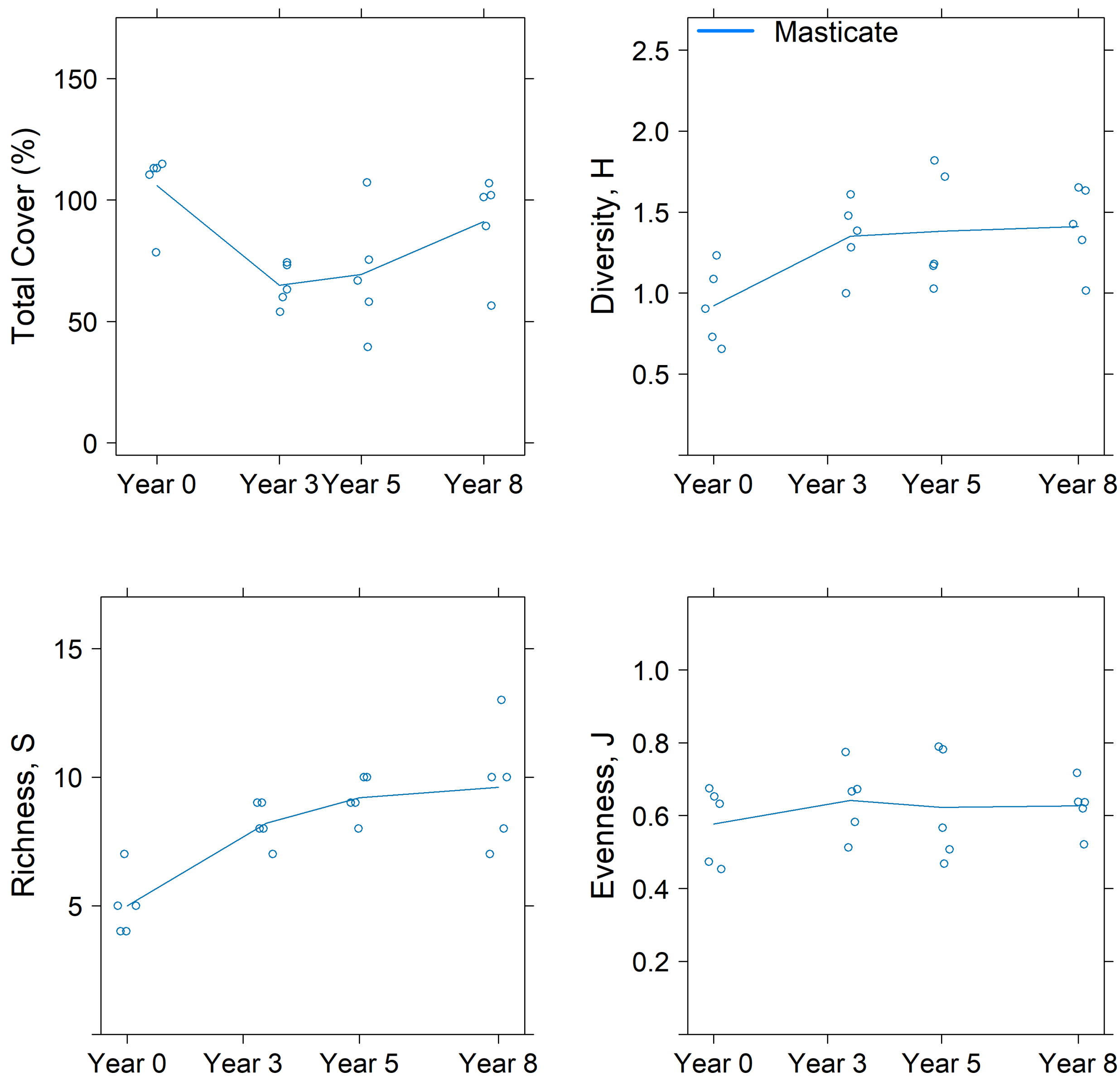


Figure 4-4. Unit 25 community structure from Baseline (Year 0) (2014) to eight years after mastication (2024). Five masticated transects were analyzed in Unit 25.

Mixed-design ANOVAs were conducted to examine the effect of Unit and age on mean percent bare ground and mean percent herbaceous cover (Table 4-2). In all Year 8 Units, there was no evidence suggesting that either Unit, age, or an interaction between Unit and age influenced bare ground or herbaceous cover.

Table 4-2. Mixed-design ANOVA Results for Unit 25 and Units 13 and 20 Containment Lines Bare Ground and Herbaceous Cover.

Factor	Bare Ground		Herbaceous Cover	
	F	*P*	*F*	*P*
Unit	0.5406	0.6130	0.6134	0.5778
Age	4.205	0.0659	3.487	0.1052
Unit*Age	0.9313	0.4723	0.5276	0.6515

The pattern by which bare ground and herbaceous cover changed over time was relatively similar in all Year 8 Units (Figures 4-5, 4-6, and 4-7). Bare ground cover increased in all Year 8 Units between Baseline and Year 3; Unit 13 Containment Line decreased while Unit 20 Containment Line and Unit 25 increased in Year 5; and all Units decreased in bare ground cover in Year 8. All Year 8 Units increased in herbaceous cover between Baseline and Year 3; then gradually decreased between Year 3 and Year 5; Unit 13 Containment Line and Unit 25 increased in Year 8, while Unit 20 Containment Line decreased in Year 8 (Table 4-3).

Table 4-3. Average Percent of Bare Ground and Herbaceous Cover in Unit 25 and Units 13 and 20 Containment Lines.

Cover Type % (Year)	Unit 13 Containment Line	Unit 20 Containment Line	Unit 25
Bare ground (Baseline)	11%	16%	9.2%
Bare ground (Year 3)	25%	19%	31%
Bare ground (Year 5)	22%	31%	37%
Bare ground (Year 8)	15%	24%	17%
Herbaceous (Baseline)	0.30%	0.60%	0.32%
Herbaceous (Year 3)	8.3%	27%	13%
Herbaceous (Year 5)	3.5%	15%	3.6%
Herbaceous (Year 8)	4.7%	12%	13%

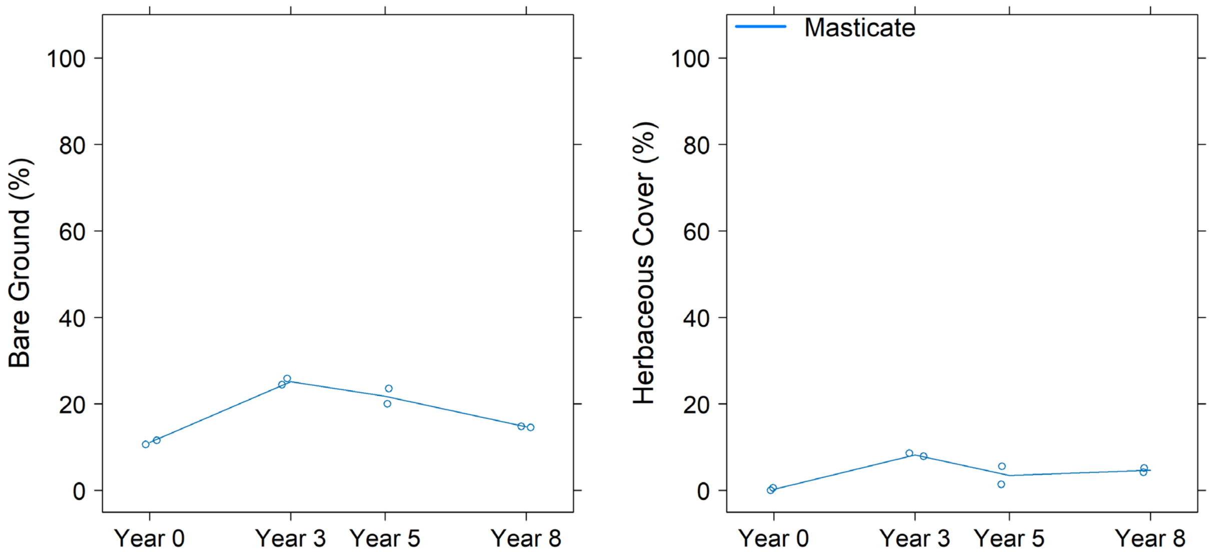


Figure 4-5. Unit 13 Containment Line bare ground and herbaceous cover between Baseline (2015), Year 3 (2019), Year 5 (2021), and Year 8 (2024). Two masticated transects were analyzed in Unit 13 Containment Line.

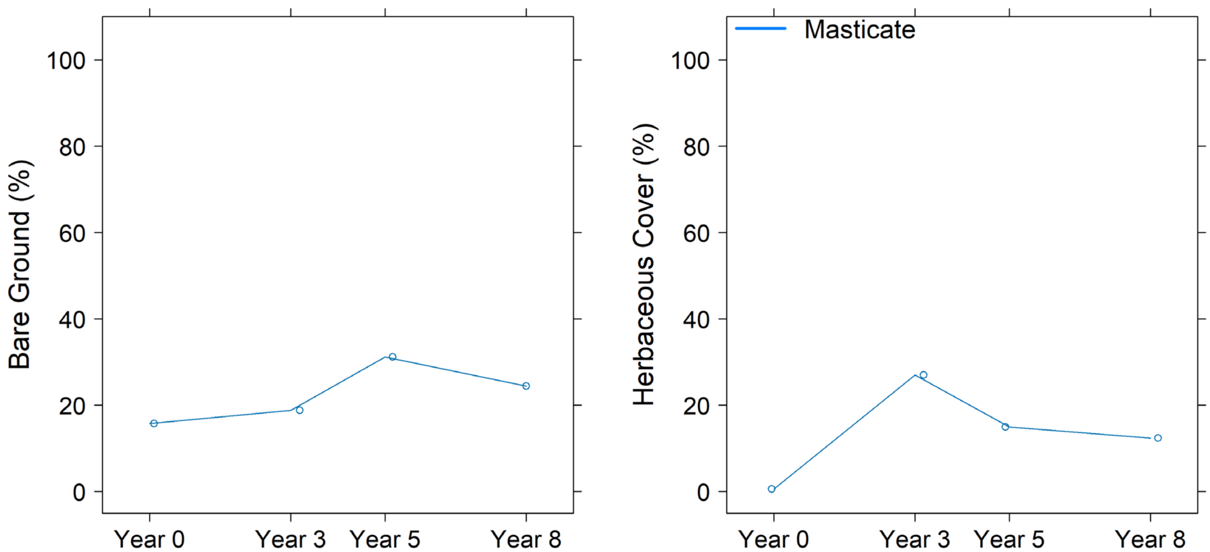


Figure 4-6. Unit 20 Containment Line bare ground and herbaceous cover between Baseline (2015), Year 3 (2019), Year 5 (2021), and Year 8 (2024). One masticated transect was analyzed in Unit 20 Containment Line.

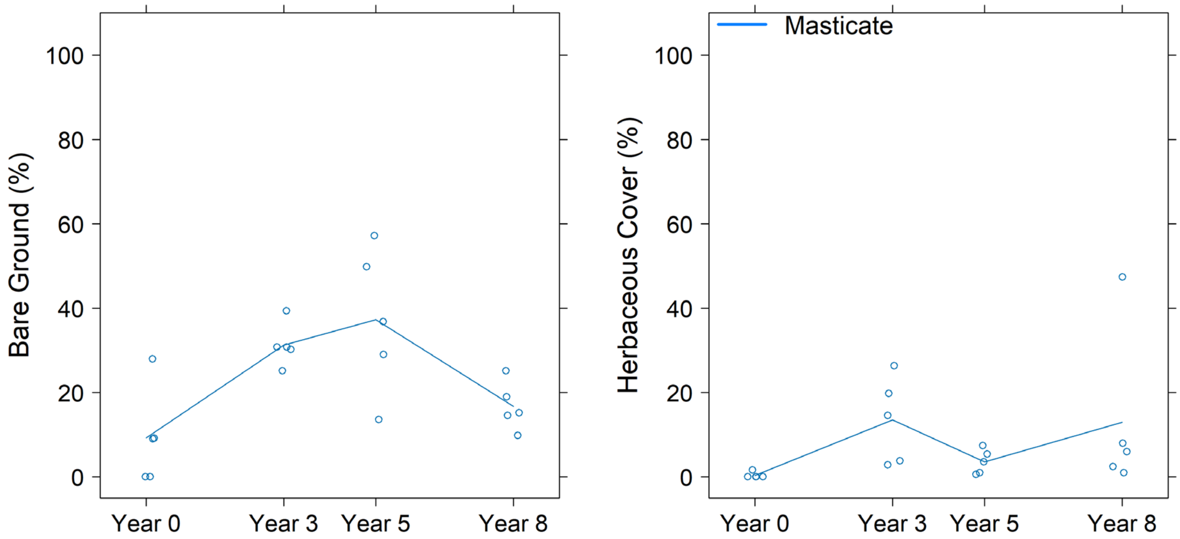


Figure 4-7. Unit 25 bare ground and herbaceous cover between Baseline (2014), Year 3 (2019), Year 5 (2021), and Year 8 (2024). Five masticated transects were analyzed in Unit 25.

PERMANOVAs were conducted to examine the effect of Unit and age on community composition in Year 8 Units. The results indicate that Unit and Age influence community structure, suggesting that species composition varies across sites and over time. The interactions observed between Unit and Age factors suggest that changes in community structure may not be uniform across all sites or time points. (Table 4-4).

Table 4-4. Two-way PERMANOVA Results for Unit 25 and Units 13 and 20 Containment Lines Community Compositions, based on Bray-Curtis Distance Matrices.

Factor	*F*	*p*
Age	1.950	0.0352
Unit	5.118	0.0002
Unit*Age	1.775	0.0159

Rank abundance curves (RAC) provide additional context to the PERMANOVA results by illustrating how species' relative abundances shift, even when certain dominant taxa remain present. The RACs illustrate that community composition of Year 8 Units generally responded similarly to treatment over time (Figures 4-8, 4-9, and 4-10). All Year 8 Units were either dominated by shaggy-barked manzanita, chamise, or co-dominated by shaggy-barked manzanita and chamise in all years. Unit 13 Containment Line was co-dominated by shaggy-barked manzanita and chamise in all years but shifted from slightly greater shaggy-barked manzanita cover in Baseline ($C_{13\,ARTO}$ = 47%, $C_{13\,ADFA}$ = 51%), to greater chamise cover in Year 8 ($C_{13\,ARTO}$ = 38%, $C_{13\,ADFA}$ = 49%). Dwarf ceanothus (*Ceanothus dentatus*), which was not present in Baseline, grew in abundance to become the third most dominant species in Unit 13 Containment Line in Year 8 (9.1%). Unit 20 Containment Line was dominated by chamise in all survey years but chamise cover decreased between Baseline (77%) and Year 3 (36%) and remained below baseline in Year 5 and Year 8 ($C_{20\,ADFA}$ = 40%, $C_{20\,ADFA}$ = 39%). Monterey ceanothus was the third most dominant species in Unit 20 Containment Line in Year 8 (16%). Unit 25 was dominated by shaggy-barked manzanita in all years, following by chamise. Percent cover of shaggy-barked manzanita and chamise generally decreased from Baseline ($C_{25\ ARTO}$ = 65%, $C_{25\ ADFA}$ = 29%) to Year 3 ($C_{25\ ARTO}$ = 27%, $C_{25\ ADFA}$ = 17%), then increased steadily to Year 8 ($C_{25\ ARTO}$ = 45%, $C_{13\ ADFA}$ = 21%). Black sage (*Salvia mellifera*) was the third most dominant species in Unit 25 in Year 8 (6.1%).

