Covered and Invasive Species Management: Crestridge Ecological Reserve and South Crest Properties

TASKS 1-4: Covered Species Mapping, Invasive Species Mapping, Invasive Plant Control, and Early Detection Plan

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CONSERVATION BIOLOGY INSTITUTE

EXECUTIVE SUMMARY

The Conservation Biology Institute (CBI) and partners conducted covered and invasive species mapping, monitoring, and management on the Crestridge Ecological Reserve (CER) and South Crest properties (South Crest) in 2011 and 2012 as part of a Transnet EMP Grant (contract no. 5001586). This document functions as the final report for the following tasks:

Task 1 – Invasive Species Mapping

Task 2 – Covered Species Mapping

Task 3 – Invasive Plant Control

Task 4 – Early Detection Plan

The location of the subject properties is depicted in Figure ES-1. The CER is owned by the California Department of Fish and Game (CDFG) and managed by the Endangered Habitats Conservancy (EHC); EHC owns and manages the South Crest properties. Both properties support MSCP covered species and sensitive habitats, and function as critical landscape linkages between the northern and southern MSCP. Surrounded by residential development and heavily impacted by the 2003 Cedar Fire, these properties are subject to ongoing invasive plant issues. Specific task actions included invasive plant and covered plant species mapping and risk assessments, invasive plant control and experimental studies, and development of an early detection invasive control plan.

Under Task 1, a total of 25 invasive plant species of concern were mapped on the subject properties, including 21 species on CER and 14 species on South Crest. An additional high priority invasive plant was documented just south of the South Crest boundary. The invasives mapping provides a baseline against which to measure the effectiveness of management actions. Invasive species were grouped into management categories based on distribution, abundance, and management feasibility. Within each category, species were then prioritized for treatment based on population size, impacts, and threats to conservation targets. Management recommendations were developed for each species, including an overall management goal, objectives necessary to achieve that goal, and treatment priorities.

Under Task 2, four covered plant species were mapped on the South Crest properties: Dehesa beargrass (*Nolina interrata)*, Parry's tetracoccus (*Tetracoccus dioicus),* San Diego thornmint (*Acanthomintha ilicifolia)*, and variegated dudleya (*Dudleya variegata)*. The focus of this mapping effort was to assess the post-Cedar Fire status of these populations, including distribution and threats, and to recommend management actions, if necessary.

The majority of the Dehesa beargrass population occurs on clay and gabbro soils in the Skeleton Flats area of South Crest, with additional plants on the slopes above Dehesa Road. A comparison of pre- and post-Cedar Fire occurrences indicated that fire may have stimulated plant growth or made existing plants more visible by opening up the habitat in some areas; however, decreases in population size were documented in the western portion of Skeleton Flats, in an area heavily infested by the nonnative grass, purple false brome (*Brachypodium distachyon)*. An altered fire regime, invasive plants, and

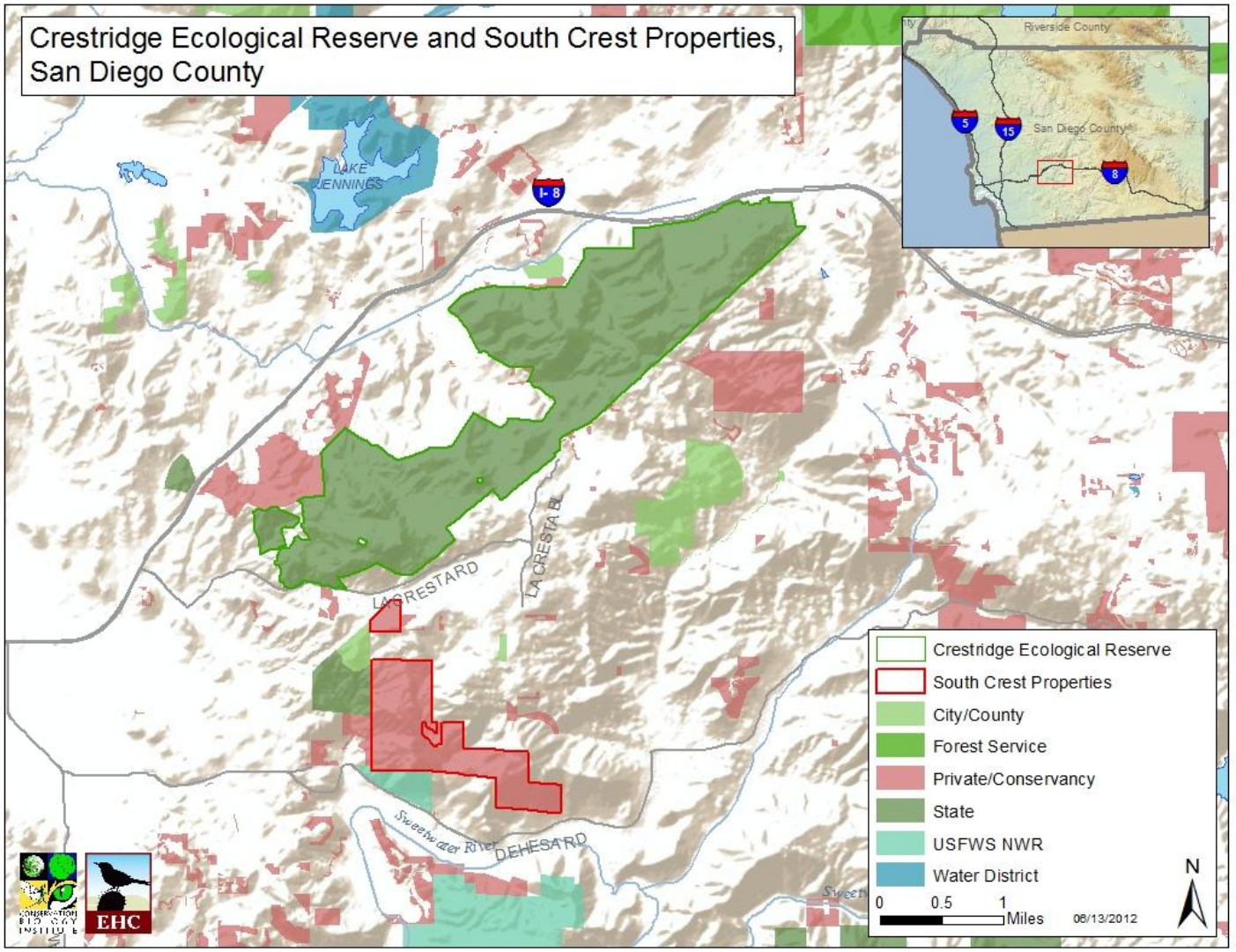

Figure ES-1. Project Location.

potentially, low genetic diversity, were identified as the primary threats to this species onsite; impacts from unauthorized recreational use may also be an issue. We developed a draft conceptual model for Dehesa beargrass and management goals and objectives to address threats.

Parry's tetracoccus also occurs on Skeleton Flats and the slopes above Dehesa Road. Pre- and post-fire distribution of plants was roughly the same; however, population size increased after fire at all locations. It was not clear whether the number of plants increased or whether plants became more visible as habitat was opened up. Small populations of San Diego thornmint and variegated dudleya were detected onsite in 2012. These populations do not correspond to pre-fire localities; much of the pre-fire habitat of these species has been infested by *Brachypodium*. The primary threats to these three species are fire, invasive plants, and recreational uses. Based on these threats, management goals and objectives were developed for these species.

Task 3 dealt specifically with invasives control and included focused treatments in four areas on CER: (1) a 10-acre grassland restoration site; (2) 5 acres of coastal sage scrub undergoing post-fire restoration; and (3) 5 acres of a coast live oak/Engelmann oak grove; and (4) San Diego thornmint habitat on Thornmint Hill. In the restoration sites, multiple treatments resulted 75-90% control of invasives in established areas and about 15% control in newly planted areas. Although the level of effort required to treat these areas has decreased over time, spot-treatments of key species are recommended to allow native grasses to continue to thrive and expand their cover, allow emergence of a native herbaceous component, and prevent nonnative species from contributing to the soil seed bank. Similarly, control efforts in the oak grove resulted in 70% control of the key invasive species, long-flowered veldt grass (*Ehrharta longiflora*), and additional treatments are recommended until this species is eradicated. Invasives control efforts on Thornmint Hill focused on an experimental design to test the efficacy of alternative treatment methods for controlling *Brachypodium* prior to widespread application. Results indicated that herbicide treatment was the most effective in controlling *Brachypodium* cover, but also resulted in a significant increase in exotic species richness. The mechanical treatment was intermediate in effectiveness between herbicide and the control, and effectiveness of this treatment may be enhanced when thatch is left in place. Finally, data indicated that thatch removal was not a significant factor in treatment effectiveness. In addition to the four focus areas, additional invasive control efforts were conducted at both sites in response to results from the invasives mapping (Task 1).

Task 4 included development of an Early Detection Plan (EDP) and initiation of surveillance surveys. The EDP establishes a system of surveillance (early detection), assessment, and action (rapid response) to prevent the introduction and spread of new invasive plant species on CER and South Crest, prevent the spread of existing invasive plant species into new locations on these sites, and respond quickly to identified invasive species threats. Components of the EDP include (1) a target list of species for surveillance; (2) the surveillance team (including training and education); (3) a map of suitable surveillance locations; (4) a species-specific schedule for surveillance activities; (5) reporting procedures; and (6) a plan for rapid response. Early detection and rapid response is widely acknowledged as the most effective strategy for invasive species management in terms of cost, feasibility, and long-term resource protection.

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PURPOSE AND BACKGROUND

Non-native, invasive plants pose one of the greatest threats to the biological integrity of preserve lands because of their ability to displace native species, degrade wildlife habitat, and alter ecosystem processes (Belnap et al. 2005; Ehrenfeld 2003; Evans et al. 2001; Cox 1999; Wilcove et al. 1998; D'Antonio and Vitousek 1992; Huenneke et al. 1990; Vitousek et al. 1990; and many others). Both the Crestridge Ecological Reserve (CER) and South Crest (South Crest) properties are surrounded by urban and rural development and are susceptible to recurrent invasive plant infestations. The 2003 Cedar Fire exacerbated the spread and establishment of invasive plants on both properties. In 2009 and 2010, invasive species mapping was conducted opportunistically, rather than comprehensively, and only on CER; this mapping also documented threats to covered species and sensitive habitats.

The objective of this task was to produce a comprehensive invasive plant database for CER and South Crest as a baseline for future management and monitoring activities. Invasive species mapping was conducted on those portions of CER that had not been previously assessed, and on the entire South Crest property, focusing on invasive species that pose the greatest threat to covered species and habitats, and for which control efforts are likely to be effective. To the degree feasible, selection and prioritization of species for mapping were coordinated with efforts currently underway with the regional invasive species mapping program being conducted under a separate SANDAG Transnet EMP grant. However, a number of the invasives mapped on CER and South Crest are considered problematic at the preserve-level and are not necessarily a high mapping priority region-wide.

SURVEY SCHEDULE

Focused invasive plant mapping was conducted by botanists Patricia Gordon-Reedy and Jessie Vinje, and field assistant Curtis Battle, according to the schedule in Table 1-1. In addition, invasive species were mapped occasionally during surveys for covered species (see Task 2).

SURVEY METHODOLOGY

Invasive plant mapping included the following tasks:

- Assigned unique identifier names to each individual or stand; these names will be used consistently in all documents, maps, and databases.
- Mapped occurrence locations using global positioning system (GPS) equipment; mapping included an attribute for either direct counts or estimates of the size of the stand, and GPS coordinate accuracy.
- Completed invasive species survey forms for each unique occurrence.
- Assessed threats to sensitive resources (see also Task 2).

Table 1-1. Invasive Plant Mapping Survey Schedule.

Survey Personnel[1]	Survey Date	Property[2]	Location
PGR/CB	3/14/2011	CER	Thornmint Hill (slopes east of Rios Canyon Road)
PGR/CB	3/28/2011	CER	Rios Canyon Road
PGR/CB	3/30/2011	CER	Rios Canyon Road
PGR/CB	4/5/2011	South Crest	Skeleton Flats/Orchard Avenue
PGR/CB	4/6/2011	South Crest	Skeleton Flats
PGR/CB	4/13/2011	South Crest	Skeleton Flats
PGR/CB	4/14/2011	South Crest	Slopes above Dehesa Road
PGR/CB	4/20/2011	CER	Thornmint Hill (slopes east of Rios Canyon Road)
PGR/CB	5/24/2011	South Crest	Skeleton Flats
PGR/CB	6/30/2011	South Crest	Skeleton Flats
PGR/CB	8/26/2011	CER	Trail north of Gibson property
JV/CB	5/23/2012	South Crest	Skeleton Flats
JV/CB	5/29/2012	CER	Rios Canyon; Gibson Highlands (adjacent to CER); Horsemill Road oak grove

[1] PGR = Patricia Gordon-Reedy; JV = Jessie Vinje; CB = Curtis Battle.
[2] CER = Crestridge Ecological Reserve; South Crest = South Crest properties.

Survey methodology consisted of systematically assessing habitat, with an initial focus on areas or landscape features known to serve as conduits for invasion, such as roads, trails, riparian corridors, and areas of natural and anthropogenic disturbance. For CER, surveyors focused on areas that had not yet been assessed, although we did some re-mapping and/or refined mapping of previously mapped occurrences. On South Crest, the entire site was assessed; steep slopes were accessed directly, to the degree feasible, or surveyed with binoculars where direct access was not possible. In the latter case, aerial imagery was used to refine mapping locations.

Locations of invasive plant populations were recorded using a Garmin 60CSX GPS unit; GPS locations for invasive plants are listed in Appendix A. Data points were recorded as either points or polygons, depending largely on the size of the infestation. Polygon boundaries were collected by walking the outer boundary of the population; points represent the center point of an individual or small stand of plants. Population size was recorded as direct counts where feasible or as an areal extent (i.e., square feet or acreage). Invasive plant data forms were completed for each unique occurrence; these data forms are included in Appendix B.

RESULTS

In 2011 and 2012, 25 invasive plant species of concern were documented on CER and South Crest. This total includes 21 species on CER (Figure 1-1) and 14 species on South Crest (Figure 1-2). Eleven of the species mapped occur on both properties (Table 1-2). Infestations range from a single plant to large, nearly monospecific, stands in excess of 60 acres. An additional high priority invasive species, artichoke thistle (*Cynara cardunculus*), was observed offsite but in proximity to South Crest. Although this species was not mapped, it is included in the following discussions because of its potential to impact sensitive resources on the subject properties.

Appendix C includes a description of each invasive species with respect to biology and life history, habitat, threats, and location and extent onsite.

MANAGEMENT STRATEGIES

In keeping with state and regional invasive plant management strategies (Cal-IPC 2012; CBI in prep.), this document groups invasive species into management categories based on distribution, abundance, and management feasibility. These categories do not necessarily prioritize species for management, but rather, provide an indication of appropriate management strategies. Within each category, species are then prioritized for management by population size, invasiveness, and threats to sensitive resources. The five management categories include:

- Category 1: Surveillance
- Category 2: Eradication
- Category 3: Containment/Eradication
- Category 4: Control
- Category 5: Suppression

Categories 1-3 correspond to both state and regional categories (Cal-IPC 2012; CBI in prep.). Categories 4 and 5 are included in the regional invasive management strategy and typically deal with species that are problematic at the preserve-level (CBI in prep.). Placement of species within management categories corresponds closely to state and regional placement; exceptions are primarily in the surveillance category. Where Category 3-5 species occur in low numbers on CER or South Crest, eradication may be feasible *if* management actions are implemented before the populations experience significant expansion. Where eradication is successful, species should be moved to Category 1 for surveillance. Management categories are described below. Species placement within management categories is listed below and in Table 1-3.