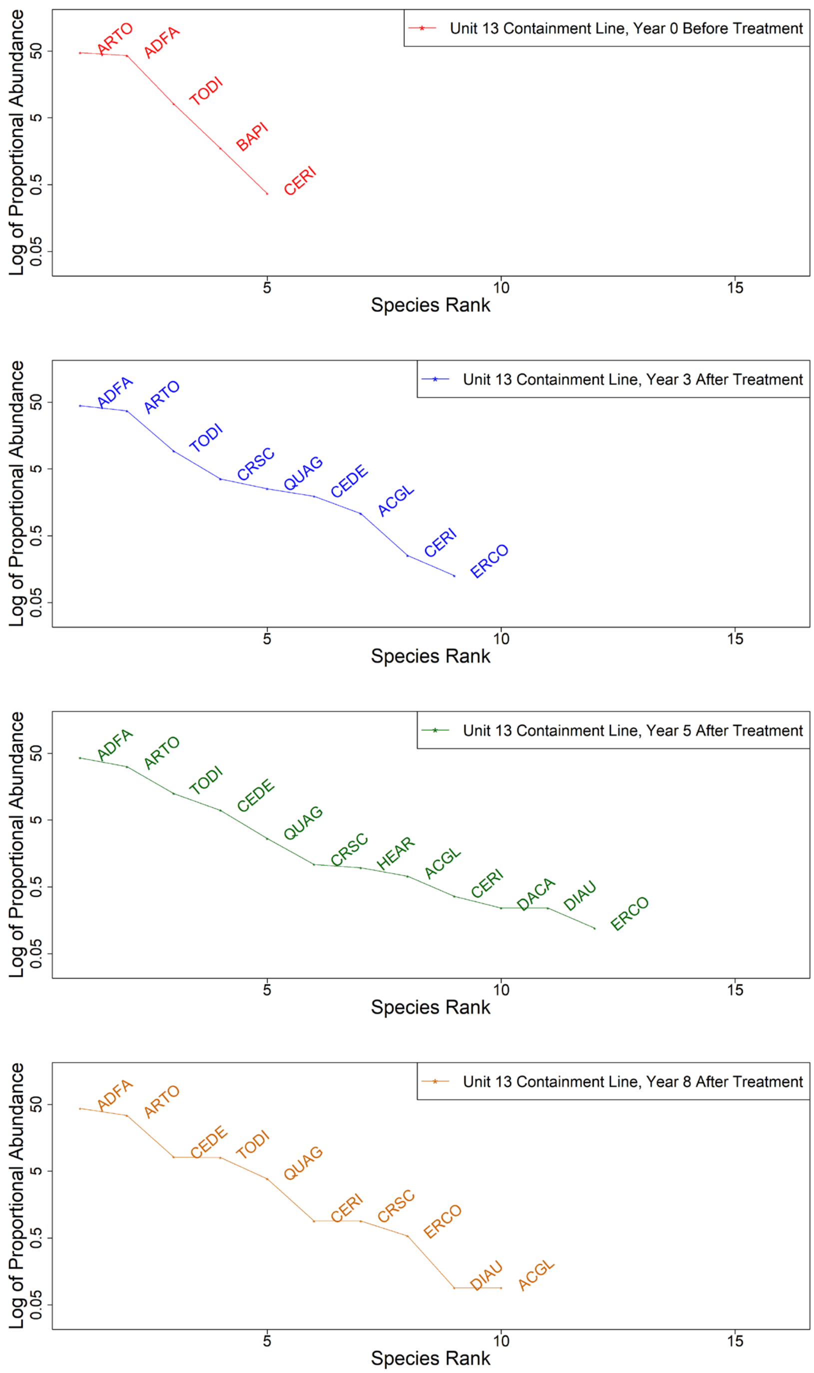


Figure 4-8. Unit 13 Containment Line rank abundance curves between Baseline (2015) and Year 8 (2024). Six species present in Year 8 surveys compared to Baseline included deerweed (*Acmispon glaber*), dwarf ceanothus, sticky monkeyflower (*Diplacus aurantiacus*), peak rush-rose (*Crocanthemum scoparium*), golden yarrow (*Eriophyllum confertiflorum*), and coast live oak. One species present in Baseline surveys but absent in Year 8 was coyote brush. Two masticated transects were analyzed in Unit 13 Containment Line. Y-axis is in $\log_{10}$ scale.

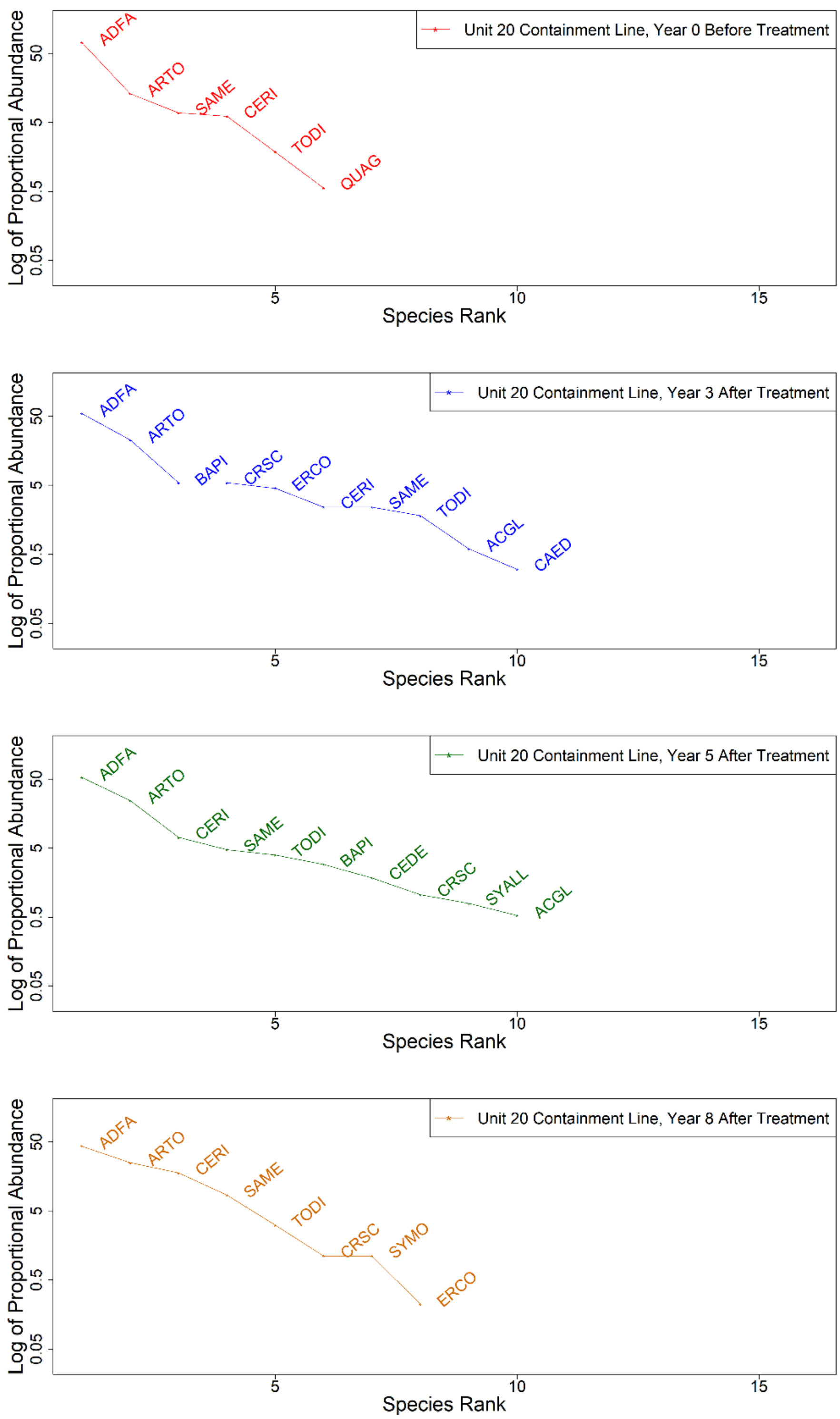


Figure 4-9. Unit 20 Containment Line rank abundance curves between Baseline (2015) and Year 8 (2024). New species present in Year 8 surveys compared to Baseline included peak rush-rose, creeping snowberry (*Symphoricarpos mollis*), and golden yarrow. One species present in Baseline surveys but absent in Year 8 was coast live oak. One masticated transect was analyzed in Unit 20 Containment Line. Y-axis is log_{10} scale.

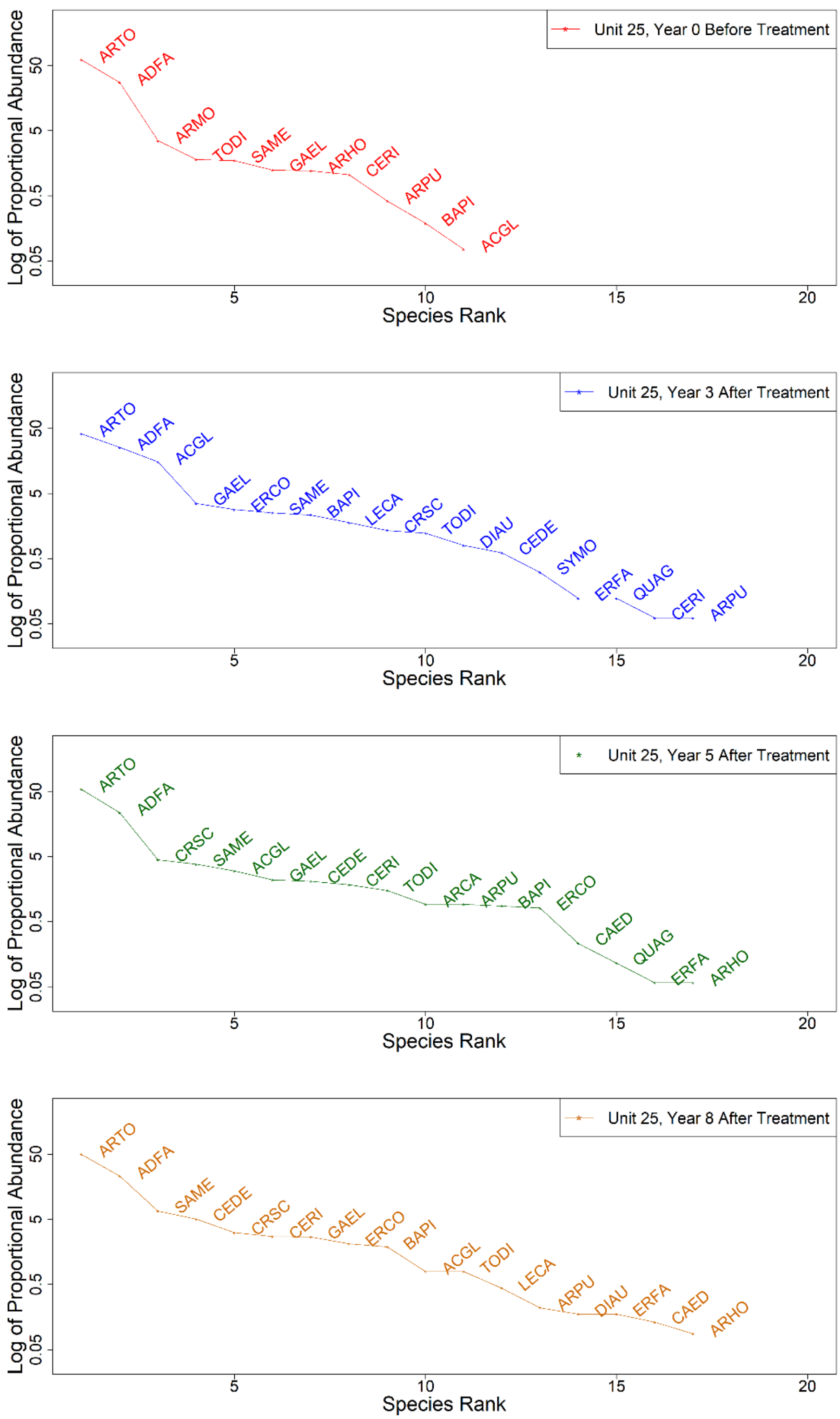


Figure 4-10. Unit 25 rank abundance curves between Baseline (2014) and Year 8 (2024). New species present in Year 8 surveys compared to Baseline include iceplant, dwarf ceanothus, peak rush-rose, sticky monkeyflower, golden yarrow, Eastwood's goldenbush, and pitcher sage (*Lepechinia calycina*). One species present in Baseline surveys but absent in Year 8 was Toro manzanita. Five masticated transects were analyzed in Unit 25. Y-axis is $\log_{10}$ scale.

Generally, HMP shrub species that were present in Year 8 Units in Baseline persisted in Year 8, with the exception of Toro manzanita in Unit 25 (Figures 4-11, 4-12, and 4-13). Monterey ceanothus was present in Baseline in all Year 8 Units, and Hooker's manzanita, sandmat manzanita, and Eastwood's goldenbush were also present at Unit 25.

Monterey ceanothus exceeded Baseline conditions in all Units at a similarly fast rate of recovery, recovering at 250% of Baseline conditions in Unit 13 Containment Line ($C_{13\ CERI,\ Year\ 8}$ = 1%), 242% of Baseline conditions in Unit 20 Containment Line ($C_{20\ CERI,\ Year\ 8}$ = 16%), and 221% of Baseline conditions in Unit 25 ($C_{25\ CERI,\ Year\ 8}$ = 2.5%). According to Coele *et al.* (2011), ceanothus seed germination is closely related to both heavy rainfall and fire treatment, with precipitation likely being the most important stimuli for germination and plant growth. The highest rate of recovery of Monterey ceanothus in each Unit occurred between Year 5 and Year 8; this could be attributed to the well-above normal water year in 2022-2023 and the normal water year in 2023-2024.

There were no other HMP shrub species present in Units 13 and 20 Containment Lines. In Unit 25, Hooker's manzanita was present in small quantities on one transect, recovering to 6% of Baseline conditions ($C_{25\ ARHO,\ Baseline}$= 1.3%, $C_{25\ ARHO,\ Year\ 8}$ = 0.08%), after being absent in Year 3. Sandmat manzanita, also only present on one transect, decreased in cover from Baseline ($C_{25\ ARPU,\ Baseline}$ = 0.44%) to Year 3 ($C_{25\ ARPU,\ Year\ 3}$= 0.04%), increased in Year 5 ($C_{25\ ARPU,\ Year\ 5}$= 0.64%), then decreased again in Year 8 ($C_{25\ ARPU,\ Year\ 8}$= 0.20%). Toro manzanita was present in Baseline in Unit 25 ($C_{25\ ARMO,\ Baseline}$ = 3.7%) on two transects; however, the species did not return in any of the subsequent years. Lastly, Eastwood's goldenbush was not present in Baseline in any Unit but was observed in Year 3 ($C_{25\ ERFA}$ = 0.08%), Year 5 ($C_{25\ ERFA}$ = 0.04% cover), and Year 8 ($C_{25\ ERFA}$ = 0.16% cover) in Unit 25.

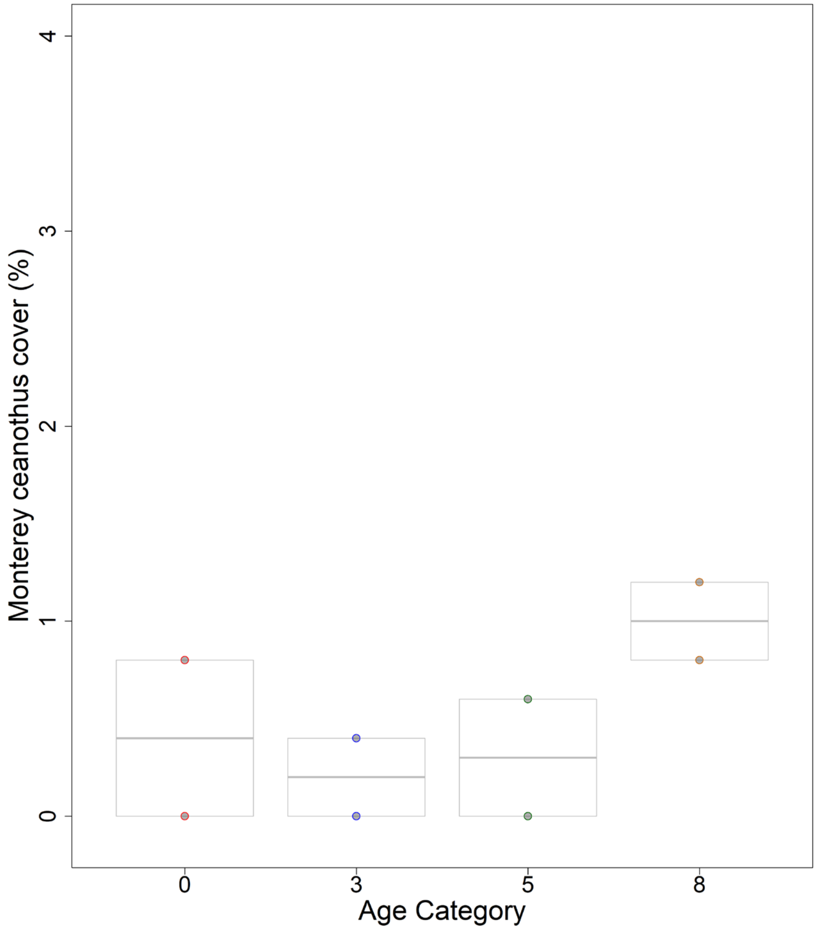


Figure 4-11. Unit 13 Containment Line HMP shrub species cover between Baseline (2015) and Year 8 (2024). The colored dots represent the percent cover of the respective species for each transect within an age category. The thick grey line in the box represents the median, the top and bottom edges of the central box represent the upper (3rd) and lower (1st) quartile, respectively. Two masticated transects were analyzed in Unit 13 Containment Line.

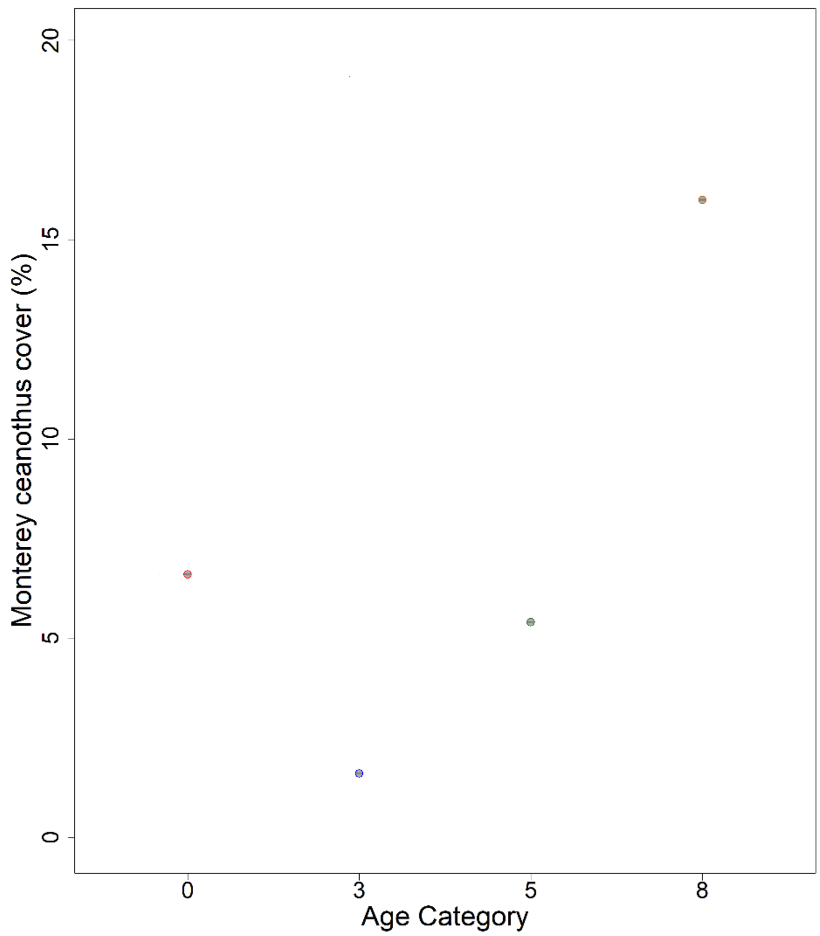


Figure 4-12. Unit 20 Containment Line HMP shrub species cover between Baseline (2015) and Year 8 (2024). The colored dots represent the percent cover of the respective species for each transect within an age category. One transect was analyzed in Unit 20 Containment Line.

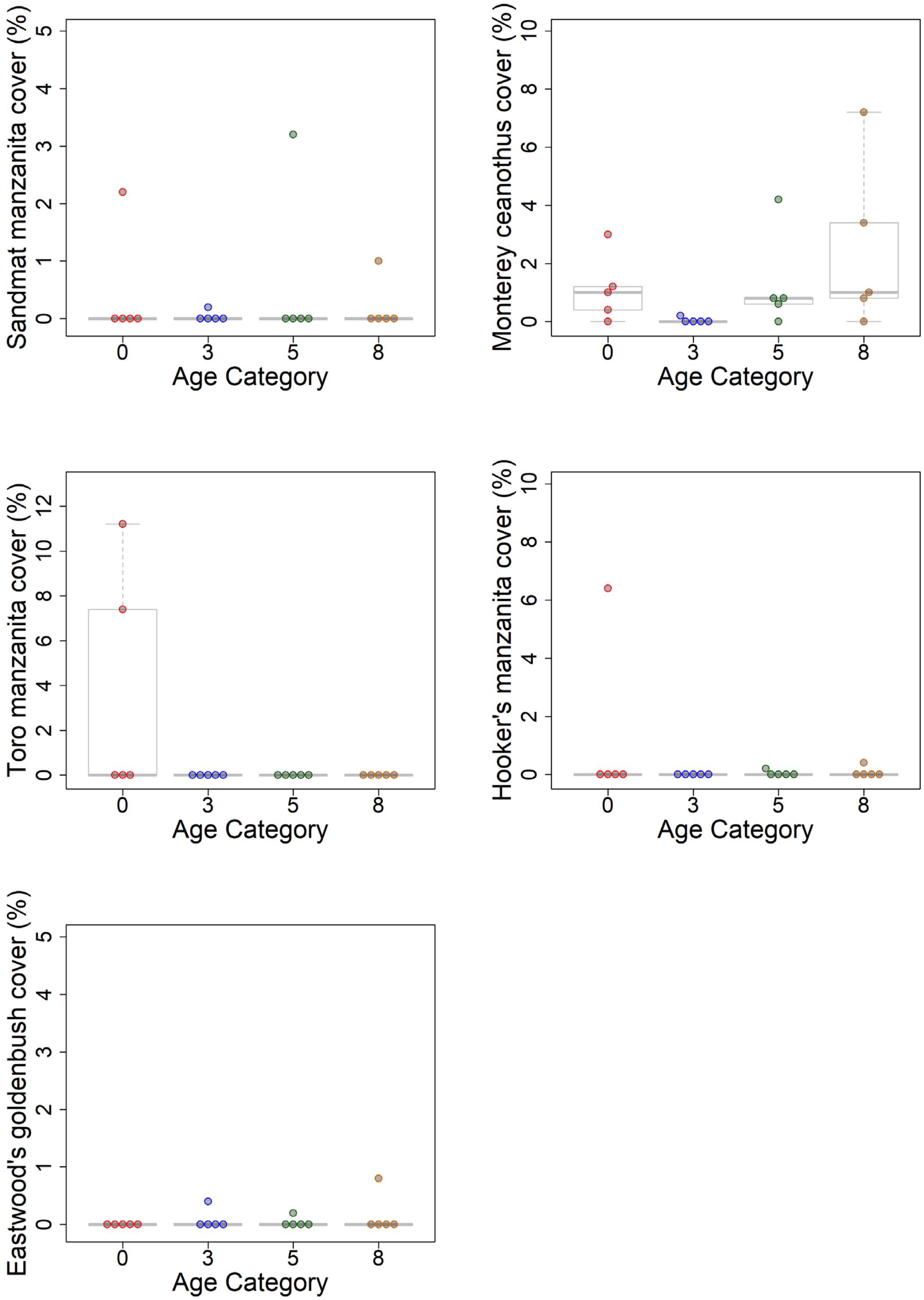


Figure 4-13. Unit 25 HMP shrub species cover between Baseline (2014) and Year 8 (2024). The colored dots represent the percent cover of the respective species for each transect within an age category. The thick grey line in the box represents the median, the top and bottom edges of the central box represent the upper (3rd) and lower (1st) quartile, respectively. Five masticated transects were analyzed in Unit 25. Scales not equivalent.

NMDS ordinations for Unit 25 illustrate that community compositions in Year 8 are on a trajectory toward Baseline compositions (Figure 4-14). Community composition is represented by the shape and location of ellipses in the ordination space, where ellipses with similar shape and location imply similar community composition. In Year 3 after treatment, ellipses are typically in a different location on the ordination than the Baseline ellipses since species composition has shifted. By Year 5, the location of ellipses generally shifts back towards the Baseline ellipse location. Year 8 ellipses, however, tend to overlap with, or are nearer to, the Baseline ellipses than either Year 3 or Year 5, implying that community composition is more like Baseline in Year 8 than in Years 3 and 5.

There was an insufficient number of transects in Unit 13 Containment Line (n=2) and Unit 20 Containment Line (n=1) to conduct an NMDS ordination or a Wilcoxon signed-rank test, therefore an ordination plot is not provided for these units. To examine changes in community composition in Units 13 and 20 Containment Lines, community statistics (total cover, diversity, species richness, and species evenness) were evaluated over time. As seen in Figure 4-2 and 4-3, community composition in Units 13 and 20 Containment Lines generally had the sharpest divergence from Baseline conditions in Year 3, followed by stabilization or a gradual return to Baseline conditions in Year 5 and Year 8. Total cover in Units 13 and 20 Containment Lines had a sharp decrease in Year 3 and a steady increase through Year 8, while diversity increased in Year 3 and remained relatively stable through Year 8. Both Units had an overall increase in species richness from Baseline to Year 8 and relatively stable evenness throughout the years. Overall, these Units generally showed a progressive change in community structure and composition, returning towards Baseline conditions post-treatment. However, due to small sample sizes, these results may not fully capture the effects of mastication in these areas.

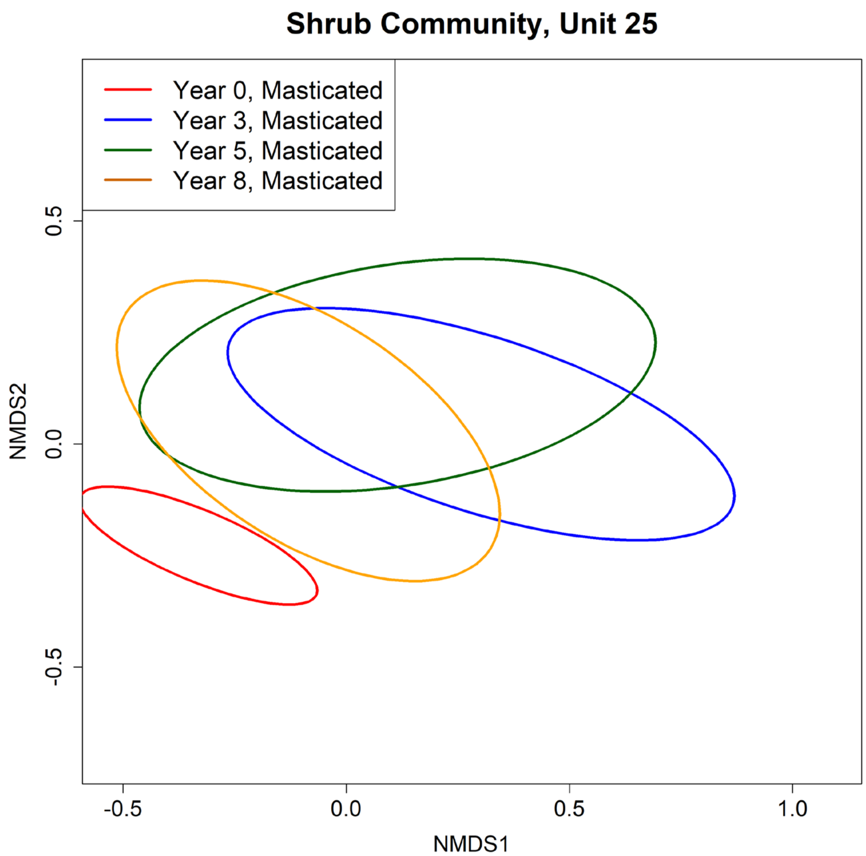


Figure 4-14. NMDS ordination plot showing Unit 25 community composition changes between Baseline (2014), Year 3 (2019), Year 5 (2021), and Year 8 (2024). Five masticated transects were analyzed in Unit 25. NMDS ordinations for Unit 25 illustrate that community compositions in Year 8 are on a trajectory toward Baseline compositions.

4.4.3 Annual Grass Monitoring

Non-native annual grassland cover was surveyed and mapped for Unit 25 and Units 13, 20, and 31 Containment Lines in 2024. Non-native annual grass cover increased between Baseline and Year 3 and gradually decreased in Year 5 and Year 8 for Unit 25 and Units 20 and 31 Containment Lines; while in Unit 13 Containment Line, annual grass cover increased between Baseline and Year 5, and decreased between Year 5 and Year 8 (Appendix D, Figures D-1 through D-4). Estimated areas occupied by each density class in 2024 are summarized in Table 4-5. Density class 3 (>25% cover) had the largest areal extent in all surveyed areas in 2024. Density class 3 contained an area of approximately 3.6 acres in Unit 13 Containment Line, 2.63 acres in the Unit 20 Containment Line, 2.94 acres in the Unit 31 Containment Line, and 21.19 acres in Unit 25 (Table 4-5).

Table 4-5. Estimated Area Occupied by Annual Grasses in Unit 25 and Units 13, 20, and 31 Containment Lines between Baseline (2014 and 2015) and Year 8 (2024).