CATEGORY 1: SURVEILLANCE (EARLY DETECTION, RAPID RESPONSE)

Category 1 includes those invasive species not currently known to be present on CER or South Crest, but with a reasonable potential for occurrence in the future based on proximity, suitable habitat, and rate or

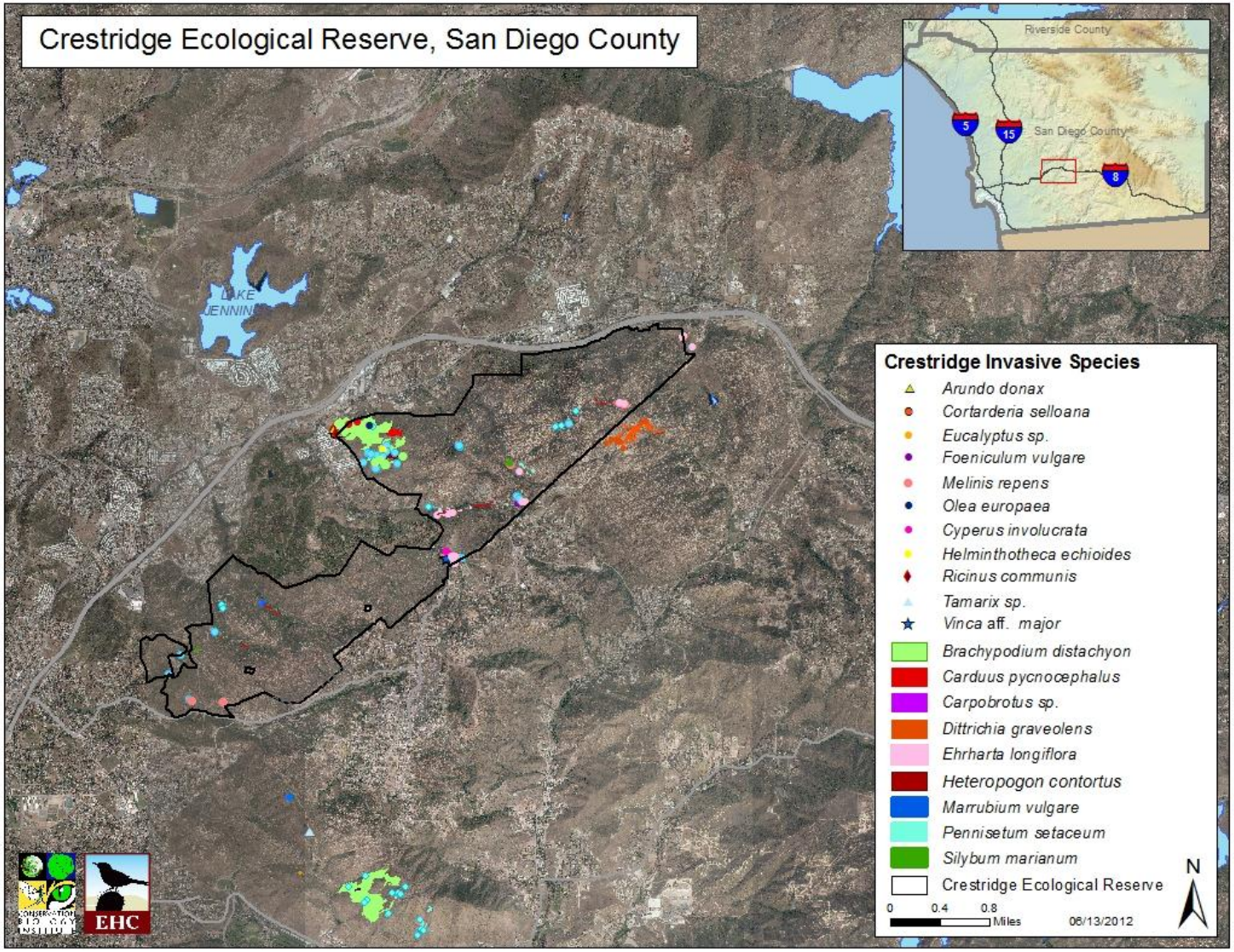

Figure 1-1. Invasive Plant Species, Crestridge Ecological Reserve.

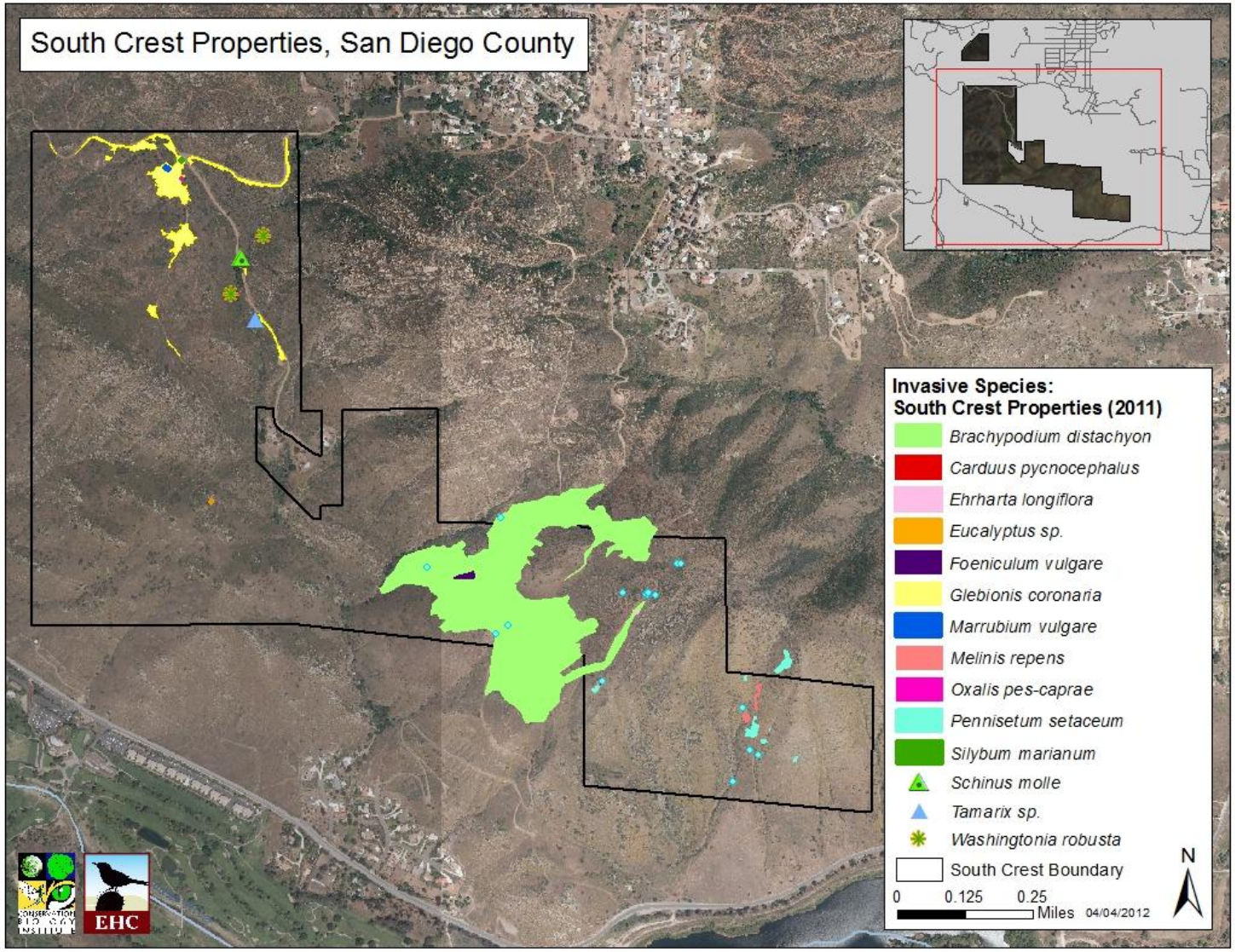

Figure 1-2. Invasive Plant Species, South Crest Properties.

Table 1-2. Invasive Plants Detected On or Adjacent to CER and South Crest.

Scientific Name **(Common Name)**	**CER**	**South Crest**
Arundo donax (Giant reed)	X	
Brachypodium distachyon (Purple false brome)	X	X
Brassica tournefortii (Saharan mustard)		X
Carduus pycnocephalus (Italian thistle)	X	X
Carpobrotus sp. (Iceplant, Hottentot-fig)	X	
Cortaderia selloana (Pampas grass)	X	
Cynara cardunculus (Artichoke thistle)[1]		
Cyperus involucrata (Umbrella sedge)	X	
Dittrichia graveolens (Stinkwort)	X	
Ehrharta longiflora (Long-flowered veldt grass)	X	X
Eucalyptus sp. (Eucalyptus, gum tree)	X	X
Foeniculum vulgare (Sweet fennel)	X	X
Glebionis coronaria (Garland chrysanthemum)		X
Helminthotheca echioides (Bristly ox-tongue)	X	
Heteropogon contortus (Tanglehead)	X	
Marrubium vulgare (Horehound)	X	X
Melinis repens (Natal grass)	X[1]	X
Olea europaea (Olive)	X	
Oxalis pes-caprae (Bermuda buttercup)		X
Pennisetum setaceum (Fountain grass)	X	X
Ricinus communis (Castor bean)	X	
Schinus molle (Peruvian peppertree)	X[1]	X
Silybum marianum (Blessed milk thistle)	X	X
Tamarix sp. (Tamarisk)	X	X
Vinca aff. *major* (Periwinkle)	X	
Washingtonia robusta (Washington fan palm)		X

Table 1-3. Invasive Species Management Categories

Management Category	*Scientific Name* (Common Name)
1 - Surveillance[1]	*Cynara cardunculus* (Artichoke thistle)
2 - Eradication	*Brassica tournefortii* (Saharan mustard) *Cyperus involucrata* (Umbrella sedge) *Dittrichia graveolens* (Stinkwort) *Heteropogon contortus* (Tanglehead) Vinca aff. *major* (Periwinkle)
3 – Containment/Eradication	*Arundo donax* (Giant reed) *Cortaderia selloana* (Pampas grass) *Tamarix* sp. (Tamarisk)
4 - Control	*Brachypodium distachyon* (Purple false brome) *Carpobrotus* spp. (Iceplant) *Ehrharta longiflora* (Long-flowered veldt grass) *Eucalyptus* sp. (Eucalyptus, gum tree) *Foeniculum vulgare* (Sweet fennel) *Olea europaea* (Olive) *Pennisetum setaceum* (Fountaingrass) *Ricinus communis* (Castor bean) *Schinus molle* (Peruvian peppertree) *Washingtonia robusta* (Washington fan palm)
5 - Suppression	*Carduus pycnocephalus* (Italian thistle) *Glebionis coronaria* (Garland chrysanthemum) *Helminthotheca echioides* (Bristly ox-tongue) *Marrubium vulgare* (Horehound) *Melinis repens* (Natal grass) *Oxalis pes-caprae* (Bermuda buttercup) *Silybum marianum* (Blessed milk-thistle)

[1] Includes only species detected near CER during the invasives mapping effort; refer to Task 4 for an expanded list of species for the early detection plan.

mode of spread. In identifying surveillance species, the focus is on targets most likely to impact sensitive species and habitats. A preliminary list of surveillance species is included in Task 4 as part of the Early Detection Plan. It is anticipated that additional species will be added to this list in the future; further, this list should be reviewed and updated at regular (e.g., 3-5 year) intervals. When a surveillance species is detected, it moves to Category 2, and is prioritized for management. Both surveillance and early detection/rapid response facilitate identification and eradication of potentially problematic species before they pose a significant threat, thus protecting resources and minimizing long-term management costs.

Species: *Cynara cardunculus (note: additional species not detected onsite or in proximity to the sites, but known from the area will be added to this category).*

CATEGORY 2: ERADICATION

Eradication entails complete removal of all infestations on the reserve. Eradication efforts generally focus on small and/or isolated populations of invasive species, although it may be occasionally used for satellite infestations of species that are well-established elsewhere onsite. Once a species is eradicated, it moves to the surveillance, or early detection, list (Category 1). Category 2 species that spread beyond the eradication stage should be reclassified into Categories 3, 4, or 5, as appropriate.

Eradication may require multiple treatments/monitoring to ensure success. Within this category, prioritization should focus on species with the highest ranking/greatest impact.

Species: *Brassica tournefortii, Cyperus involucratus*, *Dittrichia graveolens, Heteropogon contortus, Vinca* aff. *major.*

CATEGORY 3: CONTAINMENT/ERADICATION

Containment limits the spread from existing infestations, and generally focuses on high priority invasive plants that impact natural resources, including sensitive species and habitats. At the regional level, containment is often a long-term effort; the invasive species may be contained, but not necessarily eradicated, from all or a portion of the region.

On the subject properties, Category 3 includes species that are widely distributed throughout the region and are highly impactive to species, habitats, and ecosystem processes. Because these species currently occur singly or in low numbers onsite, eradication may be feasible *if* management actions are implemented before the populations experience significant expansion. If these populations are eradicated, the species should be moved to Category 1.

Species: *Arundo donax, Cortaderia selloana, Tamarix* spp.

CATEGORY 4: CONTROL

Category 4 includes species that are widely distributed throughout the region and which may result in significant impacts where they occur in large stands or in sensitive habitats. Large stands of these species also have the potential to alter ecosystem processes. While control across the region may not be practical, control at the preserve-level generally provides significant benefits to biological resources, particularly where infestations are large, spreading, and/or impact sensitive species or habitats. Because of the potential for re-invasion, long-term management may be required for these species.

A number of species that would otherwise be placed into Category 3 species at the regional level may be placed in Category 4 at the preserve-level, particularly where populations are small and the potential for long-term control is high (e.g., *Carpobrotus* spp., *Eucalyptus* spp., *Foeniculum vulgare*, *Tamarix* spp., and *Washingtonia robusta).*

Species: *Brachypodium distachyon*, *Carpobrotus* spp., *Ehrharta longiflora*, *Eucalyptus* sp., *Foeniculum vulgare*, *Olea europaea, Pennisetum setaceum, Ricinus communis, Schinus molle, Washingtonia robusta.*

CATEGORY 5: SUPPRESSION

Species in Category 5 are generally widely distributed and abundant throughout the region. Because widespread control of these species is not realistic, management typically occurs only in association with other restoration work or to protect specific resources. Category 5 species are prioritized for management based on impacts to sensitive species and habitats.

Species: *Carduus pycnocephalus, Glebionis coronaria, Helminthotheca echioides, Marrubium vulgare, Melinis repens, Oxalis pes-caprae, Silybum marianum.*

MANAGEMENT PRIORITIES

Due to the number of invasive species detected on the subject properties and the proximity of these sites to continual propagule inputs, invasive plant control is expected to be a long-term management activity on CER and South Crest. In addition, funding may not be available to treat all species in all locations. Therefore, invasive plants are prioritized for treatment based on (1) current extent onsite; (2) current or potential impacts; and (3) threat to conservation targets, including covered species and sensitive habitats. From a practical standpoint, ease or feasibility of control may also be a factor. For high or medium priority species that occur in multiple stands, an additional level of prioritization can provide a 'roadmap' for treatment.

Regional or state risk assessment ratings or scores are used to inform management priorities, as discussed below. However, it is important to note that impacts and thus, management priorities, may differ significantly at the regional- versus preserve-level. For example, a species that is ranked as a high management priority at the regional level may have a lower priority at the preserve-level where it occurs in small numbers or in marginal habitat. Conversely, a species considered to be a low or moderate management priority across the region may take on additional significance where it directly impacts sensitive resources at the preserve-level.

To prioritize invasive species for treatment, we use a modified approach that generally follows Cal-IPC 2011; Perlmutter et al. (2009); and others. Each species is ranked according to the factors listed above, i.e., extent, impacts, and threats. Information on extent and threats is based on species-specific mapping conducted on CER and South Crest; information on impacts is derived from the draft regional plant assessment forms (PAFs) (CBI in prep.), where available, or state (Cal-IPC) PAFs, unless otherwise noted. Ranking criteria for preserve-level prioritization is presented in Table 1-4; ranking results are presented in Table 1-5. Table 1-6 identifies management priorities based on these rankings. Species with scores in the low- to mid-range (total score = 4-8) are the highest priorities for management. The lowest scoring species (total score = 4-6) are highly impactive or newly detected invasives that occur in low numbers and are not yet problematic onsite, but could become so if left unchecked. Species in the mid-score range (total score = 7-8) are generally more widespread onsite, but threaten conservation

Table 1-4. Ranking Criteria for Preserve-level Prioritization.