Cover Class	Baseline (acres)	Year 1 (acres)	Year 3 (acres)	Year 5 (acres)	Year 8 (acres)
Unit 13 Containment Line					
1 (Low) = 1 - 5%	0.06	1.24	2.09	2.56	0.46
2 (Medium) = 6-25%	1.44	1.38	2.06	2.36	0.18
3 (High) = >25%	4.43	0.53	4.17	3.76	3.60
Total Acreage	**5.93**	**3.15**	**8.32**	**8.67**	**4.24**
Unit 20 Containment Line					
1 (Low) = 1 - 5%	0.05	2.85	4.91	8.55	0.75
2 (Medium) = 6-25%	0.27	4.95	2.63	1.51	0.98
3 (High) = >25%	0.58	2.41	2.92	0.31	2.63
Total Acreage	**0.90**	**10.21**	**10.46**	**10.36**	**4.36**
Unit 25					
1 (Low) = 1 - 5%	0.22	20.06	22.90	20.89	2.81
2 (Medium) = 6-25%	1.62	3.86	12.14	6.10	3.32
3 (High) = >25%	3.52	6.43	7.74	9.71	21.19
Total Acreage	**5.36**	**30.35**	**42.78**	**36.70**	**27.32**
Unit 31 Containment Line					
1 (Low) = 1 - 5%	0.13	5.59	5.42	5.99	0.38
2 (Medium) = 6-25%	0.04	1.74	7.84	3.13	1.06
3 (High) = >25%	0.00	0.80	5.41	4.10	2.94
Total Acreage	**0.17**	**8.13**	**18.67**	**13.22**	**4.38**

4.4.4 Invasive and Non-Native Species Monitoring

Of the target invasive species, only iceplant was observed in Year 8 Units. Two patches of iceplant were observed in the central half of Unit 20 Containment Line, and two patches of iceplant were observed in the western portion of Unit 31 Containment Line (Appendix E, Figures E-1 through E-2). Minor occurrences of non-native herbaceous cover were observed in Unit 25 and Units 13 and 20 Containment Lines during transect monitoring (Appendix G, Tables G-1 through G-3).

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5 CONCLUSIONS

5.1 HMP Annuals

Results of HMP annual species surveys on multiple Units over varying amounts of time since treatment have shown that these species tend to persist following vegetation clearance activities. In 2024, comparison to Baseline was conducted for all age classes. Treatment-related effects were not assessed in any of the Units surveyed in 2024 due to utilization of only one treatment (mastication).

In general, observed densities and frequency of occurrence of HMP annual species were consistent with historical Baseline conditions. Monterey gilia and Monterey spineflower seed set, abundance, and survival are highly complex (Fox *et al.*, 2006; Fox, 2007). Both species are generally correlated with rainfall; however, their survival mechanisms are different. Monterey gilia is negatively affected by herbivory and its survival mechanism is a persistent seed bank. Monterey spineflower is not affected by herbivory and its survival mechanism is its ability to readily germinate under optimal conditions. Considering these life strategies, the densities of these species would be expected to fluctuate between years in response to rainfall, seed bank conditions, or herbivory.

Seaside bird's-beak densities are also variable (Watts *et al*., 2010). The cause of this variability is highly complex and can be the result of several factors including variable reproduction and germination rates, host availability, herbivory or seed predation, or competition from invasive species.

5.1.1 HMP Annuals Success Criteria

The Revised Protocol provided specific success criteria for re-establishment of HMP annual species following treatment (Tetra Tech and EcoSystems West, 2015b). Comparisons of survey data to these success criteria are provided in Table 6-1. The only criterion that could not be assessed was comparison of the percentage of bare ground relative to Baseline conditions for Range 48 because no shrub transect surveys were required in this Unit.

Sixty-seven percent of HMP annuals success criteria were met for the 2024 survey year (Table 5-1). The HMP annual success criterion requires that frequency of occurrence is at least 90% of the Baseline frequency in any post-treatment year. The only criterion not met was seaside bird's beak in Range 48 (Year 5). Seaside bird's beak did not occupy any Range 48 grids in Year 5 (2024) or Year 3 (2022); this is a decrease from one grid occupied in Year 1 (2020) and two grids occupied in Baseline (2013). Due to low Baseline occupancy of seaside bird's beak in this Unit, a change of occupancy in one grid represents a substantial change in frequency in the Unit. Also, as described in Watts *et al*. (2010), seaside bird's beak seed production can vary from zero to as many as ten thousand seeds per plant, depending on the year or site. Therefore, these results are consistent with previous survey results and may be indicative of chance fluctuations that do not necessarily demonstrate a response to remediation activities (Terracon, 2021 and 2023; Appendix B Figure B-3).

Table 5-1. Evaluation of Success Criteria for HMP Annuals.

Year Class	Units	Criterion	Baseline	2024	Pass/Fail
Year 5	Range 48	Frequency of Monterey gilia > 90% of Baseline frequency	$f_{Range\ 48} = 0.46$	$f_{Range\ 48} = 0.54$	Pass
		Frequency of seaside bird's-beak > 90% of Baseline frequency	$f_{Range\ 48} = 0.15$	$f_{Range\ 48} = 0.00$	Fail
		Frequency of Monterey spineflower > 90% of Baseline frequency	$f_{Range\ 48} = 0.92$	$f_{Range\ 48} = 1.00$	Pass
		Bare ground > Baseline condition	--	--	--

5.2 Shrub Community

Results of shrub community structure analyses reaffirm results of previous surveys. Year 8 showed a progressive change in community structure and composition, returning towards the Baseline assemblage as seen in the ordination plots or through qualitative observations if an ordination plot was not provided. This pattern has been observed in every monitoring year since 2010 and reflects predictable successional changes in the shrub community (Tetra Tech and EcoSystems West, 2011 – 2015a; Burleson, 2016 – 2020; Terracon, 2021 – 2024). Differential responses to treatment were not assessed since all 2024 survey Units received only mastication with no prescribed burning.

HMP shrub species that were present in Year 8 Units in Baseline generally persisted in Year 8, with the exception of Toro Manzanita in Unit 25, which was present on two of five transects in Baseline only (see Figures 4-11, 4-12, and 4-13). Alternatively, Monterey ceanothus had the fastest rate of recovery, exceeding Baseline values in all three Units. The above normal water year in 2022-2023 and normal water year in 2023-2024 likely aided in the recovery of Monterey ceanothus, as ceanothus populations are known to rely heavily on germination from a persistent seed bank during unusually wet years or after occasional fires (Coale *et al*., 2011).

5.2.1 Shrub Community Success Criteria

As part of the Revised Protocol development, a series of three major shrub associations were identified based on dominant species present in Baseline surveys. Recovery was predicted to differ among these associations (Tetra Tech and EcoSystems West, 2015b). Therefore, more detailed success criteria for each of the associations, as well as criteria for the amount of bare ground and cover of invasive species were developed for the Year 8 survey. These criteria are evaluated in Table 5-2.

All success criteria were met in Year 8. Per the Revised Protocol, Year 8 is the final year required for monitoring, and given the overall positive response of vegetation to mastication in Unit 25 and Units 13 and 20 Containment Lines, they will be removed from the monitoring schedule.

Table 5-2. Evaluation of Success Criteria for Dominant Chaparral Shrub Associations on Fort Ord in Year 8 Units Monitored in 2024 (Unit 25 and Units 13 and 20 Containment Lines).

Plant Association	Criterion	Unit	Baseline value	Year 8 value	P/F
A – ARTO dominated	Average cover of ARTO > 30% of Baseline cover	13	51.3%	38.1%	Pass
		20	N/A	N/A	N/A
		25	74.2%	53.8%	Pass
	Frequency of dwarf ceanothus > 70% Baseline frequency	13	0	1	Pass
		20	N/A	N/A	N/A
		25	0	0.75	Pass
	Frequency of Monterey ceanothus >70% Baseline frequency	13	0.5	1	Pass
		20	N/A	N/A	N/A
		25	1	1	Pass
B – ADFA dominated	Average cover of ADFA > 30% of Baseline cover	13	N/A	N/A	NA
		20	77.0%	39.0%	Pass
		25	44.6%	32.0%	Pass
	Frequency of dwarf ceanothus > 70% Baseline frequency	13	N/A	N/A	NA
		20	0	0	Pass
		25	0	1	Pass
	Frequency of Monterey ceanothus >70% Baseline frequency	13	N/A	N/A	N/A
		20	1	1	Pass
		25	0	0	Pass
C/D – ARPU dominated	Frequency of ARPU > 70% of Baseline frequency	13	N/A	N/A	N/A
		20	N/A	N/A	N/A
		25	N/A	N/A	N/A
	Frequency of dwarf ceanothus > 70% Baseline frequency	13	N/A	N/A	N/A
		20	N/A	N/A	N/A
		25	N/A	N/A	N/A
	Frequency of Monterey ceanothus >70% Baseline frequency	13	N/A	N/A	N/A
		20	N/A	N/A	N/A
		25	N/A	N/A	N/A
Bare Ground	Bare ground > 90% of Baseline cover	13	11.10%	14.70%	Pass
		20	15.80%	24.40%	Pass
		25	9.24%	16.76%	Pass
Invasive plants	Invasive plants <10% cover per transect	13	0.00%	0.00%	Pass
		20	0.00%	0.00%	Pass
		25	0.00%	0.6% (max)	Pass

5.3 Annual Grasses

Annual grasses were present along the edges of roads, masticated areas, other disturbed areas, and occasionally extended into the interior of the Units monitored in 2024 (Appendix D). High annual grass density was present in all cleared fuel break areas; however, it does not appear that colonization by annual grasses is a major concern along fuel breaks because annual grasses generally decrease with time as shrubs begin to colonize these areas post-treatment (Table 4-5).

Response of annual grasses varied between age classes and Units. The cover of annual grasses in all Year 8 Units (Unit 25 and Units 13, 20, and 31 Containment Lines) increased between Baseline and Year 5, and decreased between Years 5 and 8 (Table 4-5). As shrubs continue to mature in these Units, annual grass density is expected to decrease.

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APPENDIX A

SPECIES ACRYONYMS

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Table A-1. Species acronyms, Former Fort Ord.

Acronym	Scientific Name	Common Name	Life Form
ACAMA	*Acmispon americanus var. americanus*	Spanish clover	annual herb
ACGL	*Acmispon glaber (Lotus scoparius)*	deerweed	subshrub
ACLO	*Acacia longifolia*	Sydney golden wattle	tree
ACME	*Acacia melanoxylon*	blackwood acacia	tree
ACMI	*Achillea millefolium*	common yarrow	perennial herb
ACPA	*Acaena pallida*	pale biddy-biddy	perennial herb
ACST	*Acmispon strigosus (Lotus strigosus)*	strigose lotus	annual herb
ADFA	*Adenostoma fasciculatum*	chamise	shrub
AGPA	*Agrostis pallens*	leafy bent grass	perennial grass
AGXX	*Agoseris* sp.		
AICA	*Aira caryophyllea*	silvery hair grass	annual grass
AMME	*Amsinckia menziesii*	Menzies' fiddleneck	annual herb
ARCA	*Artemisia californica*	California sagebrush	shrub
ARHO	*Arctostaphylos hookeri* ssp. *hookeri*	Hooker’s manzanita	shrub
ARMO	*Arctostaphylos montereyensis*	Toro manzanita	shrub
ARPU	*Arctostaphylos pumila*	sandmat manzanita	shrub
ARTO	*Arctostaphylos tomentosa* ssp. *tomentosa*	shaggy-barked manzanita	shrub
AVBA	*Avena barbata*	slender wild oat	annual or perennial grass
BAPI	*Baccharis pilularis*	coyote brush	shrub
BEPI	*Berberis pinnata*	California barberry	shrub
BRDI	*Bromus diandrus*	ripgut brome	annual grass
BRHO	*Bromus hordeaceus*	soft brome	annual grass
BRMA	*Briza maxima*	rattlesnake grass	annual grass
BRMAR	*Bromus madritensis* ssp. *rubens*	red brome	annual grass
BRMI	*Briza minor*	small quaking grass	annual grass
CAAF	*Castilleja affinis*	Indian paintbrush	perennial herb
CAAL	*Calochortus albus*	white globe lily	perennial herb
CABR	*Carex brevicaulis*	short-stemmed sedge	perennial grass
CACO	*Camissonia contorta*	contorted suncup	annual herb
CAED	*Carpobrotus edulis*	iceplant	perennial succulent herb
CAEX	*Castilleja exserta*	purple owl's-clover	annual herb
CAFO2	*Castilleja foliolosa*	Texas Indian paintbrush	perennial herb
CAGL	*Carex globosa*	round fruit sedge	perennial herb
CAKO	*Calamagrostis koelerioides*	fire reedgrass	perennial grass
CAMA	*Calystegia macrostegia*	coast morning-glory	Perennial herb
CAMI	*Camissoniopsis micrantha*	Spencer primrose	annual herb
CAPY	*Carduus pycnocephalus*	Italian thistle	annual herb
CARA	*Cardionema ramosissimum*	sand mat	perennial herb
CARU	*Calamagrostis rubescens*	pinegrass	perennial grass
CASU	*Calystegia subacaulis*	hill morning glory	perennial herb

Table A-1. Species acronyms, Former Fort Ord.

Acronym	Scientific Name	Common Name	Life Form
CATU	*Carex tumulicola*	Foothill sedge	Perennial herb
CAXX1	*Carex* sp.	sedge	perennial herb
CAXX2	*Castilleja* sp.		
CEDE	*Ceanothus dentatus*	dwarf ceanothus	shrub
CEIN	*Ceanothus incanus*	coast whitehorn	shrub
CEME	*Centaurea melitensis*	tocalote	annual herb
CERI	*Ceanothus rigidus (Ceanothus cuneatus* var. *rigidus)*	Monterey ceanothus	shrub
CETH	*Ceanothus thyrsiflorus*	blue blossom	shrub
CHDI	*Chorizanthe diffusa*	diffuse spineflower	annual herb
CHDO	*Chorizanthe douglasii*	Douglas' spineflower	annual herb
CHPO	*Chlorogalum pomeridianum*	wavyleaf soap plant	perennial herb
CHPUP	*Chorizanthe pungens* var. *pungens*	Monterey spineflower	HMP annual
CIBR	*Cirsium brevistylum*	clustered thistle	perennial herb
CIOC	*Cirsium occidentale*	cobwebby thistle	perennial herb
COFI	*Corethrogyne (Lessingia) filaginifolia*	common sandaster	perennial herb
COJU	*Cortaderia jubata*	jubata grass	large perennial grass
CORIL	*Cordylanthus rigidus* ssp. *littoralis*	seaside bird's beak	HMP annual
COXX	*Cortaderia* sp. *(C. jubata* or *C. selloana)*	pampas grass	large perennial grass
CRCA	*Croton californicus*	California croton	perennial herb
CRMUM	*Cryptantha muricata* var. *muricata*	showy prickly-nut cryptantha	annual herb
CRSC	*Crocanthemum (Helianthemum) scoparium*	peak rush-rose	subshrub
CRXX	*Cryptantha* sp.		annual herb
DACA	*Danthonia californica*	California oatgrass	Perennial grass
DAPU	*Daucus pusillus*	American wild carrot	annual herb
DECE	*Deschampsia cespitosa*	tufted hairgrass	perennial herb
DECO	*Deinandra corymbosa*	coastal tarweed	annual herb
DIAU	*Diplacus aurantiacus*	sticky monkeyflower	shrub
DICA	*Dichelostemma capitatum*	blue dicks	perennial herb
DRGL	*Drymocallis (Potentilla) glandulosa*	sticky cinquefoil	perennial herb
ELGL	*Elymus glaucus*	blue wild rye	perennial grass
ERBI	*Erodium brachycarpum*	foothill filaree	annual herb
ERBO	*Erodium botrys*	long-beaked filaree	annual herb
ERCA20*	*Erigeron canadensis*	horseweed	annual herb
ERCA6*	*Eriodictyon californicum*	yerba santa	shrub
ERCI	*Erodium cicutarium*	red-stemmed filaree	annual herb
ERCO	*Eriophyllum confertiflorum*	golden yarrow	subshrub
ERER	*Ericameria ericoides*	mock heather	shrub
ERFA	*Ericameria fasciculata*	Eastwood's goldenbush	shrub
ERMO	*Erodium moschatum*	white-stemmed filaree	annual herb

Table A-1. Species acronyms, Former Fort Ord.