Ranking Category	Score	Criterion
Current Extent	1	Species does not occur onsite, but occurs in proximity to the site
	2	Species occurs onsite as a new or highly limited population (e.g., one or a few occurrences), and has the potential to spread rapidly
	3	Species is present onsite in large stands that appear to be spreading
	4	Species is present onsite in small or large stands that appear to be stable (e.g., not spreading)
Current or Potential Impacts	1	Species has the potential to alter ecosystem processes (e.g., fire frequency or intensity, sedimentation, nutrient cycling)
	2	Species outcompetes dominant native species and invades undisturbed natural habitat
	3	Species does not outcompete dominant native species but may inhibit recruitment or regeneration of native species or adversely impact wildlife habitat; invasion generally follows natural (e.g., fire, flood) or anthropogenic disturbance
	4	Species impacts on native habitat and species is minimal or unknown
Conservation Target(s)	1	Species invades or has the potential to invade high value conservation lands (e.g., sensitive habitat or habitat occupied by MSCP covered species)
	2	Species invades or has the potential to invade other natural lands (e.g., non-sensitive habitat or habitat occupied by other sensitive species)
	3	Species typically infests low value lands (e.g., disturbed or ruderal habitat)

targets in some or all locations. Management strategies for these two groups differ, as does the time commitment (and funding requirements) for control. In general, species with high scores (>8) are not prioritized for management at this time, although some stands may be treated as part of restoration or general invasive control efforts. It is important to iterate that the primary objective in invasive species management is to protect and/or enhance conservation targets as opposed to merely controlling invasive species.

Table 1-5. Invasive Plant Rankings for CER and South Crest.[1]

Scientific Name **(Common Name)**	**Extent**	**Impacts**	**Threats**	**Total**
Arundo donax (Giant reed)	2	1	3	6
Brachypodium distachyon (Purple false brome)	3	1	1	5
Brassica tournefortii (Saharan mustard)	1	3	2	6
Carduus pycnocephalus (Italian thistle)	4	3	1	8
Carpobrotus spp. (Iceplant)	2	1	3	6
Cortaderia selloana (Pampas grass)	2	1	3	6
Cynara cardunculus (Artichoke thistle)	1	3	2	6
Cyperus involucrata (Umbrella sedge)	2	4	1	7
Dittrichia graveolens (Stinkwort)	2	3	2	7
Ehrharta longiflora (Long-flowered veldt grass)	3	3	1	7
Eucalyptus sp. (Eucalyptus, gum tree)	4	3	2	9
Foeniculum vulgare (Sweet fennel)	2	3	1	6
Glebionis coronaria (Garland chrysanthemum)	3	3	1	7
Helminthotheca echioides (Bristly ox-tongue)	3	4	2	9
Heteropogon contortus (Tanglehead)	4	3	1	8
Marrubium vulgare (Horehound)	4	4	3	11
Melinis repens (Natal grass)	3	3	1	7
Olea europaea (Olive)	4	4	2	10
Oxalis pes-caprae (Bermuda buttercup)	2	4	1	7
Pennisetum setaceum (Fountain grass)	3	3	1	7
Ricinus communis (Castor bean)	2	3	3	8
Schinus molle (Peruvian peppertree)	4	3	2	9
Silybum marianum (Blessed milk thistle)	3	3	3	9
Tamarix sp. (Tamarisk)	2	1	1	4
Vinca aff. *major* (Periwinkle)	2	3	1	6
Washingtonia robusta (Washington fan palm)	4	1	1	6

[1] Numbers represent scores; refer to Table 5 for a description of each ranking category and scoring criterion. Low total scores represent a higher impact and thus, higher priority for management than high scores.

Table 1-6. Invasive Plant Management Priorities.

Scientific Name (Common Name)	Management Category[1]	Prioritization Score[2]	Management Priority[3]
Cynara cardunculus (Artichoke thistle)	1	6	High
Brassica tournefortii (Saharan mustard)	2	6	High
Vinca aff. *major* (Periwinkle)	2	6	High
Cyperus involucrata (Umbrella sedge)	2	7	Medium
Dittrichia graveolens (Stinkwort)	2	7	Medium
Heteropogon contortus (Tanglehead)	2	8	Medium
Arundo donax (Giant reed)	3	6	High
Cortaderia selloana (Pampas grass)	3	6	High
Tamarix sp. (Tamarisk)	3	4	High
Brachypodium distachyon (Purple false brome)	4	5	High
Carpobrotus sp. (Iceplant)	4	6	High
Foeniculum vulgare (Sweet fennel)	4	6	High
Washingtonia robusta (Washington fan palm)	4	6	High
Ehrharta longiflora (Long-flowered veldt grass)	4	7	Medium
Pennisetum setaceum (Fountain grass)	4	7	Medium
Ricinus communis (Castor bean)	4	8	Medium
Eucalyptus sp. (Eucalyptus, gum tree)	4	9	Low
Olea europaea (Olive)	4	10	Low
Schinus molle (Peruvian peppertree)	4	9	Low
Carduus pycnocephalus (Italian thistle)	5	8	Medium
Glebionis coronaria (Garland chrysanthemum)	5	7	Medium
Melinis repens (Natal grass)	5	7	Medium
Oxalis pes-caprae (Bermuda buttercup)	5	7	Medium
Helminthotheca echioides (Bristly ox-tongue)	5	9	Low
Marrubium vulgare (Horehound)	5	11	Low
Silybum marianum (Blessed milk thistle)	5	9	Low

[1] Indicates management priority level if detected onsite.
[2] Indicates the total score from the preserve-level species ranking process (Table 6).
[3] Category 5 species are generally considered a lower priority for treatment than Categories 2-4 except where they impact covered species or sensitive habitats.

MANAGEMENT RECOMMENDATIONS

Invasive plant mapping is expected to minimize management costs by (1) prioritizing invasive species for control based on extent and threats; (2) establishing realistic management objectives (e.g., containment versus eradication), and (3) providing a baseline against which to measure the effectiveness of management actions.

For all invasive species mapped in this project, Table 1-7 presents a summary of management recommendations, while Table 1-8 provides a recommended schedule for treatment. Management goals and objectives are presented below for species or groups of species. It should be noted that where populations of invasive species are small and/or limited in extent, eradication may be feasible, regardless of the management category.

MANAGEMENT CATEGORY 1 - SURVEILLANCE

Species: *Cynara cardunculus*

Management Goal: Prevent establishment of *Cynara cardunculus* on Crestridge or South Crest.

Management Objectives:

1. Monitor likely points of entry (roads, trails adjacent to known occurrences) on a yearly basis to detect early infestations.
2. Where onsite occurrences are detected, map the extent using a GPS and collect attribute information as described in the methodology section of this report.
3. Eradicate detected plants.
4. Monitor treated areas for 2-5 years following treatment to ensure there is no re-infestation.

Treatment Priorities: Treat all infested areas immediately (subject to seasonal constraints).

Notes: Artichoke thistle currently occurs adjacent to and just south of the South Crest properties, in the vicinity of Skeleton Flats.

MANAGEMENT CATEGORY 2 - ERADICATION

Species: *Brassica tournefortii, Cyperus involucrata, Vinca* aff. *major*

Management Goal: These species are currently highly limited on Crestridge or South Crest; therefore, the management goal for these species is eradication within 2 years.

Management Objectives:

1. Treat existing plants.
2. Monitor treated areas for 2 years following treatment to ensure there is no re-infestation.

Table 1-7. Management Recommendations.

Scientific Name **(Common Name)**	**Management Category**	**Management Priority**	**Occurrences**	**Management Recommendation**
Cynara cardunculus (Artichoke thistle)	1	High	N/A	Surveillance; eradicate if detected onsite
Brassica tournefortii (Saharan mustard)	2	High	All	Eradicate; continue surveillance in Skeleton Flats area
Vinca aff. *major* (Periwinkle)	2	High	All	Eradicate; continue surveillance in Horsemill Road oak grove
Cyperus involucrata (Umbrella sedge)	2	Medium	All	Eradicate (single, small population)
Dittrichia graveolens (Stinkwort)	2	Medium	All	Eradicate; continue surveillance along edge of CER
Heteropogon contortus (Tanglehead)	2	Low	All	No action at this time
Arundo donax (Giant reed)	3	High	All	Eradicate; surveillance for new occurrences[1]
Cortaderia selloana (Pampas grass)	3	High	All	Eradicate; surveillance for new occurrences[1]
Tamarix sp. (Tamarisk)	3	High	All	Eradicate; surveillance for new occurrences[1]
Brachypodium distachyon (Purple false brome)	4	High	Selected	Focus initial treatment in important conservation areas; requires multiple years of treatment
Carpobrotus spp. (Iceplant)	4	High	All	Eradicate; surveillance for new occurrences[1]
Foeniculum vulgare (Sweet fennel)	4	High	All	Eradicate; surveillance for new occurrences
Washingtonia robusta (Washington fan palm)	4	High	All	Eradicate where feasible (based on accessibility); surveillance for new occurrences[2]
Ehrharta longiflora (Long-flowered veldt grass)	4	Medium	Selected	Focus initial treatment in important conservation areas and along trails adjacent to high quality habitat; will require multiple years of treatment

Table 1-7. Management Recommendations.

Scientific Name **(Common Name)**	**Management Category**	**Management Priority**	**Occurrences**	**Management Recommendation**
Pennisetum setaceum (Fountaingrass)	4	Medium	Selected	Focus initial treatment in important conservation areas and along trails adjacent to high quality habitat; will require multiple years of treatment
Ricinus communis (Castor bean)	4	Medium	All	Eradicate (single, small population); surveillance for new occurrences
Eucalyptus sp. (Eucalyptus, gum tree)	4	Low	N/A	No action at this time
Olea europaea (Olive)	4	Low	N/A	No action at this time
Schinus molle (Peruvian peppertree)	4	Low	Selected	Eradicate where feasible (based on accessibility); surveillance for new occurrences[2]
Carduus pycnocephalus (Italian thistle)	5	Medium	Selected	Treat in conjunction with restoration efforts or where species threatens conservation targets
Glebionis coronaria (Garland chrysanthemum)	5	Medium	All	Treat source stands first (GLCO_01, 02, 07), then remaining stands; eradication will require multiple years of treatment, and should be followed by surveillance to detect new occurrences
Melinis repens (Natal grass)	5	Medium	Selected	Treat in conjunction with restoration efforts or where species threatens conservation targets
Oxalis pes-caprae (Bermuda buttercup)	5	Medium	All	Eradicate or control (single, small population)
Helminthotheca echioides (Bristly ox-tongue)	5	Low	Selected	Low priority for management; may be treated as part of restoration or weed control efforts
Marrubium vulgare (Horehound)	5	Low	Selected	Low priority for management; may be treated as part of restoration or weed control efforts

Table 1-7. Management Recommendations.

Scientific Name **(Common Name)**	**Management Category**	**Management Priority**	**Occurrences**	**Management Recommendation**
Silybum marianum (Blessed milk thistle)	5	Low	Selected	Low priority for management; may be treated as part of restoration or weed control efforts; monitor periodically to prevent spread into natural areas

[1] Mapped occurrences have been treated and are dead and do not require re-treatment.
[2] Selected (not all) mapped occurrences have been treated; treated stands or individuals are dead and do not require re-treatment.

Table 1-8. Invasive Plant Treatment Schedule.

Scientific Name **(Common Name)**	**Recommended Treatment Schedule**
Arundo donax (Giant reed)	August to November (optimal); year-round treatment can occur if leaves are green
Brachypodium distachyon (Purple false brome)	Winter (end of January/beginning of February), before flowering occurs
Brassica tournefortii (Saharan mustard)	Winter, before seed forms
Carduus pycnocephalus (Italian thistle)	Late winter through spring
Carpobrotus sp. (Iceplant, Hottentot-fig)	Year-round
Cortaderia selloana (Pampas grass)	Fall applications are most effective, but applications can occur year-round
Cynara cardunculus (Artichoke thistle)[1]	Late winter or early spring, prior to flowering
Cyperus involucrata (Umbrella sedge)	Year-round
Dittrichia graveolens (Stinkwort)	Last spring through early fall (prior to seed set)
Ehrharta longiflora (Long-flowered veldt grass)	Late winter to early spring, prior to seed set
Eucalyptus sp. (Eucalyptus, gum tree)	Fall for maximum success (Bossard et al. 2000), but year-round treatments can occur
Foeniculum vulgare (Sweet fennel)	Early spring
Glebionis coronaria (Garland chrysanthemum)	Spring, prior to seed set
Helminthotheca echioides (Bristly ox-tongue)	Spring, prior to seed set
Heteropogon contortus (Tanglehead)	Late fall, winter, prior to seed set
Marrubium vulgare (Horehound)	Spring
Melinis repens (Natal grass)	Year-round
Olea europaea (Olive)	Year-round

Table 1-8. Invasive Plant Treatment Schedule.

Scientific Name **(Common Name)**	**Recommended Treatment Schedule**
Oxalis pes-caprae (Bermuda buttercup)	During the growing season
Pennisetum setaceum (Fountain grass)	Growing season
Ricinus communis (Castor bean)	Year-round
Schinus molle (Peruvian peppertree)	Year-round
Silybum marianum (Blessed milk thistle)	Spring prior to seed formation
Tamarix sp. (Tamarisk)	Foliar applications: late spring to early fall (Bossard et al. 2000). Cut stump: growing season or year-round, depending on herbicide
Vinca aff. *major* (Periwinkle)	Year-round
Washingtonia robusta (Washington fan palm)	Year-round

3. Monitor likely points of entry (e.g., drainage, reserve areas adjacent to developed or landscaped areas) on a yearly basis to detect new infestations.
4. Treat new infestations and monitor as described in 2, above.

Treatment Priorities: Treat all infested areas immediately (subject to seasonal constraints).

Notes: The invasiveness and threats to sensitive resources from *Cyperus involucratus* are not well-known. In addition, this species and *Vinca* aff. *major* both occur downstream from residential development, so there is a high potential for re-infestation.

Species: *Dittrichia graveolens*

Management Goal: The management goal for this species is to eradicate the population onsite within 2 years and prevent future infestations.

Management Objectives:

1. Treat existing plants.
2. Monitor treated areas for 2-5 years following treatment to ensure there is no re-infestation.
3. Monitor likely points of entry (roads, trails adjacent to known occurrences) on a yearly basis to ensure no infestation.
4. Where onsite occurrences are detected, map the extent using a GPS and collect attribute information as described in the methodology section of this report.
5. Eradicate detected plants and monitor following treatment as described in 1 and 2, above.
6. Work with neighbors to eliminate population offsite and prevent its spread onto the site.

Treatment Priorities: Treat all infested areas immediately (subject to seasonal constraints).

Notes: A large infestation occurs adjacent to Crestridge, with one small occurrence onsite. The offsite population is being treated by Crestridge neighbors; the onsite population was treated in 2011.

Species: *Heteropogon contortus*

Management Goal: The management goal for this species is to contain the population onsite, assess its status (stable versus spreading) and threats to conservation targets, and determine the need for eradication.

Management Objectives:

1. Consult with botanical and invasive species experts about the invasiveness of this species and the need for treatment.
2. If treatment is warranted, treat the entire population on CER.

3. Monitor treated areas for 2-5 years following treatment to ensure there is no re-infestation.
4. Monitor likely points of entry (roads, trails adjacent to known occurrences) every 3-5 years to ensure no infestation; a survey for this species should be conducted on the slopes above Dehesa Road.
5. Where onsite occurrences are detected, map the extent using a GPS and collect attribute information as described in the methodology section of this report.
6. Eradicate detected plants and monitor following treatment as described in 2 and 3, above.

Treatment Priorities: If this species is determined to be an invasive species of concern (see notes, below), treat the entire population on CER.

Notes: Although this species is considered a noxious weed, it is not clear whether it is an introduction on CER or whether its presence is due to an expanding range. Further, it is not clear whether the population onsite is stable or spreading. We recommend consultation with botanical and/or invasive plant experts (e.g., Cal-IPC, San Diego Natural History Museum, Weed Management Areas) to determine threats and the appropriate treatment strategy.

MANAGEMENT CATEGORY 3 – CONTAINMENT/ERADICATION

Species: *Arundo donax, Cortaderia selloana, Tamarix* sp.

Management Goal: Eradicate these species from CER and South Crest within 2 years and prevent future infestations.

Management Objectives:

1. Treat existing plants (see notes).
2. Monitor treated areas for 2 years following treatment to ensure no re-infestation.
3. Monitor likely points of entry (drainages, edge of conserved lands adjacent to residences or development) on a yearly basis to detect new infestations.
4. Treat new infestations.

Treatment Priorities: Treat all infested areas immediately (subject to seasonal constraints).

Notes: Several stands of Category 3 species were treated and eradicated in 2011 (see Task 3); future treatment efforts should focus on the remaining stands.

MANAGEMENT CATEGORY 4 - CONTROL

Species: *Brachypodium distachyon*

Management Goal: Control *Brachypodium* on Crestridge and South Crest where it impacts covered species or sensitive habitats.

Management Objectives:

1. Conduct habitat assessments to establish baseline conditions and determine desired restoration condition(s).
2. Based on habitat assessments and covered species mapping, prioritize 20 acres (10 acres on CER and 10 acres on South Crest) of *Brachypodium*-dominated habitat for treatment.
3. Develop detailed treatment and restoration plans for prioritized areas.
4. Implement invasive control measures; incorporate an experimental design component so that treatment success can be quantified.
5. Implement habitat restoration in selected treatment areas; restoration specifications shall be detailed in the restoration plans.
6. Conduct pre- and post-treatment monitoring for 2 years following initial treatment; use monitoring results to guide adaptive management.

Treatment Priorities: To be determined based on habitat assessments.

Notes: A *Brachypodium* management plan that incorporates Objectives 1-6, above, has been funded through a Transnet EMP grant and is currently in progress.

Species: *Carpobrotus sp., Foeniculum vulgare, Washingtonia robusta, Ricinus communis*

Management Goal: These Category 4 species currently occur in small stands on CER and South Crest; at the current population levels, the management goal for these species is eradication and subsequent surveillance to prevent future infestations.

Management Objectives:

1. Treat existing plants (see notes).
2. Monitor treated areas for 2 years following treatment to ensure there is no re-infestation.
3. Monitor likely points of entry (drainages, edge of conserved lands adjacent to residences or development) on a yearly basis to detect new infestations.
4. Treat new infestations and monitor, as described in 1 and 2, above.

Treatment Priorities: Treat *Foeniculum vulgare* immediately (subject to seasonal constraints); treat the remaining species as funding is available (and subject to accessibility).

Notes: *Carpobrotus* sp. (CER) and one *Washingtonia robusta* (South Crest) were treated and killed in 2011.

Species: *Ehrharta longiflora, Pennisetum setaceum*

Management Goal: These species occur in numerous, small to large stands on CER and South Crest, and many of these stands appear to be spreading. The management goal for these species is to control their spread onsite, particularly in important conservation areas.

Management Objectives:

1. Treat existing plants in selected locations.
2. Monitor treated areas for 5 years following treatment to ensure there is no re-infestation.
3. Monitor likely points of entry (drainages, edge of conserved lands adjacent to residences or development) on a yearly basis to detect new infestations.
4. Treat new infestations and monitor following treatment, as described in 1 and 2, above.
5. As funds become available, treat additional stands.

Treatment Priorities: Treatment priorities shall focus on (1) stands that impact covered species or sensitive habitats and (2) small infestations that occur along conduits for dispersal into high quality habitat. Treat additional stands as funding is available (and subject to accessibility).

Notes: In some cases, treatment may occur as part of other invasive control efforts (e.g., *Brachypodium* control on CER and South Crest).

Species: *Eucalyptus sp., Olea europaea*

Management Goal: Prevent the spread of these species on CER and South Crest.

Management Objectives:

1. Monitor occurrences every 5 years to ensure that they are not spreading.
2. If populations are spreading, treat infestations.
3. Monitor treated areas for 2 years following treatment to ensure there is no re-infestation.
4. Monitor likely points of entry (drainages, edge of conserved lands adjacent to residences or development) on a yearly basis to detect new infestations.
5. Treat new infestations and monitor after treatment, as described in 2 and 3, above.

Treatment Priorities: Both species currently occur in small stands that do not appear to be spreading. Further, removal of these species may cause habitat damage. Therefore, removal efforts are not prioritized at this time unless there is evidence of spread and/or direct impacts to covered species or habitats.

Notes: One olive tree occurs on CER; eucalyptus trees were mapped in one location each on CER and South Crest.

Species: Schinus molle

Management Goal: Although this species has a relatively low priority for treatment based on biological concerns, it often occurs in areas of high public visibility (e.g., around the Horsemill Road entrance, along roads or drainages adjacent to development). The long-term management goal is to eradicate this species in and adjacent to natural habitat and to prevent future infestations.

Management Objectives:

1. Treat existing plants, subject to funding availability (see notes).
2. Monitor treated areas for 2 years following treatment to ensure there is no re-infestation.
3. Monitor likely points of entry (drainages, edge of conserved lands adjacent to residences or development) on a yearly basis to detect new infestations.
4. Treat new infestations and monitor after treatment, as described in 1 and 2, above.

Treatment Priorities: Treat *Schinus molle* as funding becomes available; prioritize treatment in areas in or adjacent to natural habitat.

Notes: This species was treated and killed on South Crest in 2011; there may be additional, unmapped plants on both sites, particularly around developed or disturbed areas.

MANAGEMENT CATEGORY 5 – SUPPRESSION

Species: *Carduus pycnocephalus, Melinis repens*

Management Goal: Suppress these species where they threaten conservation targets.

Management Objectives:

1. Treat stands in conjunction with habitat restoration efforts (*Carduus pycnocephalus*) or where they threaten conservation targets (*Melinis repens*).
2. Monitor treated areas to determine treatment efficacy; implement adaptive management measures if treatments do not suppress species to a level specified in habitat restoration plans or to a level determined to reduce risk to conservation targets.
3. Monitor untreated stands every 5 years to determine rate of spread; reevaluate the need for treatment.

Treatment Priorities: *Carduus pycnocephalus* is relatively widespread on CER and occurs on South Crest, as well. Widespread control of this species is not practical at this time. Therefore, treatment priorities should focus on stands within designated habitat restoration sites. *Melinis repens* occurs

in association with conservation targets in a number of locations, and these sites should be the focus of initial control efforts.

Notes: Both species occur in numerous, small to large stands on both sites.

Species: *Glebionis coronaria*

Management Goal: Suppress this species on disturbed habitat in and adjacent to conserved lands; eradicate this species from sensitive habitat on South Crest within 5 years.

Management Objectives:

1. Treat existing plants; it is anticipated that suppression or eradication will require multiple years of treatment.
2. Monitor treated areas for 5 years following treatment to ensure there is no re-infestation.
3. Monitor likely points of entry (roadsides, adjacent to residential development) on a yearly basis to detect new infestations.
4. Treat new infestations and monitor after treatment, as described in 1 and 2, above.

Treatment Priorities: Treat source stands first (GLCO_01, 02, 07), then remaining stands.

Notes: This species is currently restricted to one general location on South Crest; however, it is widely planted and naturalized in the community of Crest, so re-infestation over time is likely in the absence of ongoing surveillance and treatment.

Species: *Oxalis pes-caprae*

Management Goal: Suppress this species where it impacts sensitive habitat and prevent its spread on South Crest.

Management Objectives:

1. Treat the one stand of this species that currently occurs on South Crest; based on the species' life history, multiple treatments will likely be required.
2. Monitor the treatment area to determine treatment efficacy and implement adaptive management measures if treatments are not effective.
3. Monitor the treated area for 5 years following treatment to ensure there is no re-infestation.

Treatment Priorities: The treatment priority for this species is the single stand that occurs on South Crest.

Notes: The stand on South Crest occurs in coastal sage scrub habitat. If treated relatively soon, there is a potential for control or eradication of this population.

Species: ***Marrubium vulgare, Picris echioides, Silybum marianum***

Management Goal: Suppress these species where they impact covered species or sensitive habitats.

Management Objectives:

1. Treat stands that occur in or adjacent to covered species populations or sensitive habitat as part of specific habitat restoration efforts.
2. Monitor treated areas to determine treatment efficacy; implement adaptive management measures if treatments do not suppress species to a level specified in habitat restoration plans.
3. Monitor existing stands every 5 years to determine rate of spread; reevaluate the need for treatment.

Treatment Priorities: These species are currently a low priority for management; however, they may be treated as part of ongoing habitat restoration efforts or general weed control programs.

Notes: None.

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TASK 2. COVERED SPECIES MAPPING

PURPOSE AND BACKGROUND

MSCP covered plant species have been well-documented on the Crestridge Ecological Reserve (CBI and EHC 2009; CBI 2009, 2011a, b). Therefore, covered species mapping under this contract was specific to the South Crest properties. Covered and sensitive plant species had been previously mapped on South Crest during biological surveys for the proposed Singing Hills Estates development project (REC Consultants, Inc. 2004). However, the majority of the site burned in 2003. The 2011-2012 surveys represented the first comprehensive, post-fire assessment of covered plant species onsite. Task objectives were to (1) map the location and extent of MSCP covered plant species, (2) identify threats to these species, and (3) recommend management actions to alleviate threats.

Previous survey efforts on South Crest documented the following five MSCP covered species (REC Consultants, Inc. 2004):

- *Acanthomintha ilicifolia* (San Diego thornmint)
- *Dudleya variegata* (variegated dudleya)
- *Nolina interrata* (Dehesa beargrass)
- *Tetracoccus dioicus* (Parry's tetracoccus)
- *Quercus engelmanii* (Engelmann oak)

Existing site documentation, vegetation, and edaphic factors (clay and gabbro soils) were used to guide survey efforts; thus, surveys were focused not only in areas of prior occurrence, but also in areas that supported suitable habitat for the target species. In addition, we expanded our survey list to consider covered species not previously detected onsite, but with a potential for occurrence based on habitat affinity and/or occurrence in nearby locations (e.g., Crestridge Ecological Reserve). Although efforts focused on covered species, we also mapped one sensitive, non-covered species (see below).

SURVEY SCHEDULE

Covered species surveys were conducted in 2011 by botanist Patricia Gordon-Reedy and field assistant Curtis Battle, according to the schedule in Table 2-1. Additional covered species surveys were conducted in 2012 by botanist Jessie Vinje and field assistant Curtis Battle under a separate contract. Because 2012 surveys detected two covered species that were not observed in 2011, those results are summarized in this report. For all surveys, habitat was visited multiple times to determine presence/absence of annual or small herbaceous perennial species (e.g., San Diego thornmint, variegated dudleya).

Table 2-1. Covered Species Survey Schedule.

Survey Personnel[1]	Survey Date	Species Mapped	Survey Location
PGR/CB	4/5/2011	---	Northwest corner of main property
PGR/CB	4/6/2011	*Nolina interrata* (Dehesa beargrass) *Tetracoccus dioicus* (Parry's tetracoccus)	Skeleton Flats and vicinity
PGR/CB	4/13/2011	*Nolina interrata (Dehesa beargrass)* *Tetracoccus dioicus (Parry's tetracoccus)*	Skeleton Flats and vicinity
PGR/CB	4/14/2011	*Nolina interrata (Dehesa beargrass)* *Tetracoccus dioicus (Parry's tetracoccus)*	Slopes above Dehesa Road
PGR/CB	5/24/2011	*Nolina interrata* (Dehesa beargrass)	Skeleton Flats
PGR/CB	5/26/2011	*Nolina interrata (Dehesa beargrass)* *Tetracoccus dioicus (Parry's tetracoccus)*	Skeleton Flats and vicinity; Northwest parcel
PGR/CB	6/30/2011	*Nolina interrata* (Dehesa beargrass)	Skeleton Flats and vicinity
JV/CB[2]	5/8/2012	*Acanthomintha ilicifolia* (San Diego thornmint)	Skeleton Flats and vicinity
JV/CB[2]	5/15/2012	*Acanthomintha ilicifolia* (San Diego thornmint) *Dudleya variegata* (Variegated dudleya)	Skeleton Flats and vicinity

[1] PGR = Patricia Gordon-Reedy; JV = Jessie Vinje; CB = Curtis Battle.

[2] 2012 surveys were conducted under a separate contract; however, results are summarized in this report.

SURVEY METHODOLOGY

The majority of South Crest was accessed directly or assessed visually using binoculars. Survey methodology consisted of walking transects through suitable habitat; surveyors were generally spaced no more than 5-10 m (ca. 15-30 ft) apart. Although focused surveys were conducted only for covered species, additional sensitive plant species were mapped where encountered. Locations of all sensitive plants were recorded using a Garmin 60CSX GPS unit; locality and other attribute data are included in Appendix C.

Spatial data for covered and sensitive plant species detected in 2011 was submitted to the California Natural Diversity Database. For covered species detected in 2012, California Native Species Field Survey Forms were completed and are included in Appendix D.

Where covered species were detected, we implemented components of the rare plant monitoring protocols developed by the Rare Plant Monitoring Protocol Oversight Committee (Tracey et al. 2011), to the degree feasible. In Fiscal Year 2011, the committee focused on rare perennial shrubs and trees in

Risk Groups 1 or 2, as ranked by Regan et al. (2006). One of the covered perennial species detected onsite, Dehesa beargrass is in Risk Group 1. Although specific monitoring protocols had not yet been developed for Dehesa beargrass, we followed, in part, protocols that had been established for small-leaved rose (*Rosa minutifolia*) because of similarities in life history (e.g., clonal species). Information collected for Dehesa beargrass during the South Crest surveys may contribute to development of a standardized protocol for this species.

The rare plant monitoring protocol outlines several levels of survey effort. Based on the objectives of this task, we conducted *baseline surveys* for all covered species. Baseline surveys are geared towards "obtaining an initial inventory of plant populations in a specific area for use in the later stages of a monitoring program" (Tracey et al. 2011). Toward this end, the following baseline tasks were conducted:

- Assigned unique names clearly identifying each population or stand; these names will be used consistently in all documents, maps, and databases.
- Mapped occurrence locations and identified general population areas, including an attribute for estimate of the size of the population or patch.

In addition, a number of elements of *core monitoring* were incorporated into the 2011 surveys for Dehesa beargrass. The purpose of core monitoring is to "characterize plant populations and their habitat over time and space" (Tracey et al. 2011). The following core monitoring tasks were conducted for Dehesa beargrass:

- Mapped the maximum area known to be occupied by the species onsite.
- Developed repeatable rules to map boundaries of populations.
- Mapped plants and patches of plants present using global position system (GPS) equipment.
- Recorded metadata for how patches were discerned and mapped, and GPS coordinate accuracy.
- Assigned unique names identifying each individual or patch mapped; these names will be used consistently in all documents, maps, and databases.
- Either counted individual plants or estimated plant number, density, and volume within polygons.
- Provided a definition of the counting unit.
- Assessed threats.
- For the majority of Dehesa beargrass occurrences, provided photodocumentation of plant occurrences (but did not yet establish permanent photopoints).

Mapping rules and definitions for Dehesa beargrass are described in Appendix E. Unique population and individual plant or patch names, attribute information, and metadata are included in Appendices C and F.

Parry's tetracoccus is in Risk Group 3 (Regan et al. 2006); therefore, the focus of the 2011 surveys for this species was to collect baseline data only. This consisted of mapping locations and providing an

estimate of population size. Unique population and individual plant or patch names, attribute information, and metadata are included in Appendix C.

San Diego thornmint (Risk Group 1; Regan et al. 2006) and variegated dudleya (Risk Group 2; Regan et al. 2006) were not detected during the 2011 surveys; however, both species were documented onsite in 2012 during surveys conducted as part of a separate contract. Full details of those survey efforts will be provided in a separate report. Baseline data was collected for both species, as described above for Parry's tetracoccus. These data are presented in Appendices C and D and are summarized below.

SURVEY RESULTS

Five MSCP covered species had been previously mapped on the South Crest properties (REC Consultants, Inc. 2004). In 2011, two of these species were detected: Dehesa beargrass and Parry's tetracoccus. In 2012, an additional two species were detected: San Diego thornmint and variegated dudleya. The fifth species, Engelmann oak, was not detected in 2011 and is presumed to have been killed in the 2003 Cedar fire. In addition, we also mapped the sensitive plant, Palmer's grapplinghook (*Harpagonella palmeri*) in one location onsite. All mapped occurrences are depicted on Figure 2-1. Refer to Figure 2-2 for additional detail in the Skeleton Flats area and Figure 2-3 for additional detail on the slopes above Dehesa Road. A summary of pre- and post-Cedar Fire species occurrences is presented in Table 2-2. Covered species detected in 2011 and 2012 are discussed below. Refer to the California Native Plant Society (CNPS) online inventory (http://cnps.org/cnps/rareplants/inventory/) for a description of regulatory status and CNPS ratings.