Acronym	Scientific Name	Common Name	Life Form
ERNUA	*Eriogonum nudum* var. *auriculatum*	ear-shaped wild buckwheat	shrub
ERVI	*Eriastrum virgatum*	virgate eriastrum	annual herb
EURA	*Eurybia radulina*	roughleaf aster	perennial herb
FEBR	*Festuca (Vulpia) bromoides*	brome fescue	annual grass
FEMY	*Festuca (Vulpia) myuros*	rattail sixweeks grass	annual grass
FEOC	*Festuca (Vulpia) octoflora*	sixweeks grass	annual grass
FRAF	*Fritillaria affinis*	checker lily	perennial herb
FRCA	*Frangula (Rhamnus) californica*	California coffeeberry	shrub
FRCA2	*Fremontodendron californicum*	California flannelbush	shrub
GAAP	*Galium aparine*	goose grass	annual herb
GACA	*Galium californicum*	California bedstraw	perennial herb
GAEL	*Garrya elliptica*	coast silk tassel	shrub
GAPH	*Gastridium phleoides*	nit grass	annual grass
GAPO	*Galium porrigens*	climbing bedstraw	vine
GAUS	*Gamochaeta ustulata*	purple cudweed	perennial herb
GEDI	*Geranium dissectum*	cutleaf geranium	annual herb
GEMO	*Genista monspessulana*	French broom	shrub
GITEA	*Gilia tenuiflora* ssp. *arenaria*	sand gilia	HMP annual
HEAR	*Heteromeles arbutifolia*	toyon	shrub
HEGR	*Heterotheca grandiflora*	telegraph weed	annual herb
HEXX	*Hemizonia* sp.		annual herb
HOCU	*Horkelia cuneata*	wedge-leaved horkelia	perennial herb
HYGL	*Hypochaeris glabra*	smooth cat's-ear	annual herb
HYRA	*Hypochaeris radicata*	rough cat's-ear	perennial herb
IRDO	*Iris douglasiana*	Douglas iris	perennial herb
JUBU	*Juncus bufonius*	common toad rush	annual herb
JUPH	*Juncus phaeocephalus*	brown-headed rush	perennial grass
JUXX	*Juncus* sp.	rush	
KOMA	*Koeleria macrantha*	June grass	perennial herb
LAPL	*Layia platyglossa*	coastal tidytips	annual herb
LECA	*Lepechinia calycina*	pitcher sage	shrub
LEPE	*Lessingia pectinata* (var. *pectinata?*)	valley lessingia	annual herb
LOGA	*Logfia (Filago) gallica*	daggerleaf cottonrose	annual herb
LOMA	*Lomatium* sp.		perennial herb
LOPA	*Lomatium parvifolium*	small-leaved lomatium	perennial herb
LUAL	*Lupinus albifrons* (var. *albifrons?*)	silver bush lupine	shrub
LUAR	*Lupinus arboreus*	yellow bush lupine	shrub
LUBI	*Lupinus bicolor*	miniature lupine	annual herb
LUCH	*Lupinus chamissonis*	silver beach lupine	shrub
LUCO	*Lupinus concinnus*	bajada lupine	annual herb
LUNA	*Lupinus nanus*	sky lupine	annual herb

Table A-1. Species acronyms, Former Fort Ord.

Acronym	Scientific Name	Common Name	Life Form
LUTR	*Lupinus truncatus*	Nuttall's annual lupine	annual herb
LUXX	*Lupinus* sp.	lupine	
LYAR	*Lysimachia arvensis*	scarlet pimpernel	annual herb
LYHY	*Lythrum hyssopifolia*	hyssop loosestrife	annual herb
MAEX	*Madia exigua*	small tarweed	annual herb
MAGR	*Madia gracilis*	gumweed (slender tarweed)	annual herb
MASA	*Madia sativa*	coast tarweed	annual herb
MICA	*Micropus californicus*	cotton top	annual herb
MOUN	*Monardella undulata*	curly-leaved monardella	annual herb
MUMA	*Muilla maritima*	common muilla	perennial herb
NAAT	*Navarretia atractyloides*	holly leaf navarretia	annual herb
NAHA	*Navarretia hamata*	hooked navarretia	annual herb
NAXX	*Navarretia* sp.		annual herb
PEDE	*Pedicularis densiflora*	Indian warrior	perennial herb
PEDU	*Petrorhagia dubia*	hairypink	annual herb
PEGA	*Perideridia gairdneri*	Gairdner's yampah	perennial herb
PEMUM	*Pellaea mucronata* var. *mucronata*	bird's foot fern	fern
PETR	*Pentagramma triangularis* ssp. *triangularis*	gold back fern	fern
PHDI	*Phacelia distans*	common phacelia	annual herb
PHRA	*Phacelia ramosissima*	branching phacelia	perennial herb
PIRA	*Pinus radiata*	Monterey pine	tree
PIYA	*Piperia yadonii*	Yadon's piperia	perennial herb
PIXX	*Piperia* sp.		
PLCO	*Plantago coronopus*	cut-leaved plantain	annual herb
PLER	*Plantago erecta*	California plantain	annual herb
PLXX	*Plantago* sp.	plantain	
POCA	*Polygala californica*	California milkwort	perennial herb
POMO	*Polypogon monspeliensis*	rabbitsfoot grass	annual herb
POSE	*Poa secunda*	pine bluegrass	perennial grass
POUN	*Poa unilateralis*	San Francisco bluegrass	perennial grass
POXX	*Poa* sp.		
PSBE	*Pseudognaphalium beneolens*	fragrant everlasting	perennial herb
PSCA	*Pseudognaphalium californicum*	lady's tobacco	annual herb
PSRA	*Pseudognaphalium ramosissimum*	pink everlasting	biennial herb
PSST	*Pseudognaphalium stramineum*	cottonbatting plant	perennial herb
PSXX	*Pseudognaphalium* sp.		
PTAQP	*Pteridium aquilinum* var. *pubescens*	western bracken fern	fern
QUAG	*Quercus agrifolia*	coast live oak	tree
QUPAS	*Quercus parvula* var. *shrevei*	Shreve oak	tree
QUWIF	*Quercus wislizeni* var. *frutescens*	chaparral oak	tree
RIMA	*Ribes malvaceum*	chaparral currant	shrub

Table A-1. Species acronyms, Former Fort Ord.

Acronym	Scientific Name	Common Name	Life Form
RISA	*Ribes sanguineum*	red flowering currant	shrub
RISP	*Ribes speciosum*	fuchsia-flowered gooseberry	shrub
ROCA	*Rosa californica*	California wild rose	shrub
ROGY	*Rosa gymnocarpa*	wood rose	shrub
RUAC	*Rumex acetosella*	sheep sorrel	perennial herb
RUUR	*Rubus ursinus*	California blackberry	woody vine
SABI	*Sanicula bipinnatifida*	purple sanicle	perennial herb
SALA	*Salix lasiolepsis*	arroyo willow	shrub
SAME	*Salvia mellifera*	black sage	shrub
SEGL	*Senecio glomeratus*	cutleaf burnweed	annual or perennial herb
SESY	*Senecio sylvaticus*	woodland ragwort	annual herb
SIBE	*Sisyrinchium bellum*	western blue-eyed grass	perennial herb
SIGA	*Silene gallica*	small flower catchfly	annual herb
SOAS	*Sonchus asper*	prickly sow thistle	annual herb
SOOL	*Sonchus oleraceus*	common sow thistle	annual herb
SOUM	*Solanum umbelliferum*	blue witch	shrub
SOXX	*Solidago* sp.	goldenrod	perennial herb
STPU	*Stipa pulchra*	purple needle grass	perennial grass
STVI	*Stephanomeria virgata*	tall stephanomeria	annual herb
SYALL	*Symphoricarpos albus* var. *laevigatus*	common snowberry	subshrub
SYMO	*Symphoricarpos mollis*	creeping snowberry	subshrub
TODI	*Toxicodendron diversilobum*	poison oak	shrub
TOFR	*Toxicoscordion fremontii*	Fremont's star lily	perennial herb
TOMI	*Toxicoscordion micranthum*	small flowered star lily	perennial herb
TRAN	*Trifolium angustifolium*	narrow-leaved clover	annual herb
TRBI	*Trifolium bifidum*	notch leaf clover	annual herb
TRFR	*Trifolium fragiferum*	strawberry clover	perennial herb
TRIX	*Triteleia ixioides*	coast pretty face	perennial herb
TRMI	*Trifolium microcephalum*	smallhead clover	annual herb
TROB	*Tribolium obliterum*	Capetown grass	perennial herb
TRVA	*Trifolium variegatum*	variegated clover	annual herb
TRWI	*Trifolium willdenovii*	tomcat clover	annual herb
URLI	*Uropappus lindleyi*	silver puffs	annual herb
VAOV	*Vaccinium ovatum*	huckleberry	shrub
VISA	*Vicia sativa*	garden vetch	annual herb
VIHI	*Vicia hirsute*	tiny vetch	annual herb
ZEDA	*Zeltnera davyi*	Davy's centuary	annual herb
ZEMU	*Zeltnera muehlenbergii*	Muehlenberg's centaury	annual herb

*Numbered codes correspond with the species acronym codes on the USDA PLANTS Database (USDA NRCS, 2024).

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APPENDIX B

MAPS: HMP ANNUALS GRIDS

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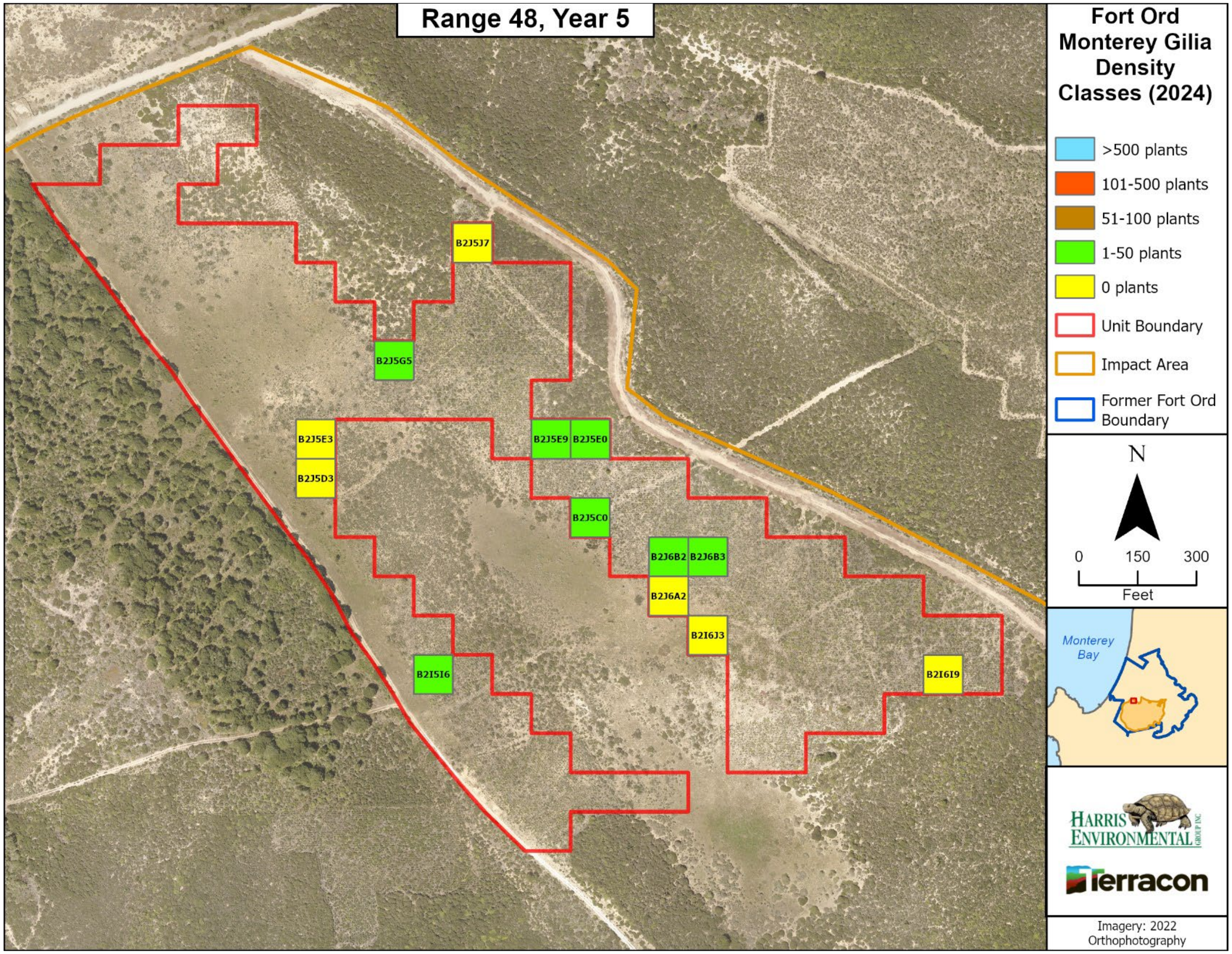

Figure B-1. Map of Monterey gilia density; Range 48 (Year 5).

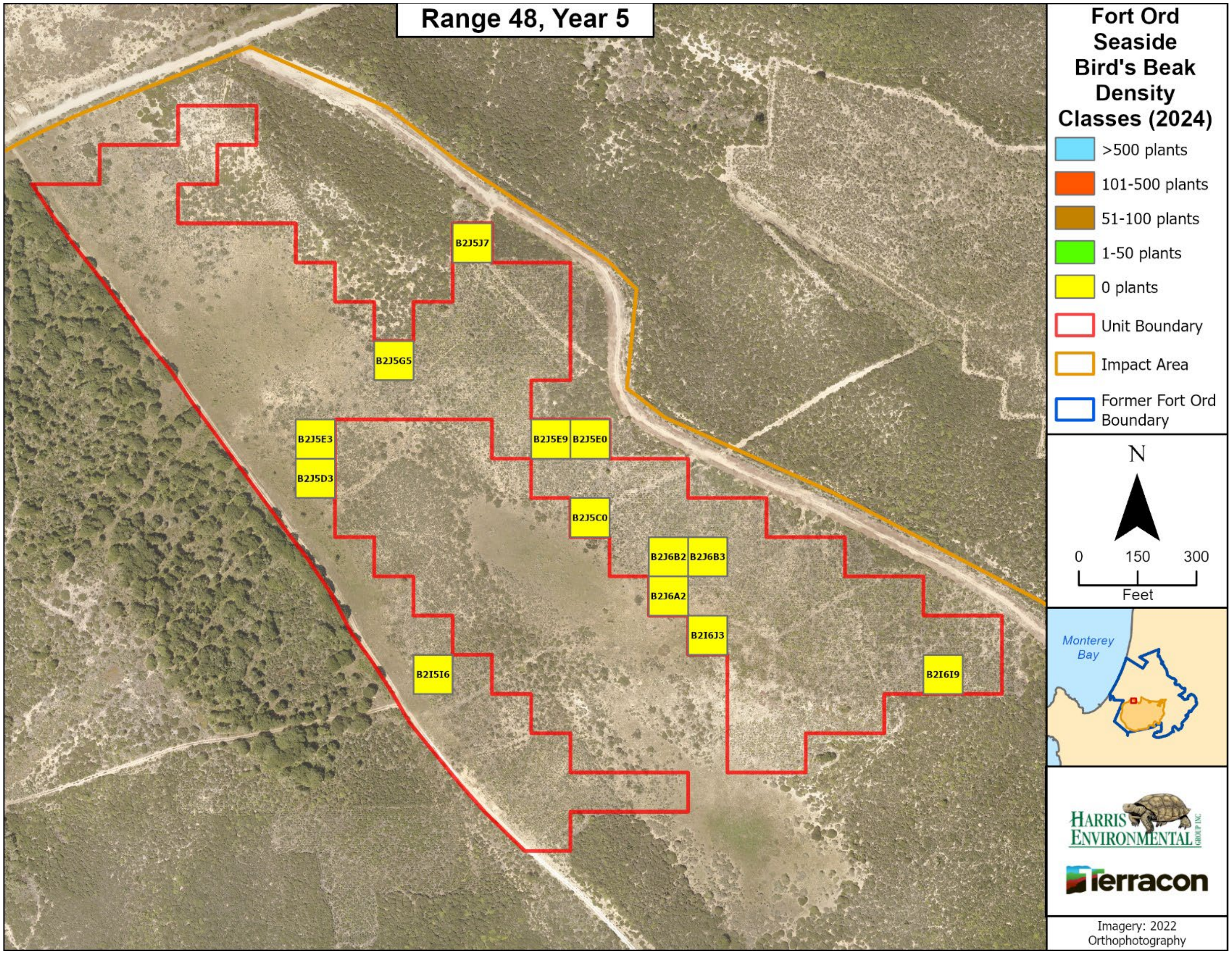

Figure B-2. Map of seaside bird's beak density; Range 48 (Year 5).