Nolina interrata
Dehesa beargrass
Federal Status: None
State Status: Endangered
CNPS rating: 1B.1

Biology, Life History, and Distribution. Dehesa beargrass is a perennial herb that is restricted in distribution to San Diego County and Baja California, Mexico. This species is a soil endemic that is restricted to gabbro or metavolcanic soils (Rombouts 1996; CNPS 2012). It typically occurs in chaparral (CNPS 2012), although patches onsite are also found in grassland habitat. Dehesa beargrass is a fire-adapted species that re-sprouts from an underground stem. Flowering generally occurs between June-July, but is extremely sporadic and enhanced by fire (Rombouts 1996). This species is known from only about 10 occurrences in the U.S., and all of these are in or near the Dehesa Valley (CNPS 2012). The population on South Crest is considered part of or adjacent to the type locality for this species. Dehesa beargrass is a MSCP covered species and is considered a narrow endemic species in the region. Refer to Appendix G for additional information on the species' distribution, biology, life history, and threats.

Population Size. In 2011, we mapped 97 'patches' of Dehesa beargrass, representing an estimated 1665 'clusters' (Figure 2-1). Following Rombouts (1996), a patch is defined as a group of clusters with a nearest neighbor distance of less than 2 m; patches may be comprised of as few as 2 to over 50 clusters. A cluster is defined as a collection of individual ramets (rosettes) that are growing together closely. A

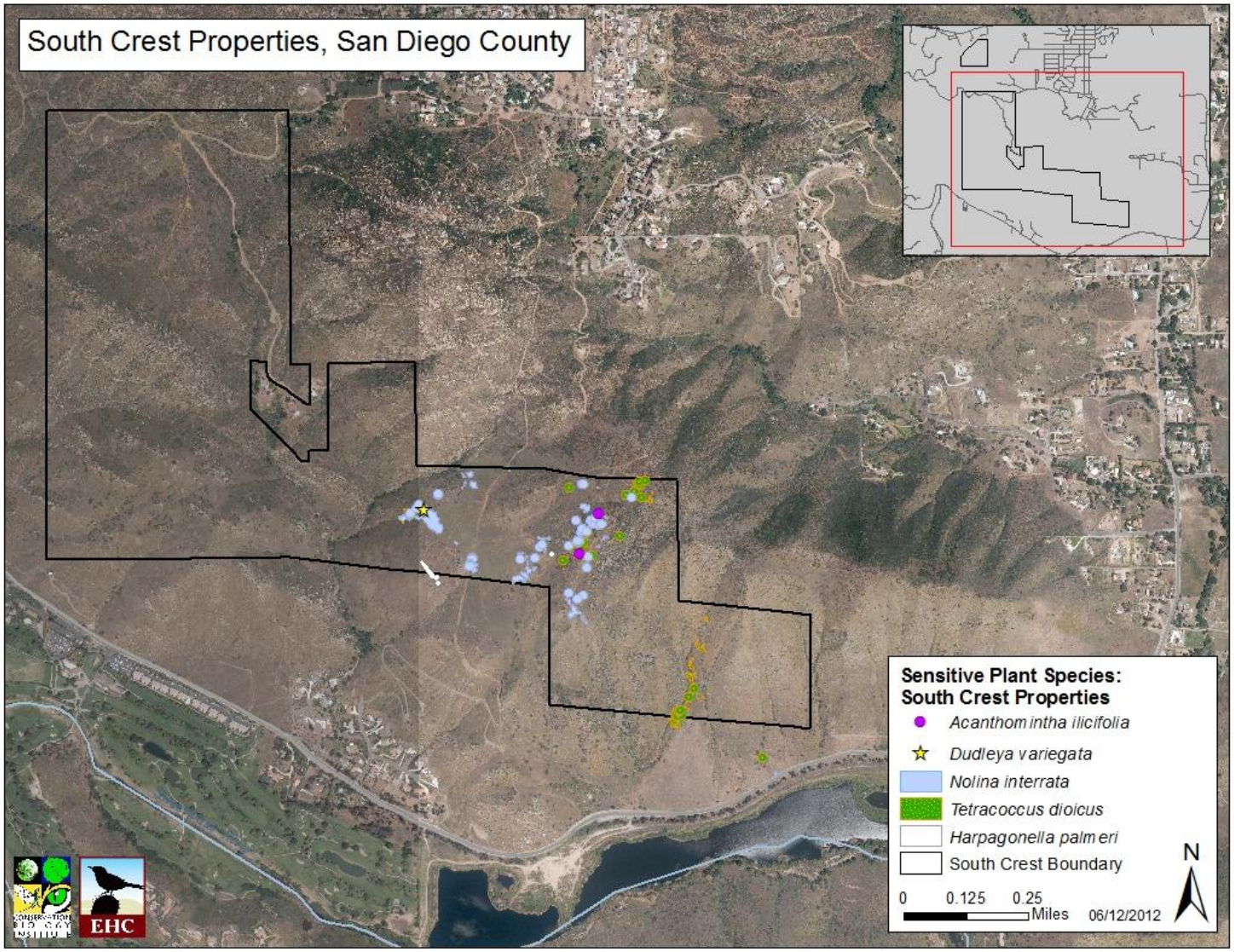


Figure 2-1. Sensitive Plant Species Detected on the South Crest Properties, 2011-2012.

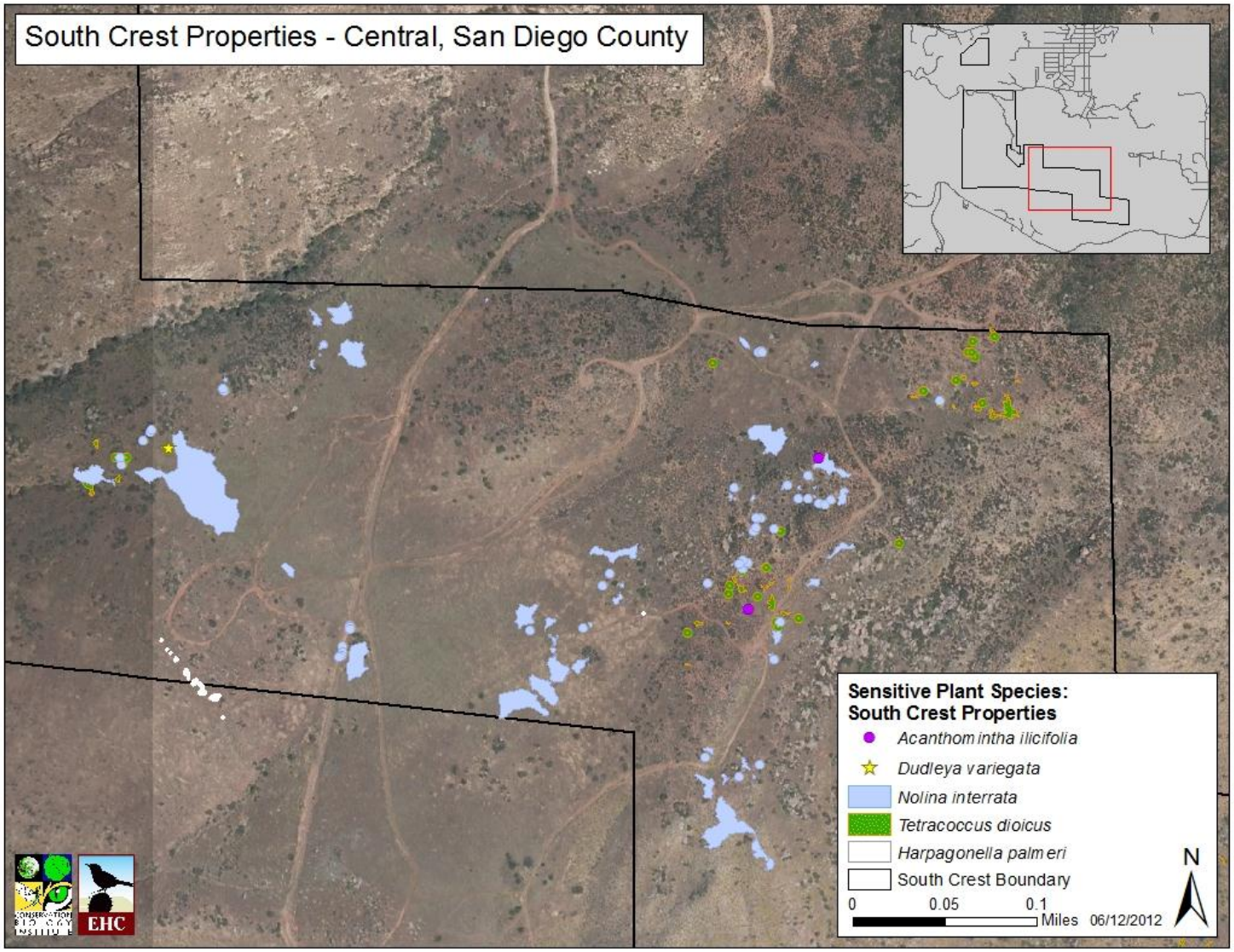


Figure 2-2. Sensitive Plant Species, Skeleton Flats, South Crest Properties, 2011-2012.

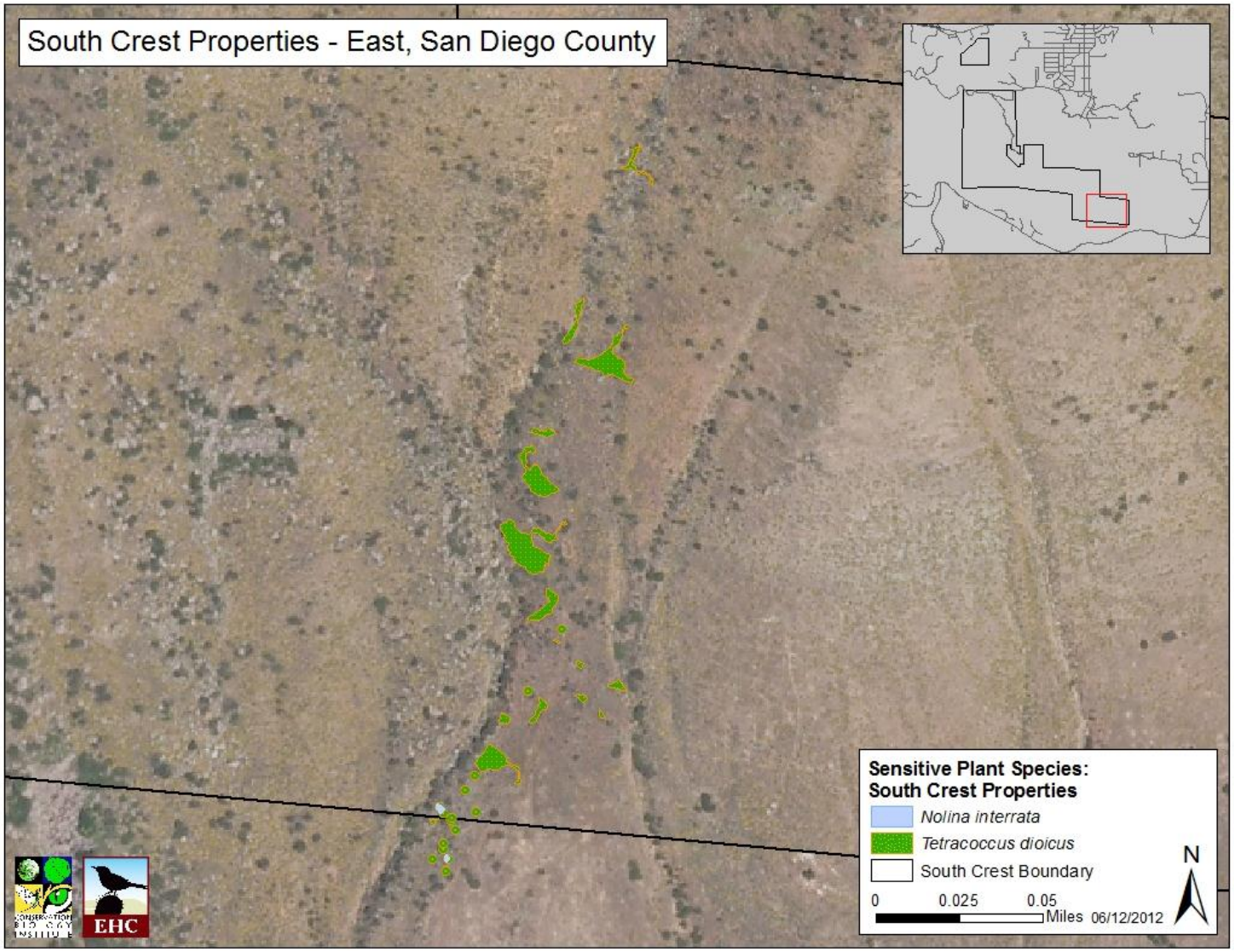


Figure 2-3. *Nolina interrata* and *Tetracoccus dioicus*, Slopes above Dehesa Road, South Crest Properties, 2011.

Table 2-2. Summary of Pre- and Post-fire MSCP Covered Plant Species Occurrences on South Crest.

Scientific Name **(Common Name)**	**Survey Year**	**Detected**	**Comments**
Acanthomintha ilicifolia (San Diego thornmint)	2004	Yes	REC Consultants, Inc. (2004) mapped 18 seedlings in the southeastern portion of the Skeleton Flats grassland. This occurrence is adjacent to but south of the South Crest properties.
	2011	No	Surveyed both the 2004 locality and adjacent habitat on South Crest. No plants were detected in either location. The majority of habitat onsite is dominated by dense, nonnative grasses.
	2012	Yes	Detected by CBI biologists while establishing index plots for *Nolina interrata*. Two stands were mapped on gabbro soils east of Skeleton Flats. Neither occurrence corresponds to the 2004 locality.
Dudleya variegata (Variegated dudleya)	2002/2004	Yes	REC Consultants, Inc. (2004) mapped an estimated 3,915 plants in and adjacent to the Skeleton Flats grassland. Of this total, 347 plants occurred on South Crest, while the remaining plants occurred adjacent to and south of the property line.
	2011	No	Surveyed potentially suitable habitat onsite, including the 2002/2004 localities. No plants were detected. The majority of habitat onsite is dominated by dense, nonnative grasses.
	2012	Yes	Surveyed potentially suitable habitat onsite, including the 2002/2004 localities. Eleven plants were detected onsite, with additional plants occurring offsite. The majority of habitat onsite is dominated by dense, nonnative grasses.
Nolina interrata (Dehesa beargrass)	2002/2004	Yes	REC Consultants, Inc. (2004) mapped an estimated 4,647 clusters on and adjacent to South Crest. Of this total, an estimated 1,773 clusters occurred on the South Crest properties.
	2011	Yes	Mapped all *Nolina interrata* locations onsite. An estimated 1735 clusters in 97 discrete stands were detected. However, it is unclear that cluster delineation is consistent between mapping years; thus, the analysis of this species also looks at stand locations between years (see text).
Tetracoccus dioicus (Parry's Tetracoccus)	2002/2004	Yes	REC Consultants, Inc. (2004) mapped 238 plants. Of this total, an estimated 188 plants were mapped on the South Crest properties.
	2011	Yes	388 plants on the South Crest properties.

Table 2-2. Summary of Pre- and Post-fire MSCP Covered Plant Species Occurrences on South Crest.

Scientific Name **(Common Name)**	**Survey Year**	**Detected**	**Comments**
Quercus engelmannii (Engelmann oak)	2002/2004	Yes	REC Consultants, Inc. (2004) mapped one tree in coast live oak riparian forest adjacent to and just south of Orchard Avenue.
	2011	No	Not detected. Presumed to have been killed in the 2003 Cedar Fire.

cluster may contain 2-30 rosettes, although 5-15 is more typical (Rombouts 1996). The nearest neighbor distance between ramets is generally less than 20 cm. Population size estimates in the Skeleton Flats area and on the slopes above Dehesa Road are depicted in Figures 2-4 and 2-5, respectively.

Patch Size. The majority of the Dehesa beargrass population on South Crest (94 patches; 1656 clusters) occurs in the Skeleton Flats area (Figure 2-2), while the remaining patches are on slopes above Dehesa Road (Figure 2-3). For the entire population, only 8 patches were ≤ 1 m^2, while the remaining 89 patches were ≥ 1 m^2. Plants in the smallest patches (≤ 1 m^2) were markedly shorter than plants in larger patches (Table 2-3), and may represent a separate cohort. The smaller patches generally included only one or a few clusters of basal rosettes, so showed little variability in patch area or volume. In contrast, larger patches ranged from just slightly larger than the smallest patches (i.e., 1.5 m^2) to almost 4000 m^2. For all occurrences, patch size measurements (radius, proportion of coverage, height, area, volume) are presented in Appendix E; for each patch, information on estimated number of clusters, phenology, vegetation association, fire history, and soils is presented in Appendix F. Appendix H provides photodocumentation of many (but not all) Dehesa beargrass patches mapped in 2011.

Soils. The majority of the South Crest population (86 patches; 89% of all patches) occurs on gabbro soils (Las Posas series). This includes all patches on the slopes above Dehesa Road (Figure 2-6). The remaining patches, including some of the largest patches mapped in this study, occur on clay soils (Auld series) on the flatter portions of the Skeleton Flats area (Figure 2-6).

Fire. The majority of the population (88 patches; 99% of all patches) burned in 2003 in either the Cedar Fire (85 patches) or the Dehesa Fire (3 patches) (Figure 2-7). Although a small corner of NOIN_95, at the southeast end of Skeleton Flats, burned in the Cedar Fire, the majority of this patch has not burned since the 1970 Laguna Fire. This patch is second only to NOIN_57 in patch radius; however, it has a relatively low coverage of plants within the patch boundary, so has a corresponding low patch area and volume relative to its size.

Metrics are not available to quantitatively assess pre- versus post-fire population status. However, a relative comparison showing pre-fire polygon locations (population size information attached; REC Consultants, Inc. 2004) and 2011 spatial data provides some indication of population status. The 2011 polygon mapping effort resulted in a larger number of smaller polygons than the earlier mapping effort. While polygon location does not always match up precisely between years, groupings of polygons do show high correspondence, except as noted below. Cluster counts vary widely between years, possibly due to both fire damage and variability in counting methods. Cluster counts can be time-consuming and imprecise, particularly in dense patches or patches that occur within dense, nonnative grasses.

Table 2-4 presents a comparison of the pre- and post-fire extent of Dehesa beargrass. In chaparral or coastal sage scrub that burned in the 2003 fires, the 2011 mapping identified additional patches of Dehesa beargrass. In these areas, fire may have stimulated plant growth or made existing plants more visible by opening up the habitat. Patch numbers 1-15, 22-26, and 74-88 occur in areas where Dehesa beargrass was not mapped prior to the fire (Figure 2-8). Habitat in these areas is primarily burned (but

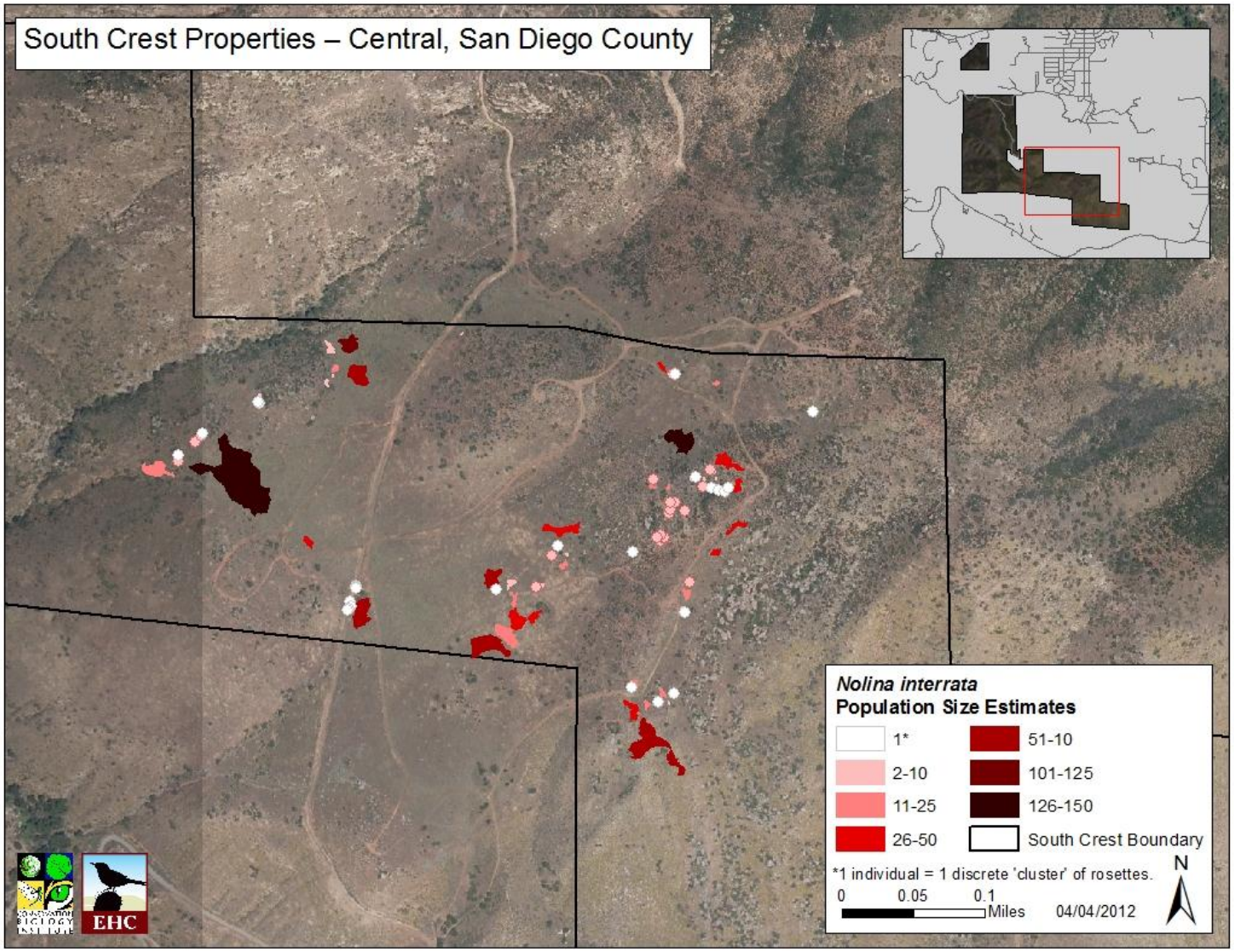


Figure 2-4. *Nolina interrata*, Skeleton Flats, South Crest Properties, 2011.

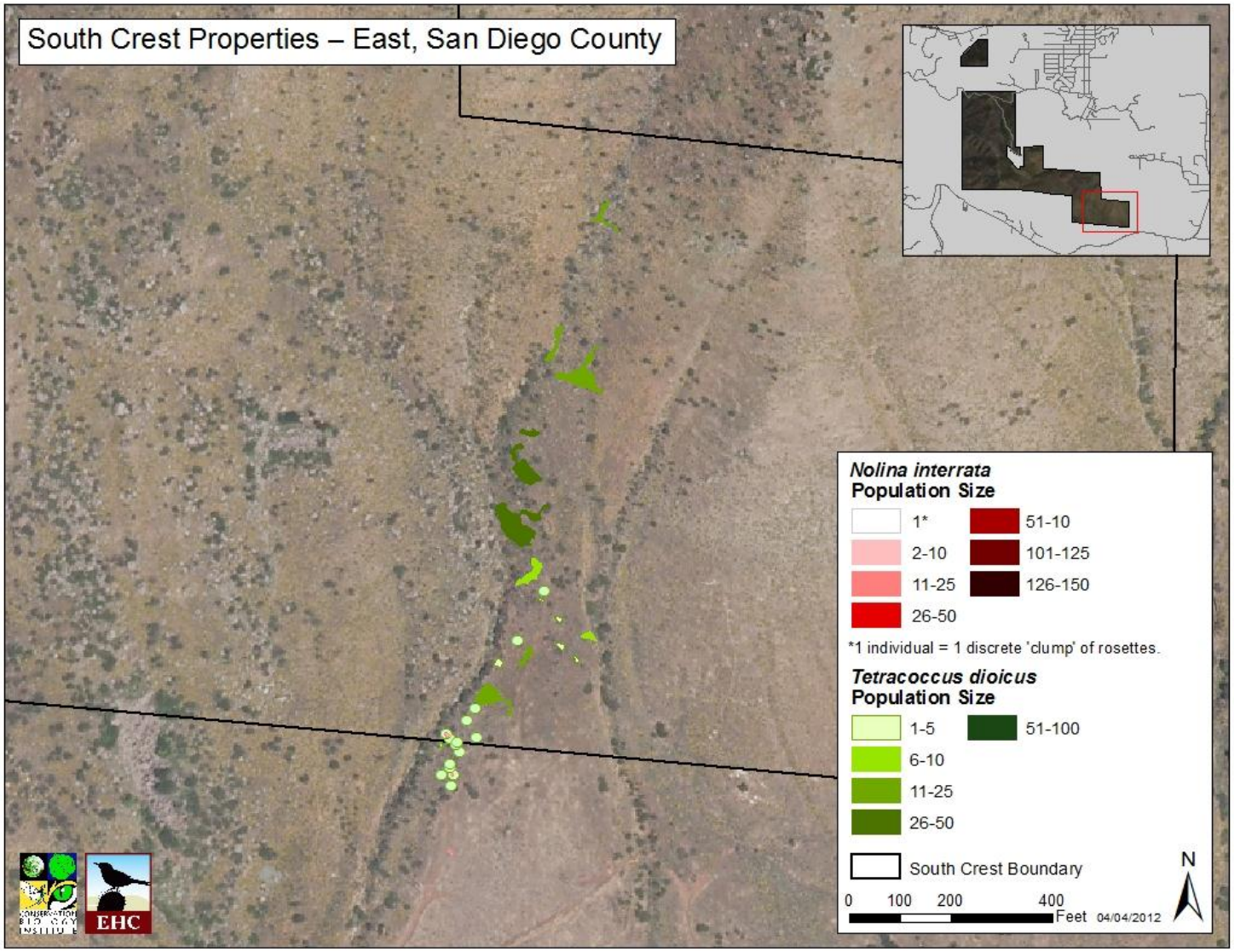


Figure 2-5. *Nolina interrata* and *Tetracoccus dioicus* Population Size, Slopes above Dehesa Road, South Crest Properties, 2011.

Table 2-3. Summary of Patch Size Information for *Nolina interrata*.

Patch Size	Patch Height (m)[1]	Patch Area (m^2) [1]	Patch Volume (m^2) [1]
Patches ≤ 1 m (n=8)			
Average	0.43	0.19	0.05
Minimum	0.20	0.02	0.00[1]
Maximum	0.80	0.57	0.21
Std. Dev.	0.23	0.20	0.08
Patches ≥ 1 m (n=89)			
Average	1.05	89.26	94.35
Minimum	0.64	1.50	1.48
Maximum	1.48	3940.81	3940.81
Std. Dev.	0.18	463.79	476.93

[1] m = meters; m^2 = square meters.

[2] Not measurable; typically a seedling or young plant.

recovering and relatively undisturbed) chaparral. Decreases in population size are generally seen in patches in the western portion of Skeleton Flats, in an area heavily infested with the nonnative grass, *Brachypodium*. It should be noted that not all patches in habitat dominated by nonnative grasses showed a decrease in size between years (e.g., NOIN_56).

Tetracoccus dioicus
Parry's tetracoccus
Federal Status: None
State Status: None
CNPS rating: 1B.2

Biology, Life History, and Distribution. Parry's tetracoccus is a perennial, deciduous shrub that occurs in chaparral and coastal sage scrub in Orange, Riverside, and San Diego counties, and Baja California, Mexico. This species occurs between 165-1000 m elevation and blooms from April-May (CNPS 2012). It is often found on gabbro soils. In San Diego County, this species occurs sporadically throughout the coastal foothills. Locations in proximity to South Crest include McGinty Mountain and Sequan Peak (Beauchamp 1986). Parry's tetracoccus is likely a fire-adapted shrub, although the fire-response mechanism is not known. This species is a MSCP covered species.

Population Size. In 2011, we mapped **77** patches of Parry's tetracoccus, representing 388 plants.[1] An estimated 58% of the entire population (45 patches; 206 plants) occurs in the Skeleton Flats area of the

[1] We mapped one additional occurrence (TEDI_71) which was offsite and consisted of one individual.

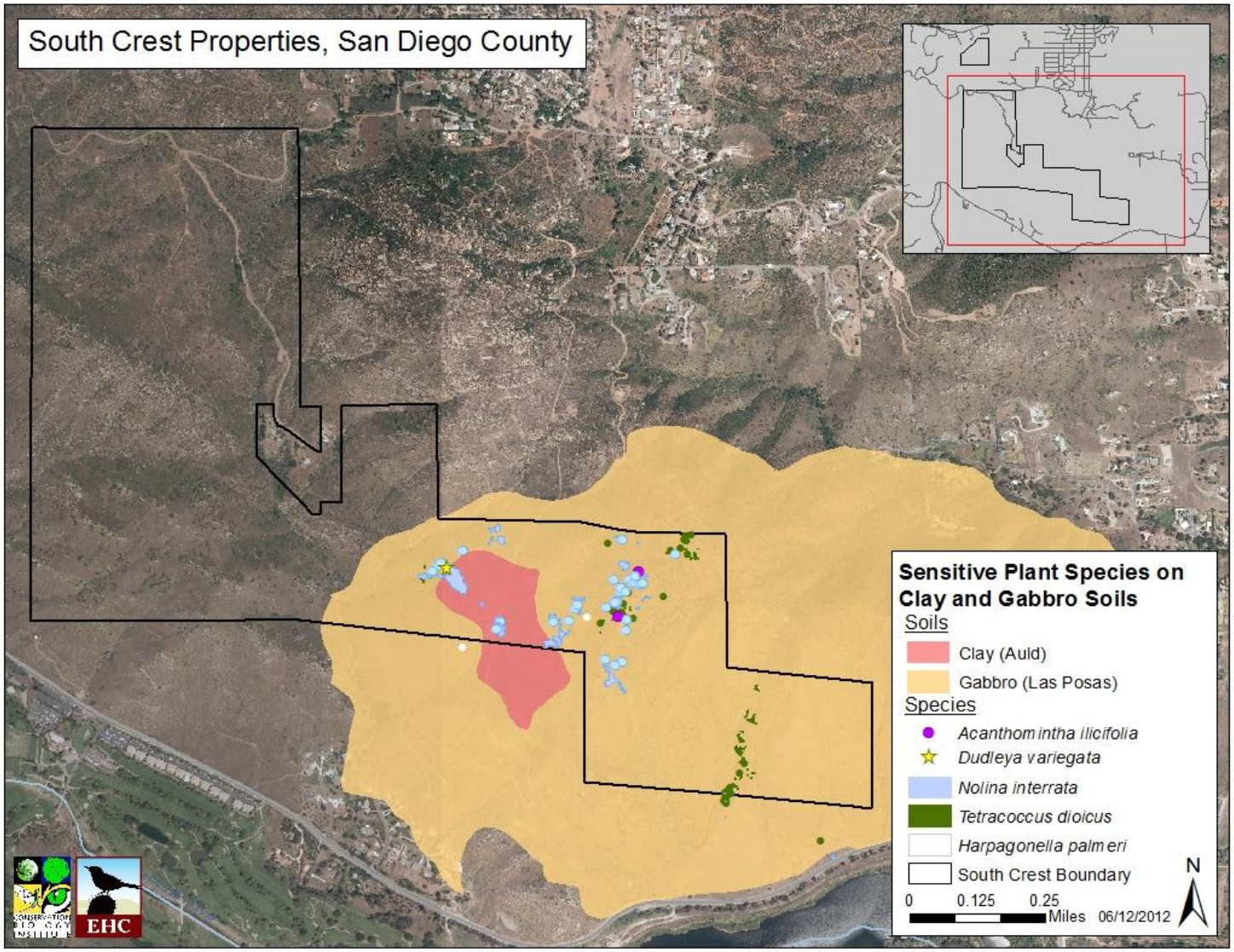


Figure 2-6. Distribution of Sensitive Plant Species on Sensitive Soils, Skeleton Flats, South Crest Properties, 2011-2012.