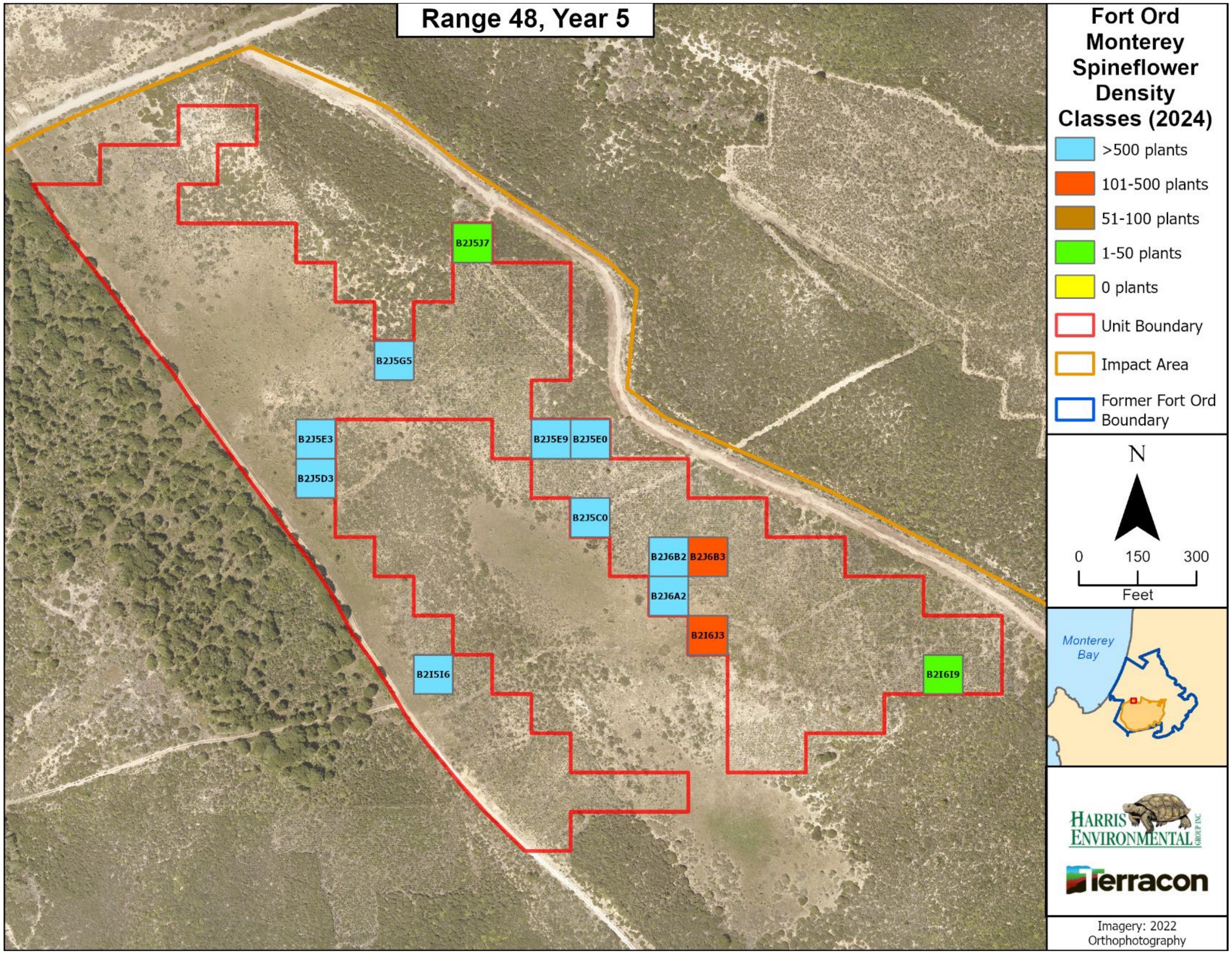

Figure B-3. Map of Monterey spineflower density; Range 48 (Year 5).

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APPENDIX C

MAPS: HMP SHRUB TRANSECTS

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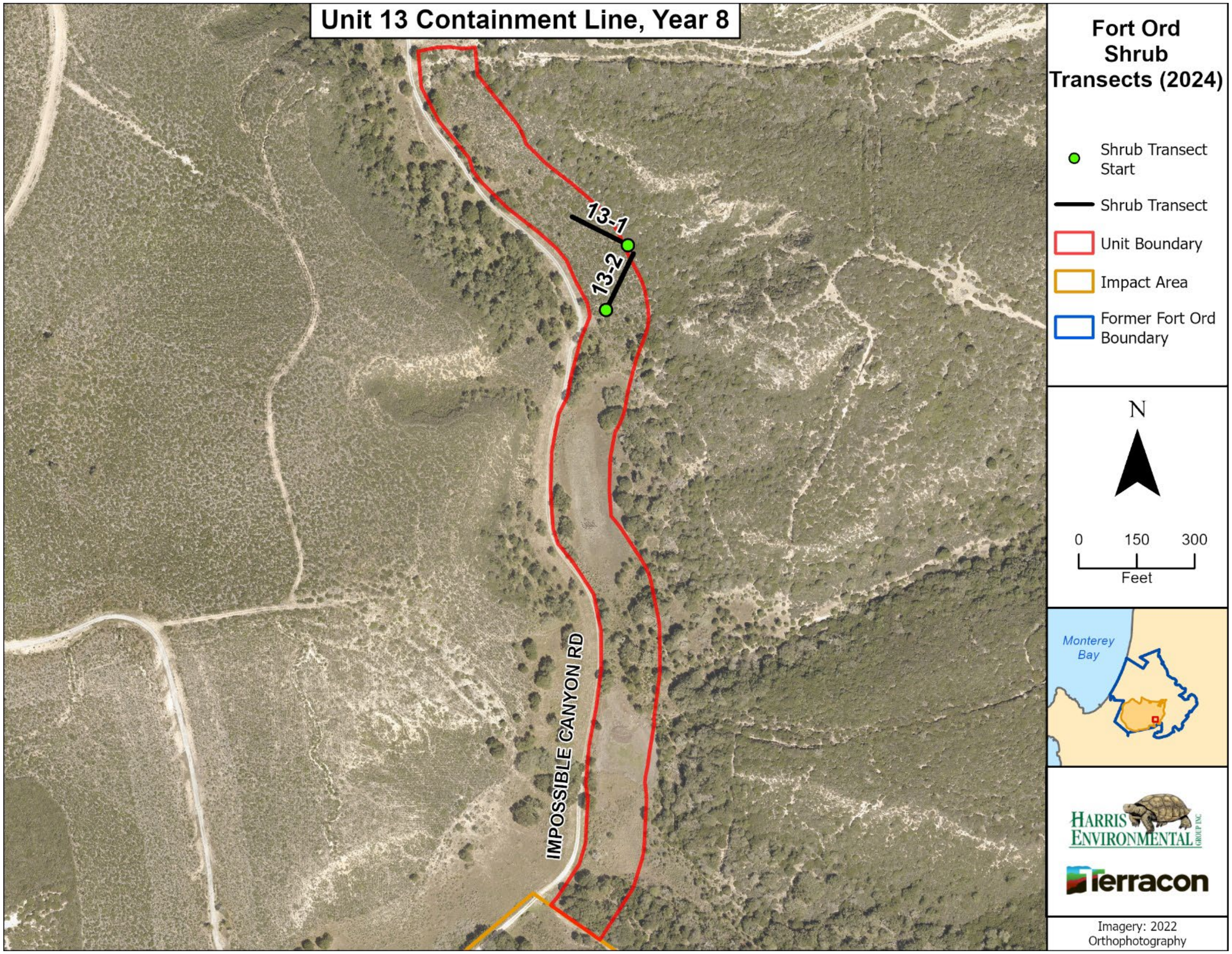

Figure C-1. Map of shrub transects; Unit 13 Containment Line (Year 8).

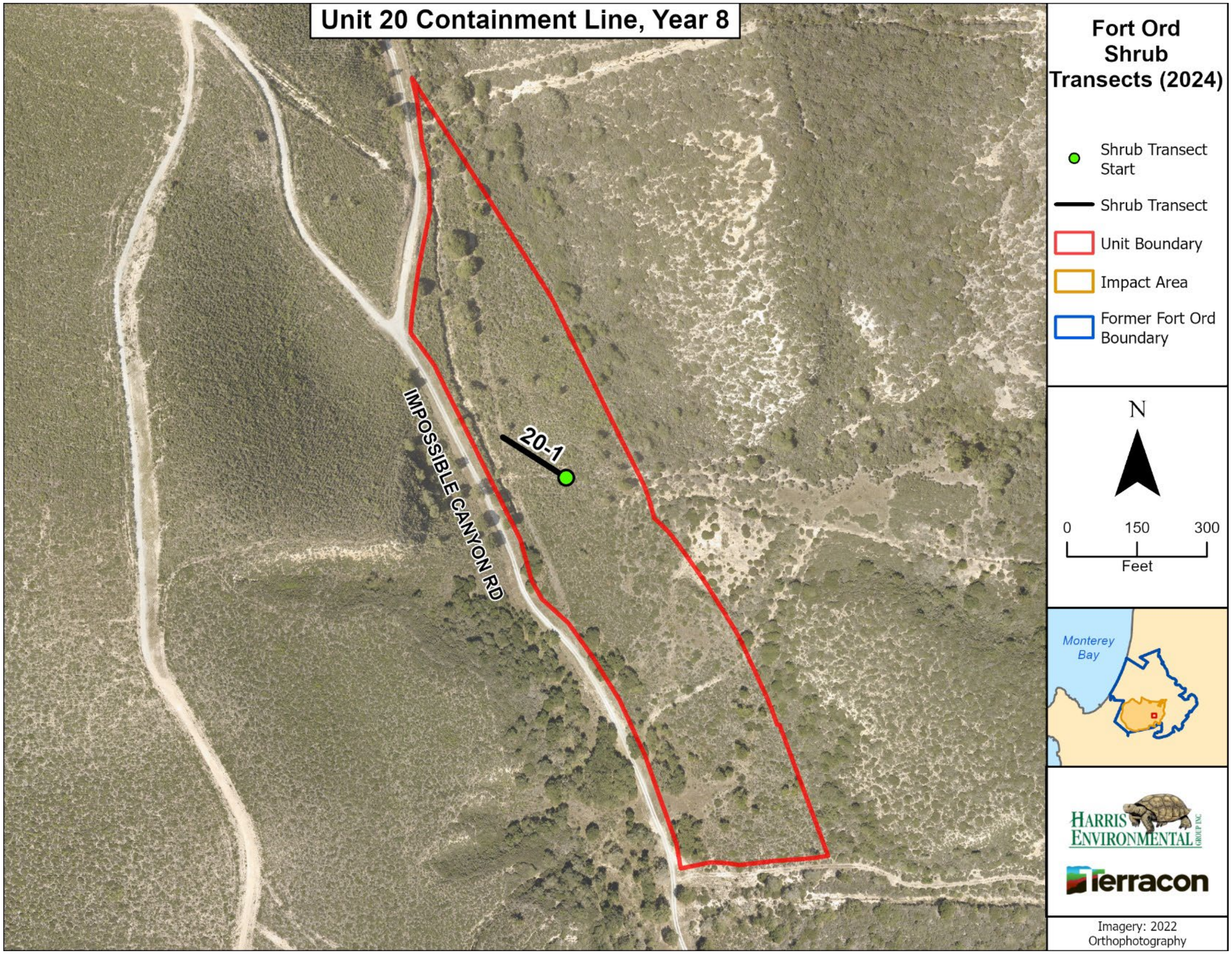

Figure C-2. Map of shrub transects; Unit 20 Containment Line (Year 8).

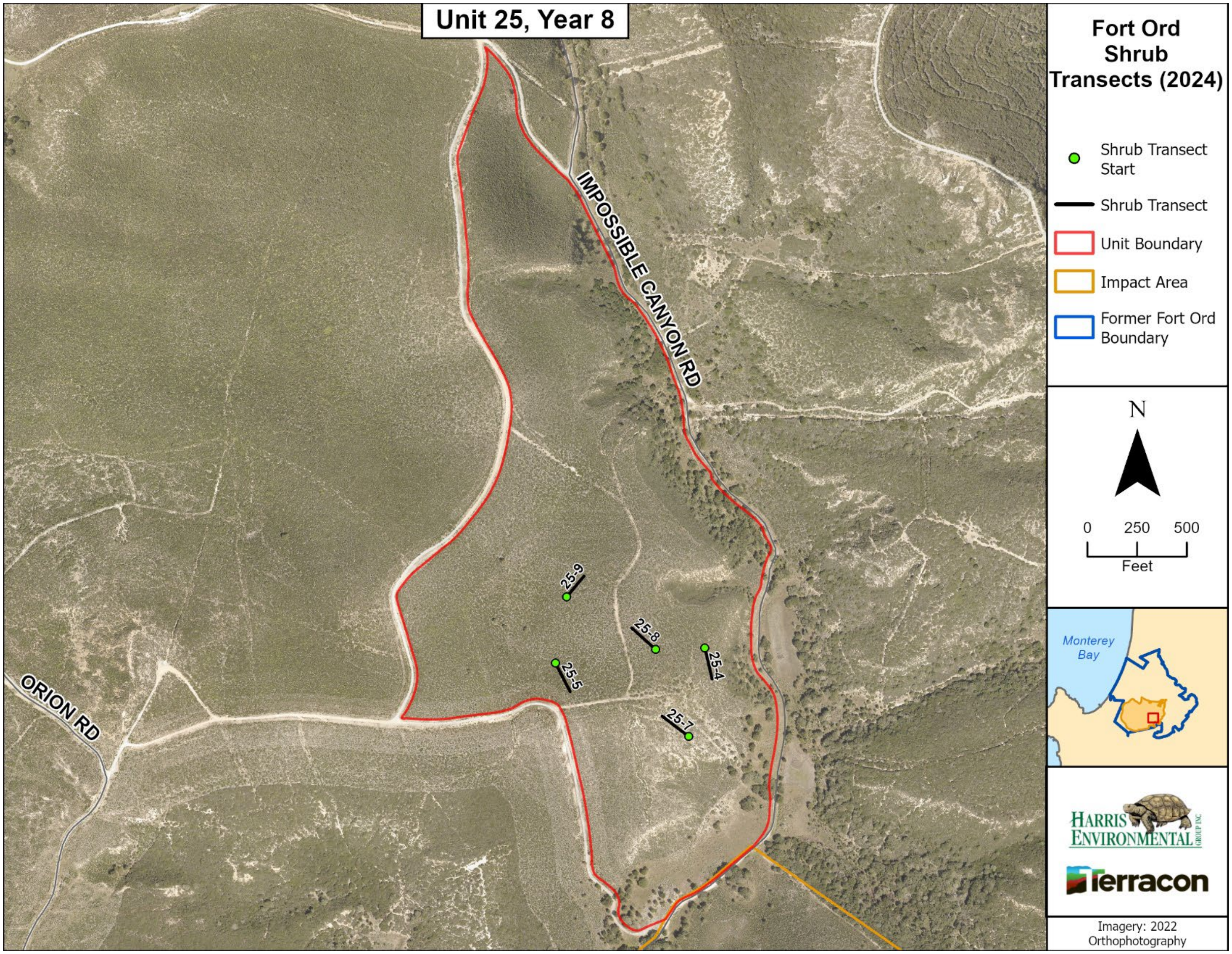

Figure C-3. Map of shrub transects; Unit 25 (Year 8).