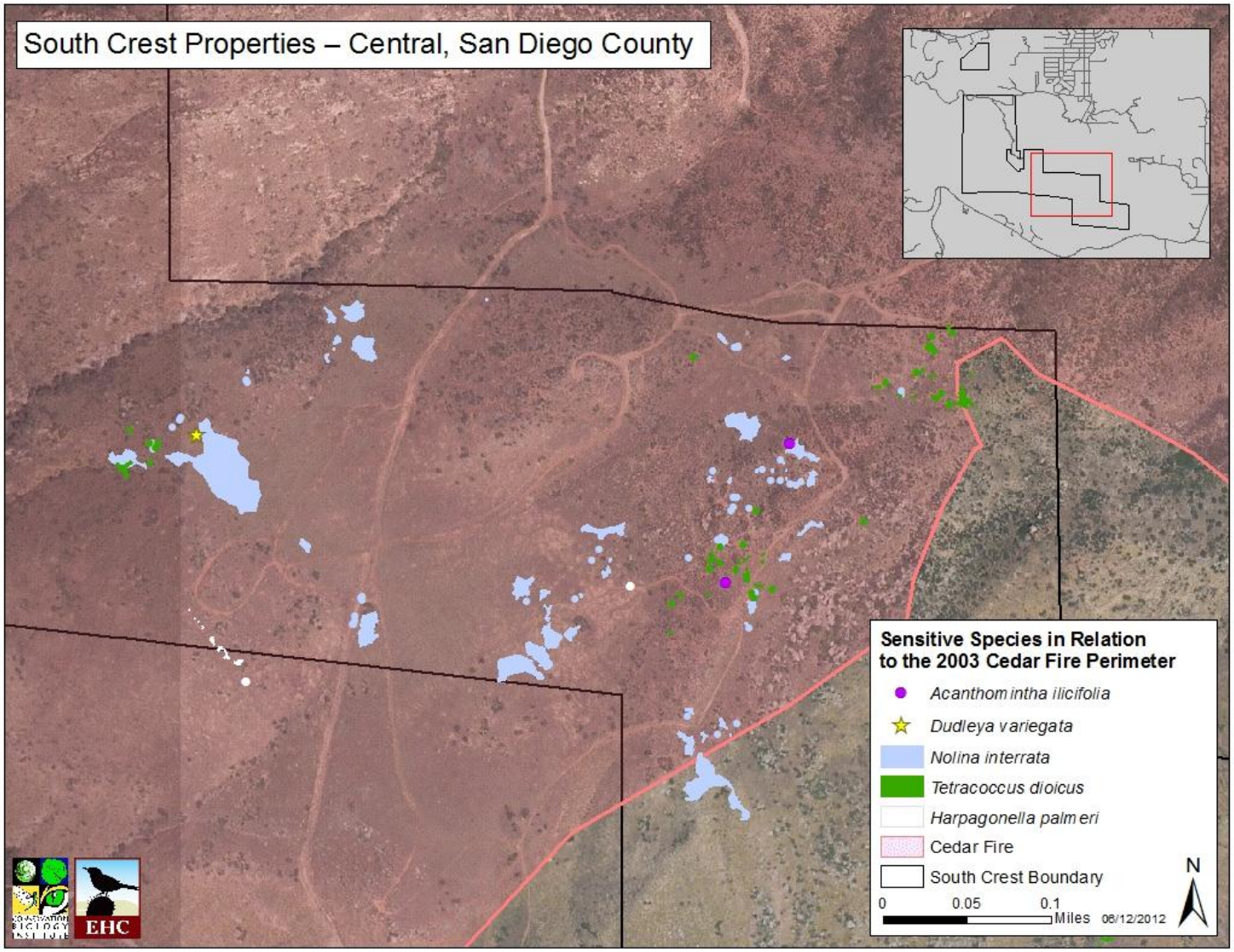


Figure 2-7. Sensitive Plant Populations within Cedar Fire Perimeter, Skeleton Flats, South Crest Properties, 2011-2012.

Table 2-4. Pre- versus Post-Fire Distribution and Abundance of *Nolina interrata*.

Stand Identification Number[1]	Pre-fire (2002/2004) Estimated Number of Clusters	Post-fire (2011) Estimated Number of Clusters	Change
1-15	--	216	Increase
16-21	164	108	Decrease
22-26	---	38	Increase
27	3	11	Increase
28-29	3	4	Increase
30-32	3	9	Increase
33-40	322[2]	87	N/A
41-55	252	378	Increase
56	19	40	Increase
57-63	611	184	Decrease
64-66	218	7	Decrease
67-72	398	225	Decrease
73	465[2]	3	N/A
74-88	---	142	Increase
89-97	126	213	Increase
Total	**2584[3]**	**1665**	

[1] Unique stand identification number assigned during 2011 (post-fire) field mapping.
[2] The majority of stand is offsite (mapped by REC Consultants, Inc. 2004).
[3] Because of the inclusion of cluster numbers for some stands that are primarily offsite, this total is somewhat higher than would have actually been mapped on the South Crest properties in 2002/2004.

property (Figure 2-2), while the remainder of the population (32 patches; 182 plants) occurs on slopes above Dehesa Road (Figure 2-3). Almost half of the patches (37 patches; 49% of all patches) consist of a single individual; the largest patch (TEDI_66) includes 36 individuals (Figures 2-5 and 2-9). The breakdown of patch size by size class is presented in Figure 2-10. For all patches, information on size, phenology, vegetation association, fire history, and soils are presented in Appendix D.

Soils. The entire population – both in the Skeleton Flats area and on slopes above Dehesa Road - occurs on gabbro soils (Las Posas series) (Figure 2-6).

Fire. The entire population of Parry's tetracoccus on South Crest burned in 2003. Patches in the Skeleton Flats area burned in the Cedar Fire (Figure 2-7), while patches on slopes above Dehesa Road burned in the Dehesa Fire.

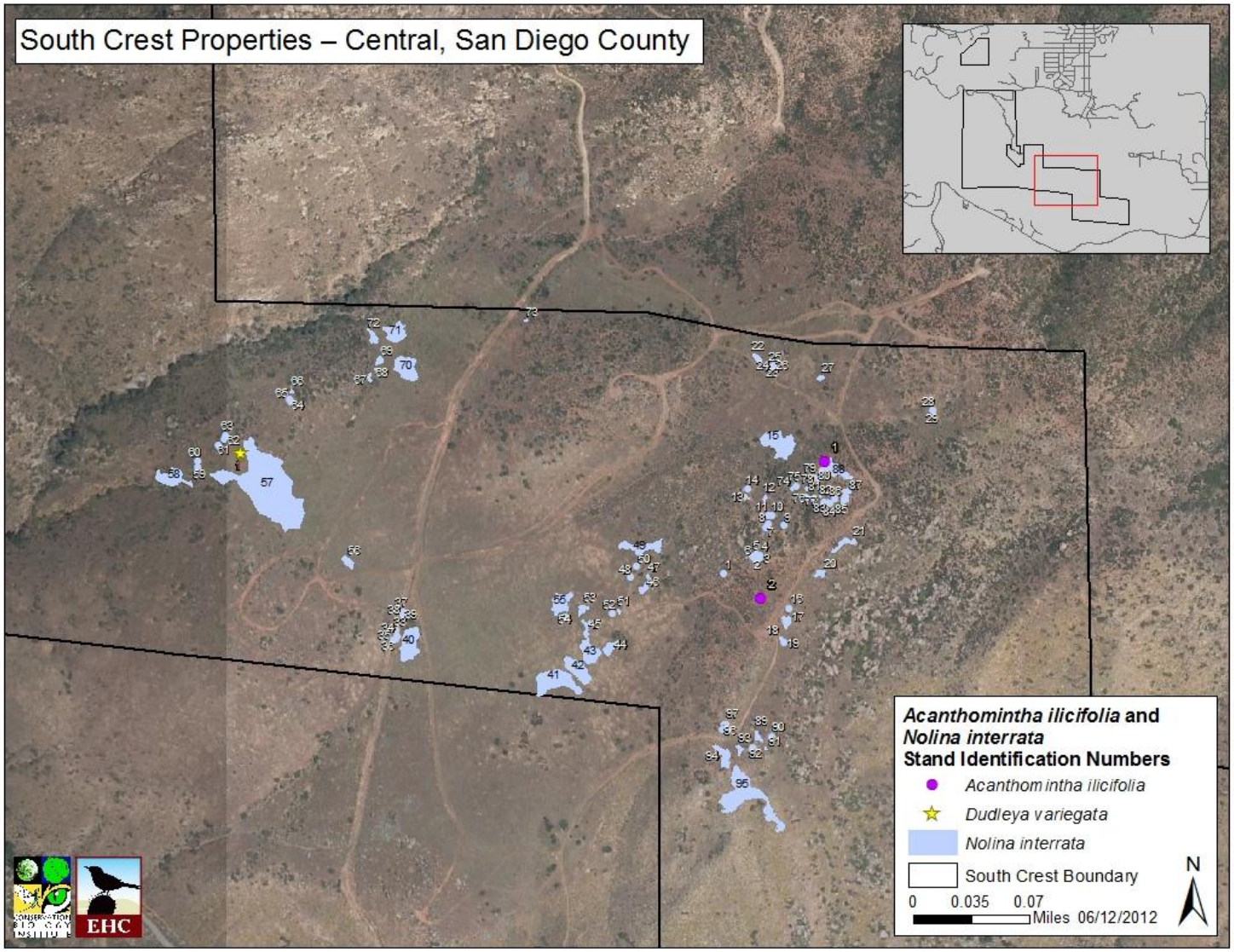


Figure 2-8. *Acanthomintha ilicifolia* and *Nolina interrata* Stand Identification Numbers, Skeleton Flats, South Crest Properties, 2011-2012.

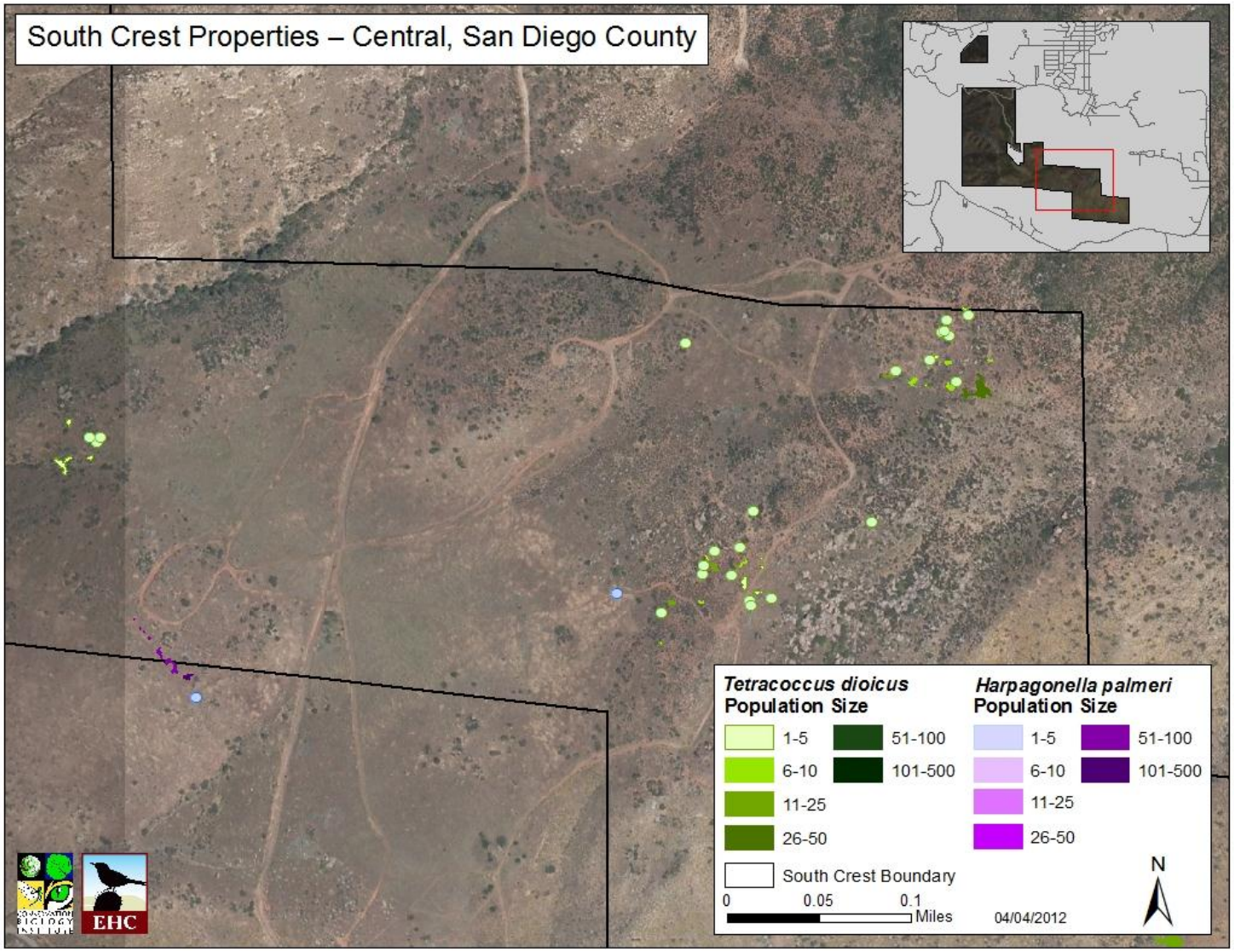


Figure 2-9. *Tetracoccus dioicus* and *Harpagonella palmeri* Population Size Estimates, Skeleton Flats, South Crest Properties, 2011.

Figure 2-10. *Tetracoccus dioicus* Distribution by Size Class.

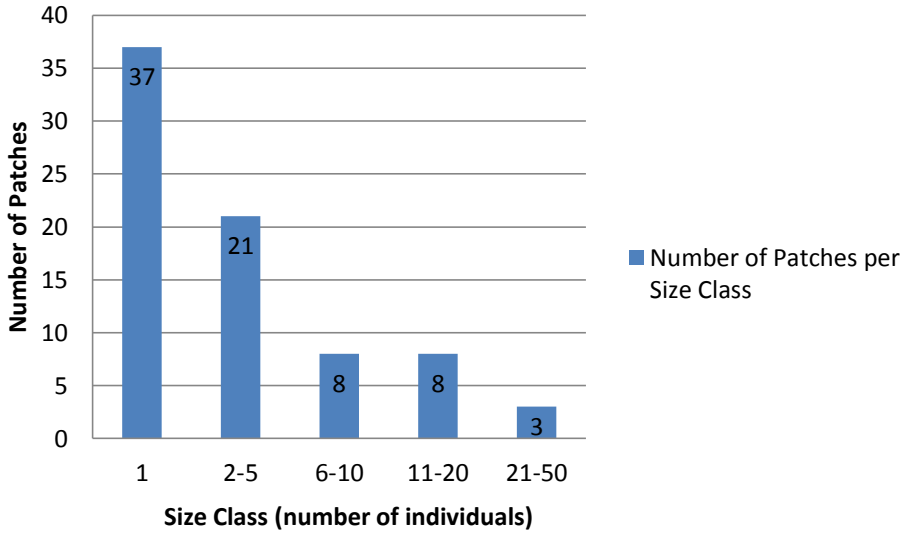


Table 2-5 presents a summary of the pre- and post-fire comparison of the Parry's tetracoccus population. Stand identification numbers in the Skeleton Flats area and on the slopes above Dehesa Road are shown on Figures 2-11 and 2-12, respectively. The distribution of plants was roughly the same between years; however, population size increased after fire at all locations. It is not clear whether the number of plants increased or whether plants became more visible as habitat was opened up. The exact fire response of this species in not known; however, it presumably germinates from the soil seedbank following fire (Sawyer et al. 2009).

Acanthomintha ilicifolia
San Diego thornmint
Federal Status: Threatened
State Status: Endangered
CNPS Rank: 1B.1

Biology, Life History, and Distribution. San Diego thornmint is a spring-blooming (April-June) annual plant that occurs on clay and gabbro soils in chaparral, scrub, grassland, and vernal pool habitats (CNPS 2012). The species is found between 10-960 m elevation in San Diego County and Baja California, Mexico (CNPS 2012). Locations in proximity to South Crest include Crestridge Ecological Reserve and McGinty Mountain. San Diego thornmint is a MSCP covered species and is considered a narrow endemic species in the region.

Table 2-5. Pre- versus Post-Fire Distribution and Abundance of *Tetracoccus dioicus*.

Stand Identification Number[1]	Pre-fire (2002/2004) Estimated Number of Plants[2]	Post-fire (2011) Estimated Number of Plants	Change
1-22	62	83	Increase
23	0	1	Increase
24-40	14	108	Increase
41-70	81	181	Increase
71-77	0	15	Increase
Total	157	388	Increase

[1] Unique stand identification number assigned during 2011 post-fire field mapping.
[2] Includes only stands mapped onsite prior to the 2003 fires; additional stands were mapped adjacent to the South Crest properties (REC Consultants, Inc. 2004).