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APPENDIX D

MAPS: ANNUAL GRASS DENSITY

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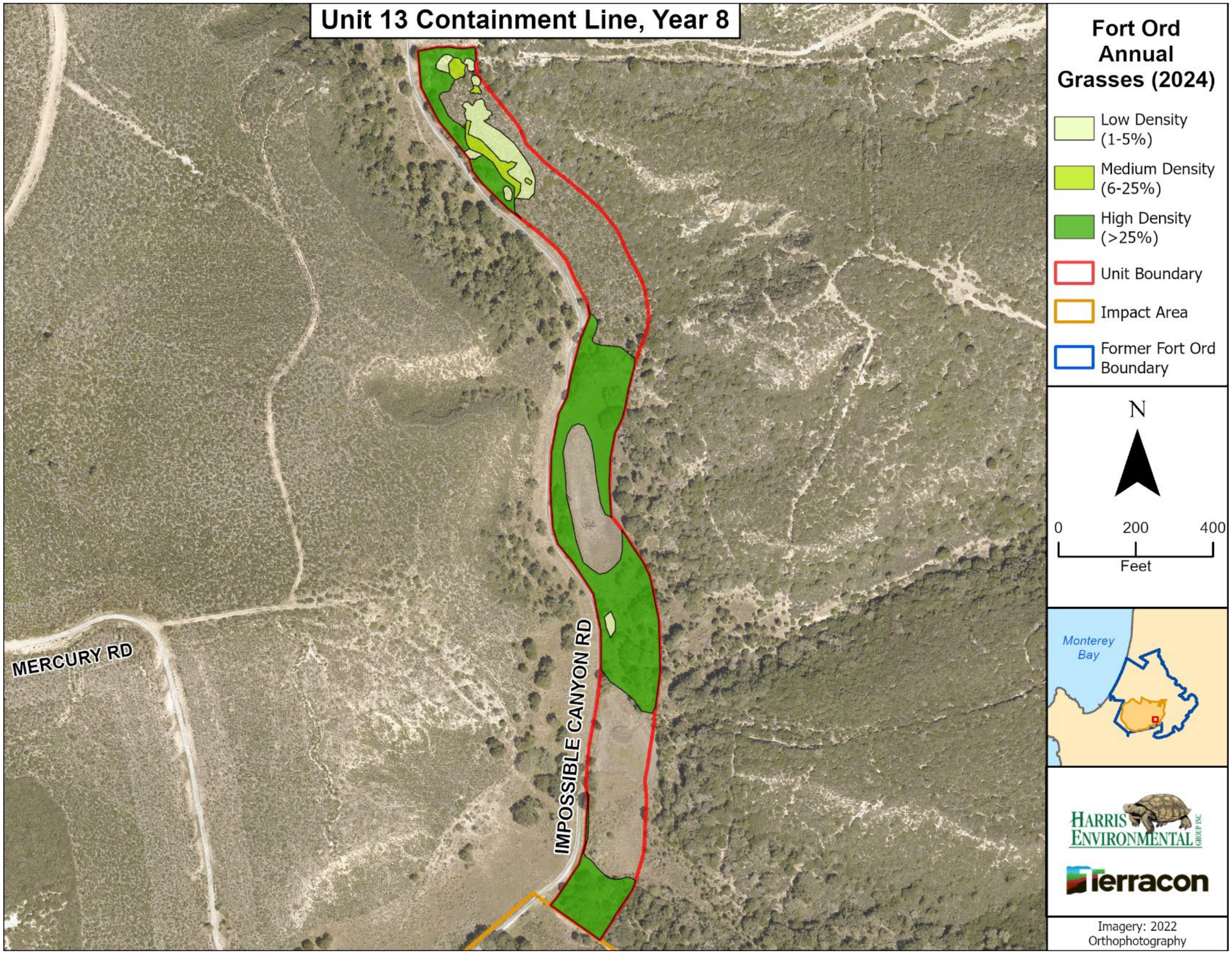

Figure D-1. Map of non-native annual grass density; Unit 13 Containment Line (Year 8).

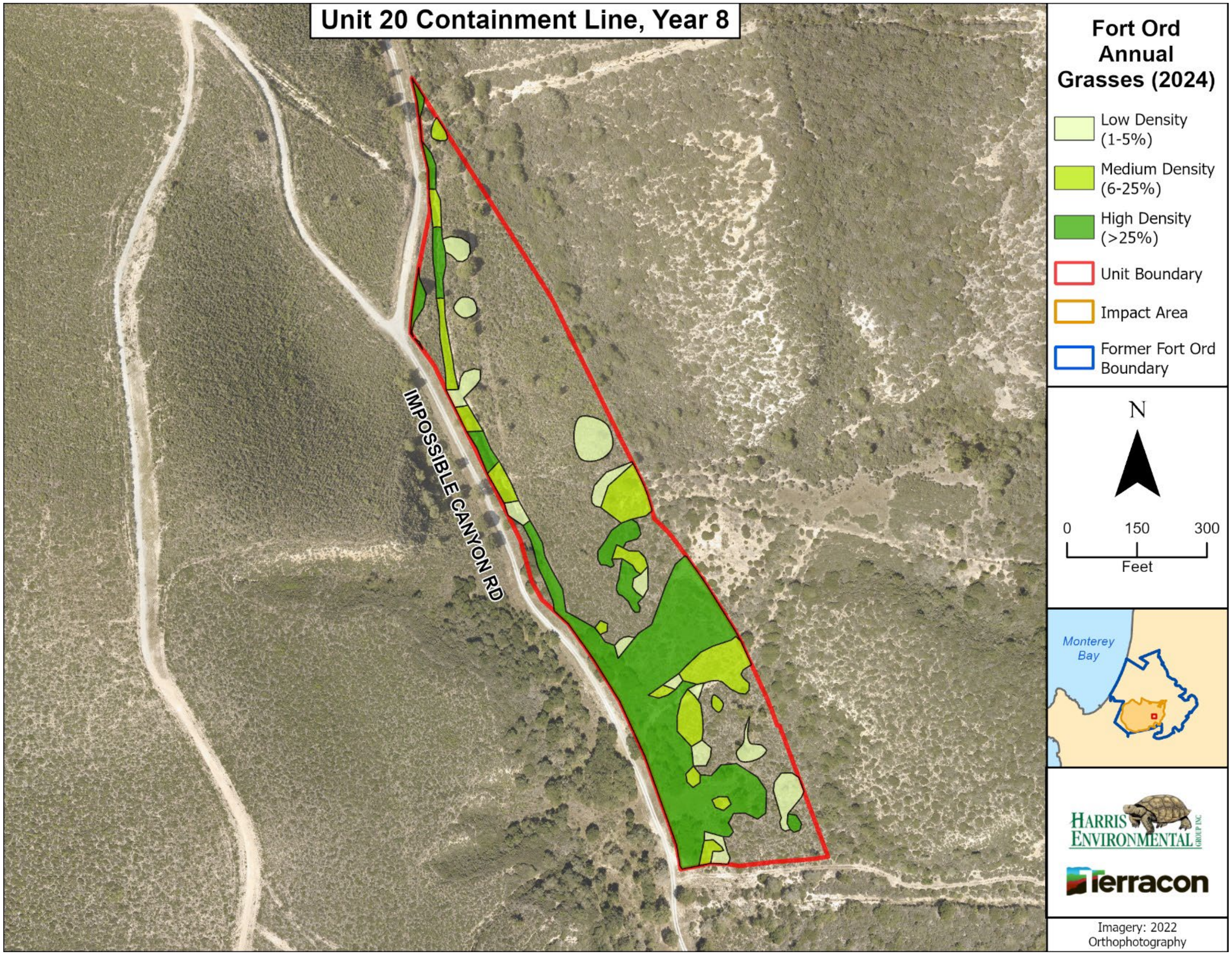

Figure D-2. Map of non-native annual grass density; Unit 20 Containment Line (Year 8).

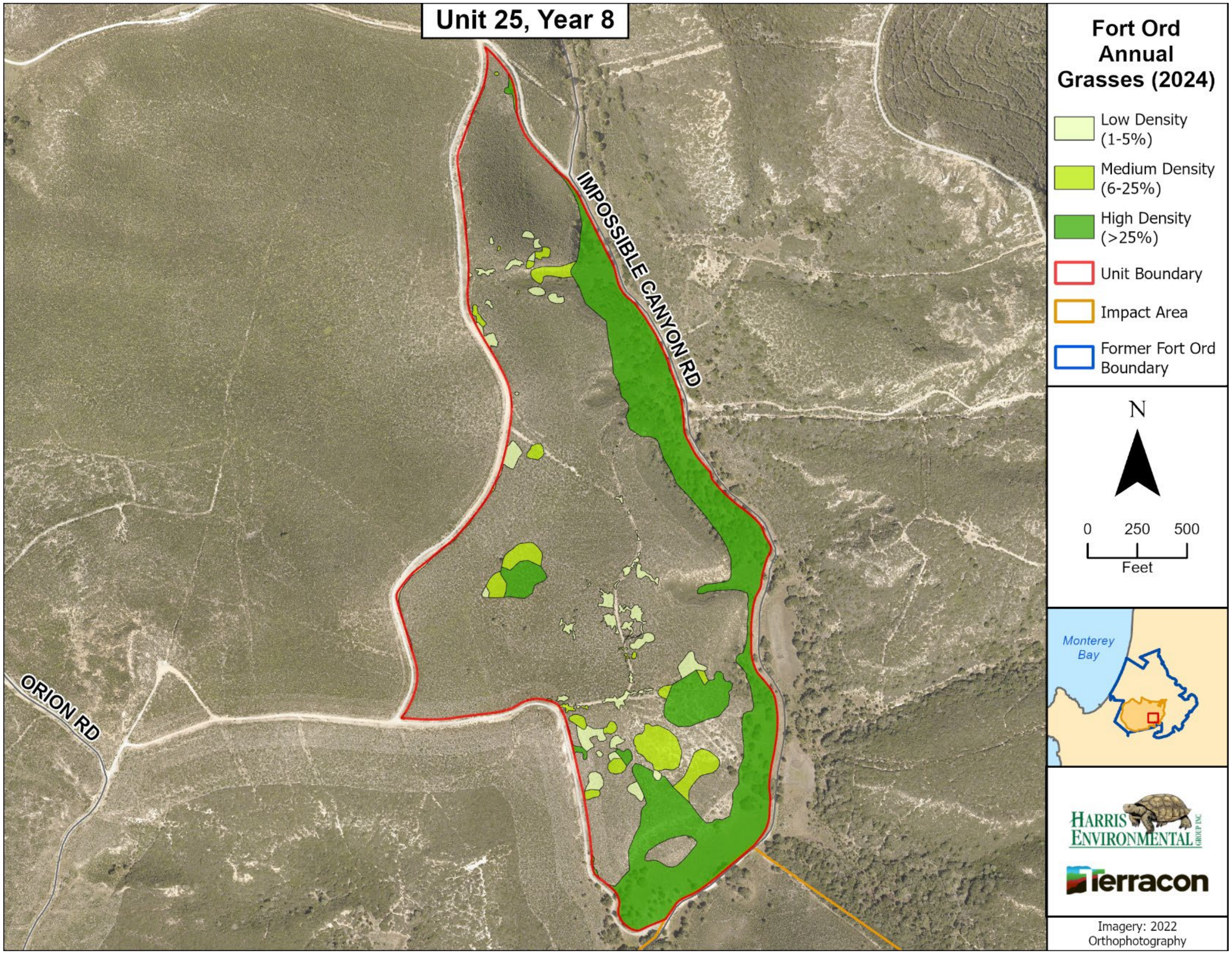

Figure D-3. Map of non-native annual grass density; Unit 25 (Year 8).

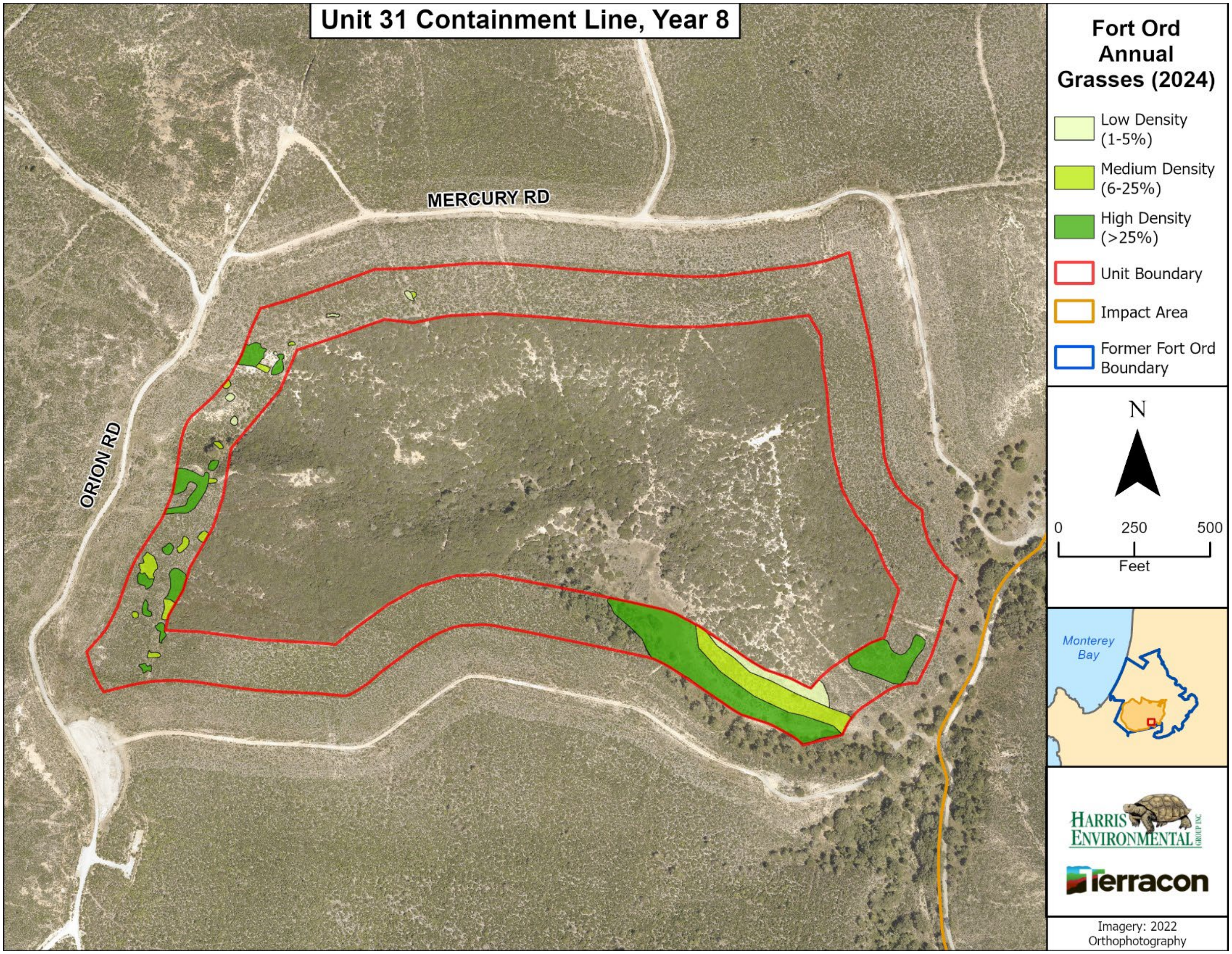

Figure D-4. Map of non-native annual grass density; Unit 31 Containment Line (Year 8).

APPENDIX E

MAPS: INVASIVE AND RARE SPECIES

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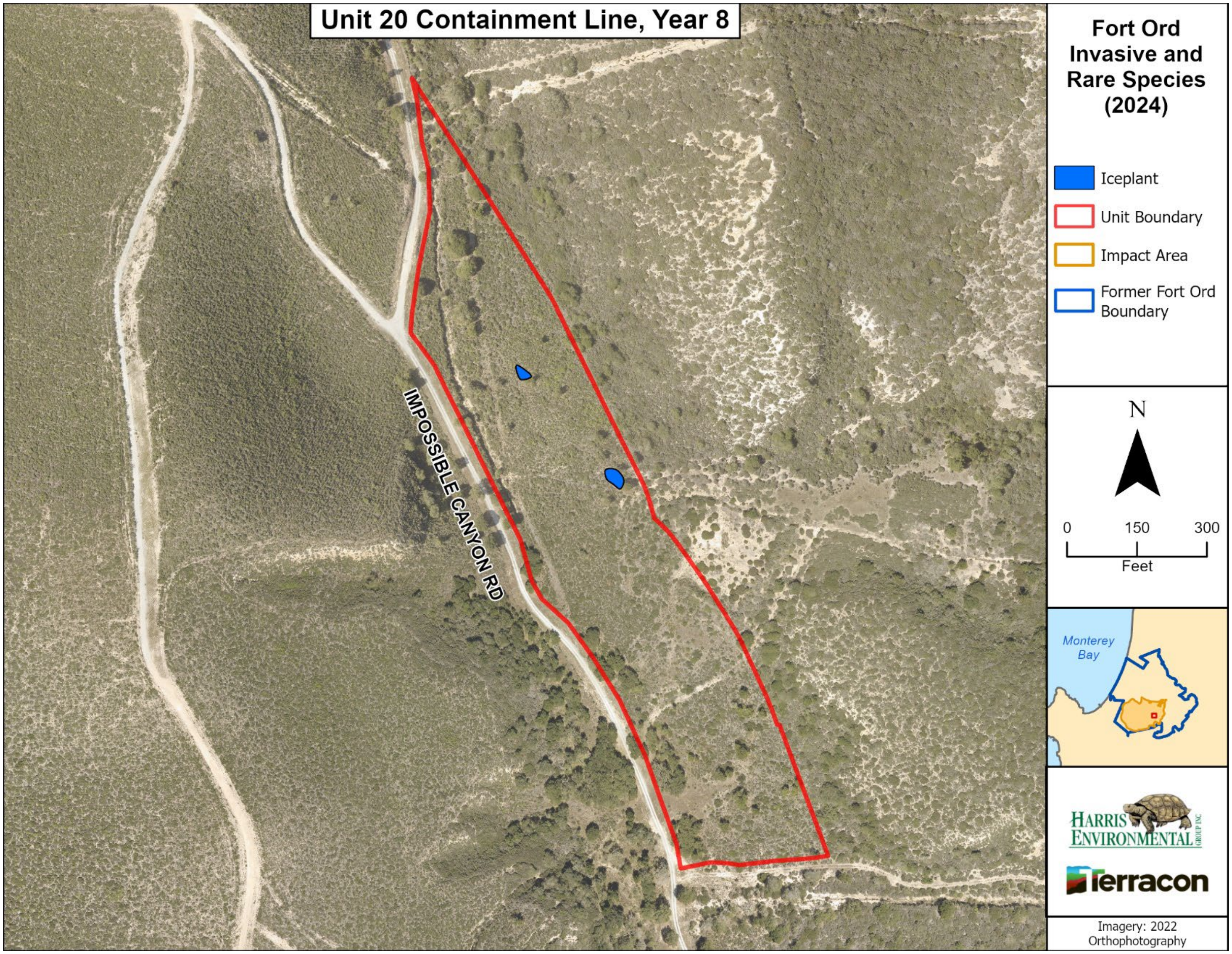

Figure E-1. Map of invasive species; Unit 20 Containment Line (Year 8).

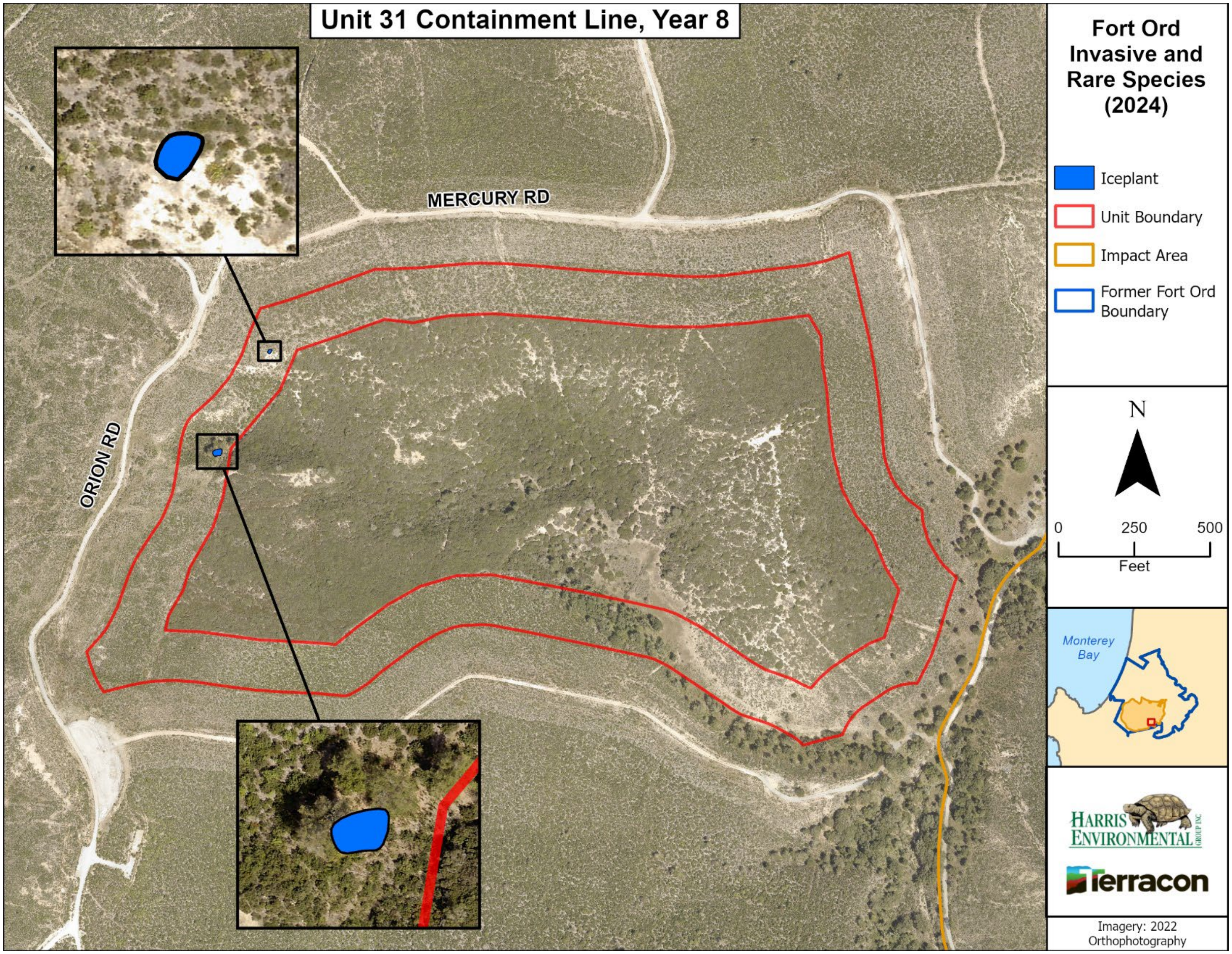

Figure E-2. Map of invasive species; Unit 31 Containment Line (Year 8).

APPENDIX F

SHRUB TRANSECT COVER DATA

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Table F-1. Year 8 Shrub Transects, Unit 13 Containment Line.

		Unit 13 Containment Line	
Code	**Species**	**13-1**	**13-2**
ACGL	*Acmispon glaber* (*Lotus scoparius*)	0.2	-
ADFA	*Adenostoma fasciculatum*	48.2	48.8
ARHO	*Arctostaphylos hookeri* ssp. *hookeri*	-	-
ARPU	*Arctostaphylos pumila*	-	-
ARTO	*Arctostaphylos tomentosa* ssp. *tomentosa*	40.6	35.6
BAPI	*Baccharis pilularis*	-	-
CAED	*Carpobrotus edulis*	-	-
CEDE	*Ceanothus dentatus*	6.6	11.6
CERI	*Ceanothus rigidus*	1.2	0.8
CRSC	*Crocanthemum* (*Helianthemum*) *scoparium*	1.2	0.8
DIAU	*Diplacus aurantiacus*	-	0.2
ERCO	*Eriophyllum confertiflorum*	1	0.2
ERFA	*Ericameria fasciculata*	-	-
GAEL	*Garrya elliptica*	-	-
LECA	*Lepechinia calycina*	-	-
QUAG	*Quercus agrifolia*	-	8.6
SAME	*Salvia mellifera*	-	-
SYMO	*Symphoricarpos mollis*	-	-
TODI	*Toxicodendron diversilobum*	7	10.8
BG	Bare Ground	14.8	14.6
HERB	Herbaceous Cover	4.2	5.2

Table F-2. Year 8 Shrub Transects, Unit 20 Containment Line.

		Unit 20 Containment Line
Code	**Species**	**20-1**
ACGL	*Acmispon glaber* (*Lotus scoparius*)	-
ADFA	*Adenostoma fasciculatum*	39
ARHO	*Arctostaphylos hookeri* ssp. *hookeri*	-
ARPU	*Arctostaphylos pumila*	-
ARTO	*Arctostaphylos tomentosa* ssp. *tomentosa*	22.4
BAPI	*Baccharis pilularis*	-
CAED	*Carpobrotus edulis*	-
CEDE	*Ceanothus dentatus*	-
CERI	*Ceanothus rigidus*	16
CRSC	*Crocanthemum* (*Helianthemum*) *scoparium*	1
DIAU	*Diplacus aurantiacus*	-
ERCO	*Eriophyllum confertiflorum*	0.2
ERFA	*Ericameria fasciculata*	-
GAEL	*Garrya elliptica*	-
LECA	*Lepechinia calycina*	-
QUAG	*Quercus agrifolia*	-
SAME	*Salvia mellifera*	7.6
SYMO	*Symphoricarpos mollis*	1
TODI	*Toxicodendron diversilobum*	2.8
BG	Bare Ground	24.4
HERB	Herbaceous Cover	12.4

Table F-3. Year 8 Shrub Transects, Unit 25.

		Unit 25				
Code	**Species**	**25-4**	**25-5**	**25-7**	**25-8**	**25-9**
ACGL	*Acmispon glaber* (*Lotus scoparius*)	1.6	-	2	-	-
ADFA	*Adenostoma fasciculatum*	15.2	36	32	6	16.6
ARHO	*Arctostaphylos hookeri* ssp. *hookeri*	-	0.4	-	-	-
ARPU	*Arctostaphylos pumila*	-	-	-	1	-
ARTO	*Arctostaphylos tomentosa* ssp. *tomentosa*	39.8	61.4	11.2	57.2	56.8
BAPI	*Baccharis pilularis*	-	1	-	2.8	4.8
CAED	*Carpobrotus edulis*	-	-	-	0.6	-
CEDE	*Ceanothus dentatus*	11.2	-	0.4	10.8	0.6
CERI	*Ceanothus rigidus*	3.4	0.8	-	7.2	1
CRSC	*Crocanthemum* (*Helianthemum*) *scoparium*	1.6	-	6.2	4.6	1.8
DIAU	*Diplacus aurantiacus*	0.4	-	-	0.4	-
ERCO	*Eriophyllum confertiflorum*	0.8	3.8	1.6	2	1.4
ERFA	*Ericameria fasciculata*	-	-	0.8	-	-
GAEL	*Garrya elliptica*	-	3.4	-	2.4	6.4
LECA	*Lepechinia calycina*	-	-	-	1.2	0.8
QUAG	*Quercus agrifolia*	-	-	-	-	-
SAME	*Salvia mellifera*	11.6	-	2.2	5.8	11
SYMO	*Symphoricarpos mollis*	-	-	-	-	-
TODI	*Toxicodendron diversilobum*	3.6	-	-	-	-
BG	Bare Ground	25.2	9.8	14.6	15.2	19
HERB	Herbaceous Cover	6	1	47.4	8	2.4

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APPENDIX G

NON-NATIVE SPECIES

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Table G-1. Non-Native Species Observed During Line Intercept Transect Monitoring in Unit 13 Containment Line.

Non-Native Herbaceous Species Name	Common Name	Species Code
Briza maxima	rattlesnake grass	BRMA
Rumex acetocella	sheep's sorrel	RUAC

Table G-2. Non-Native Species Observed During Line Intercept Transect Monitoring in Unit 20 Containment Line.

Non-Native Herbaceous Species Name	Common Name	Species Code
Aira caryophyllea	silver hair grass	AICA
Briza maxima	rattlesnake grass	BRMA

Table G-3. Non-Native Species Observed During Line Intercept Transect Monitoring in Unit 25.

Non-Native Herbaceous Species Name	Common Name	Species Code
Aira caryophyllea	silver hair grass	AICA
Bromus hordeaceus	soft brome	BRHO
Briza maxima	rattlesnake grass	BRMA
Festuca (*Vulpia*) *myuros*	rattail sixweeks grass	FEMY
Hypochaeris glabra	smooth cat’s ear	HYGL