Population Size. San Diego thornmint was not detected on South Crest in 2011; however, two stands were detected onsite in 2012 (Figure 2-8). Both stands occur on southwest-facing slopes adjacent to and east of Skeleton Flats (Figure 2-13). The smaller stand (ACIL_01; ca. 185 plants) occupies an open area characterized as a native forbland which is surrounded by chamise chaparral. The larger stand (ACIL_02; ca. 950 plants) occupies a 50 x 75' opening in chamise chaparral. San Diego thornmint was detected just offsite prior to the Cedar fire (Table 2-2). The 2012 localities represent new occurrences for this species.

Soils. Both stands of San Diego thornmint detected on South Crest in 2012 occur on gabbro soils (Figure 2-6). The pre-fire population (offsite) occurred in clay soils.

Fire. Both stands of San Diego thornmint detected on South Crest in 2012 occur within the 2003 Cedar fire boundary (Figure 2-7).

Dudleya variegata
Variegated dudleya
Federal Status: None
State Status: None
CNPS Rank: 1B.2

Biology, Life History, and Distribution. Variegated dudleya is a spring-blooming (April – June), yellow-flowered perennial herb from a corm. This species occurs in chaparral, scrub, grassland, woodland and vernal pool habitat between 3-580 m in in San Diego County and Baja California, Mexico (CNPS 2012), where it is associated with clay soils (Beauchamp 1986). Variegated dudleya is cryptic except during spring and early summer (Regan et al. 2006).

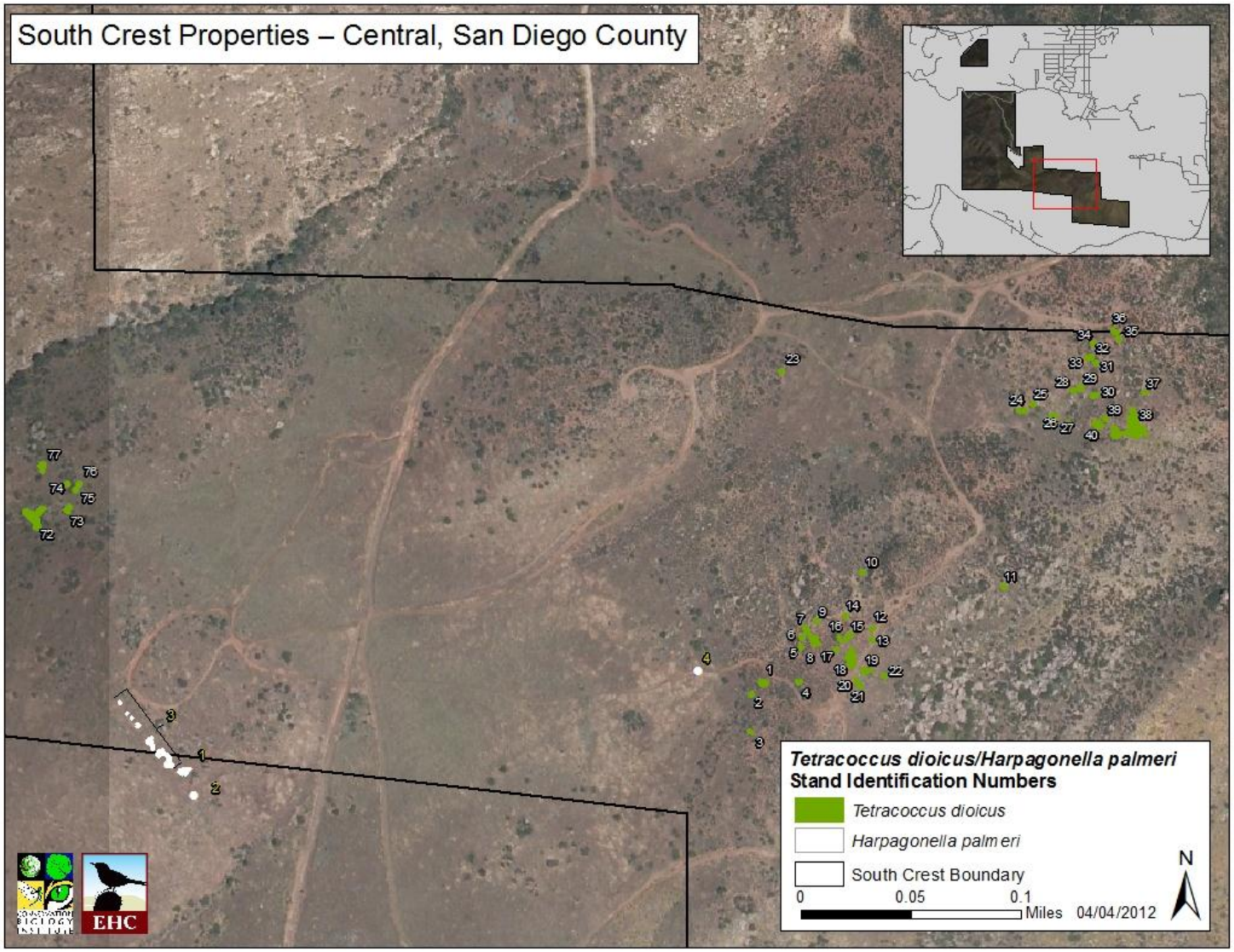


Figure 2-11. *Tetracoccus dioicus* and *Harpagonella palmeri* Stand Identification Numbers, Skeleton Flats, South Crest Properties, 2011.

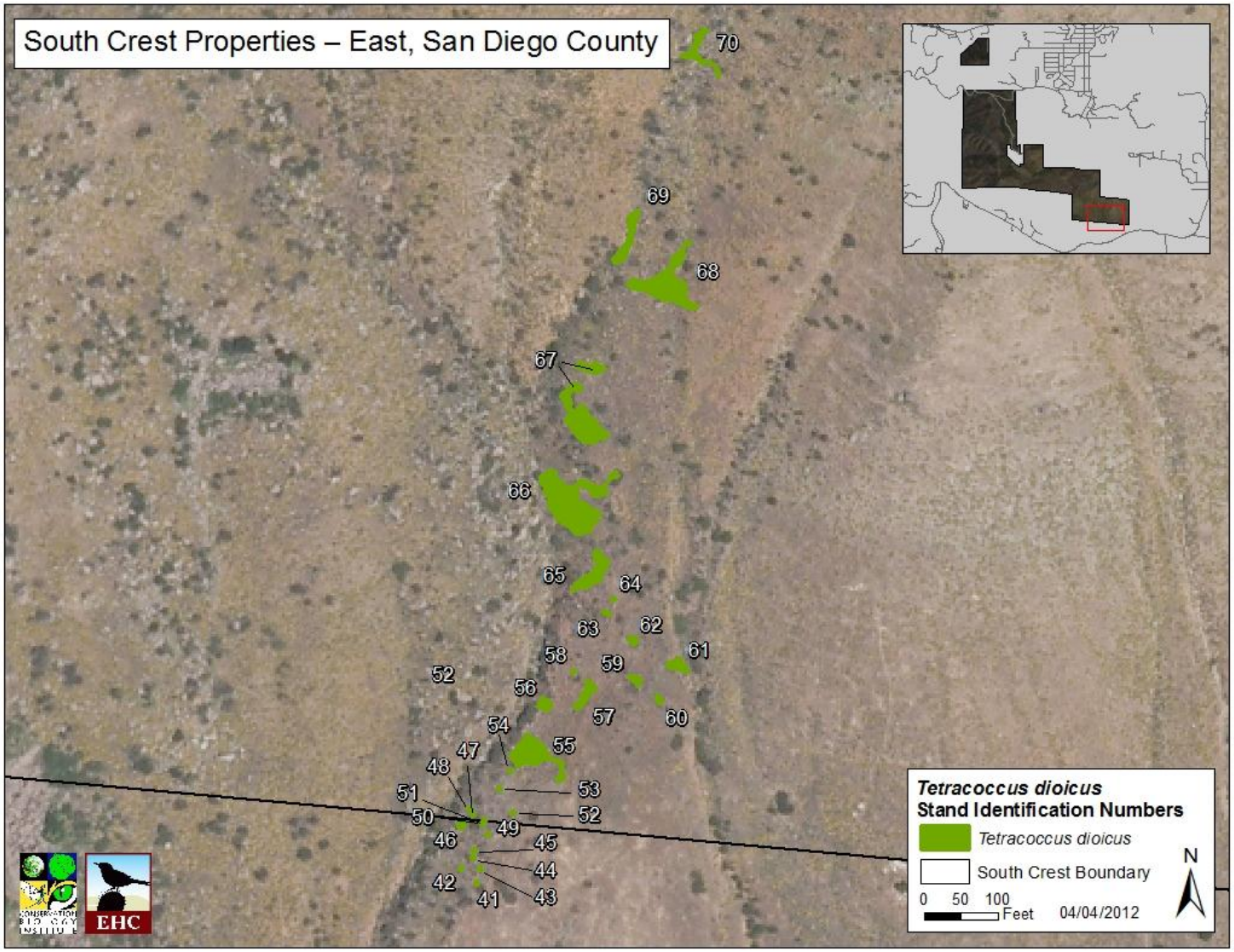


Figure 2-12. *Tetracoccus dioicus* Stand Identification Numbers, Slopes above Dehesa Road, South Crest Properties, 2011.

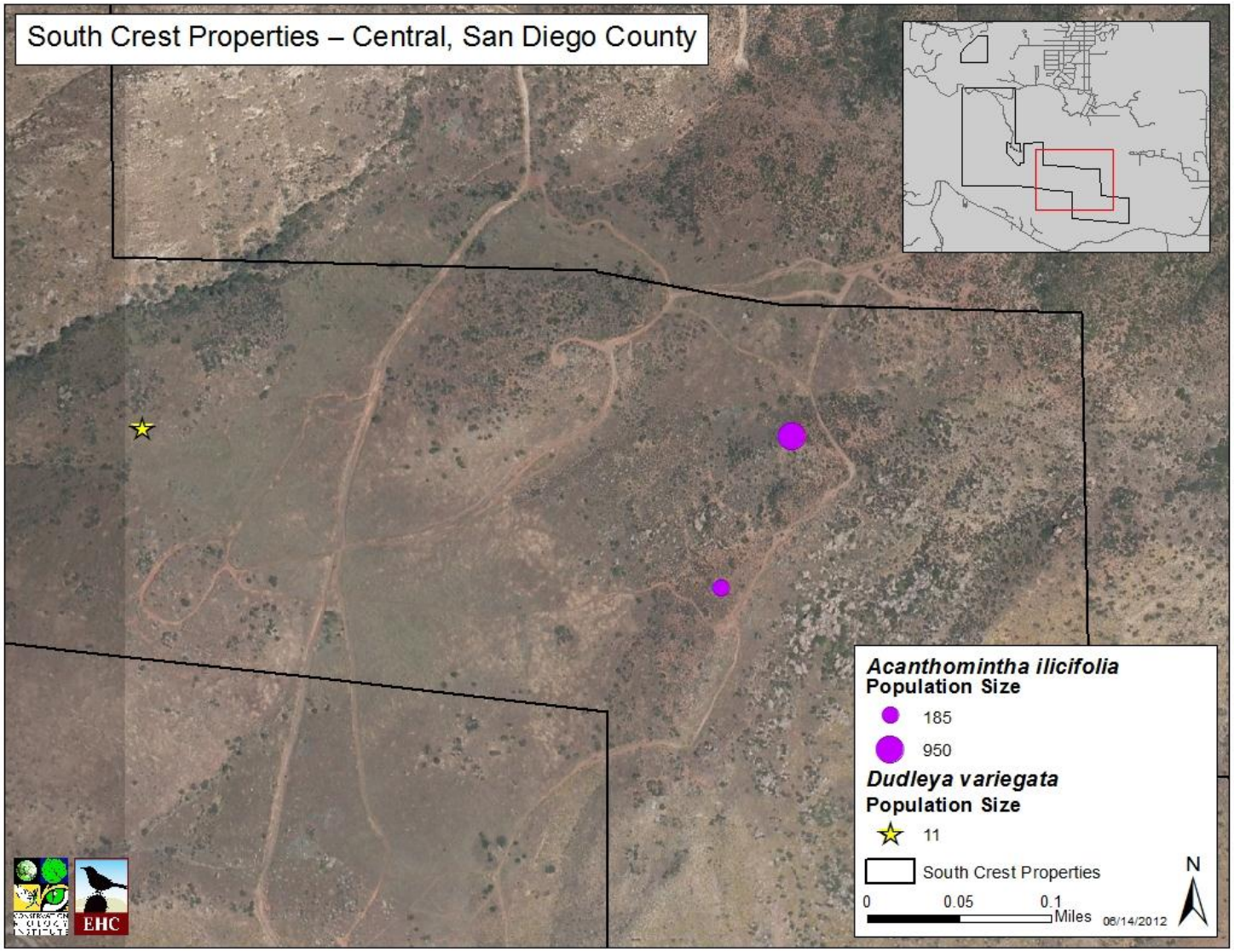


Figure 2-13. *Acanthomintha ilicifolia* and *Dudleya variegata* Population Sizes, Skeleton Flats, South Crest Properties, 2012.

Population Size. A small stand of variegated dudleya was detected onsite in 2012 in the northwestern portion of Skeleton Flats (Figure 2-8). Eleven individuals were detected within an index monitoring plot established for Dehesa beargrass (Figure 2-13); however, the population extends offsite where it is more abundant.

Soils. The 2012 stand of variegated dudleya found onsite occurs just at the edge of clay and gabbro soils (Figure 2-6), while the population offsite occurs on gabbro soils. The pre-fire, onsite occurrences of this species were primarily in clay soils.

Fire. Both the 2012 and pre-2003 occurrences of variegated dudleya on- and just offsite burned in the 2003 Cedar fire (Figure 2-7). The 2012 variegated dudleya stand detected onsite does not correspond to the pre-fire onsite localities of this species. The pre-fire occurrences, located in the central portion of Skeleton Flats, are now dominated by a dense cover of nonnative grasses, particularly *Brachypodium*. No plants were detected here in 2011 or 2012.

THREAT ASSESSMENT

Risk factors are the activities or processes that threaten the viability of populations and cause negative trends in population size (Regan et al. 2006). Regan et al. (2006) assessed risk factors – or threats – for MSCP covered species at the regional level. In the section below, we list regional risk factors for covered plant species detected on South Crest and then those factors considered most relevant onsite based on field studies and/or literature. The assessment of threats is used to develop recommendations for monitoring and managing covered plant species on South Crest (see next section).

***Nolina interrata* (Dehesa beargrass)**

Dehesa beargrass was placed in Risk Group 1 by Regan et al. (2006), who identified the following risk factors for this species across the region:

- Invasives (moderate risk)
- Altered fire regime (moderate risk)
- Removal by horticultural collectors (low risk)
- Habitat loss (low risk)

Based on field observations and literature (e.g., Rombouts 1996; USFWS 1995; Dice 1988), the primary threats to the population of Dehesa beargrass on South Crest are altered fire frequency, invasive species, and possibly, reduced genetic diversity. Direct impacts from authorized and unauthorized recreational use may also threaten individual plants.

Fire. Altered fire regimes have been identified as a risk to Dehesa beargrass (Regan et al. 2006), and can affect long-term persistence of this species. Fire suppression may result in increased fuel loads and fire intensity, senescent populations, and reduced flowering, while increased fire frequency may prevent plants from reaching maturity and contributing to the soil seedbank. Both cases may result in direct

mortality, population decline or extirpation, and/or loss of genetic diversity (USFWS 1995). Additional impacts from altered fire regimes include habitat type conversion and an increase in invasive plants.

Invasive Plant Species. Invasive plants impact native species by a variety of methods, including direct competition, displacement, and ecosystem alterations, among others. Task 1 of this report documents invasive plant species in and adjacent to Dehesa beargrass on South Crest. Of primary concern is the nonnative grass, *Brachypodium*, which forms dense stands in the central and western portions of Skeleton Flats (Figure 2-14). The dense litter produced by *Brachypodium* may provide a short-term, beneficial effect to some perennial species, including Dehesa beargrass, by retaining soil moisture and thus, resulting in increased growth. Despite this potential benefit, there is a very real concern that dense litter may be detrimental to Dehesa beargrass by (1) increasing fire intensity; (2) altering nutrient cycling due to the increase in biomass, particularly in habitat that is naturally open or characterized by very little understory; and (3) eliminating bare ground that could serve as sites for recruitment. Although sexual reproduction in this species is considered rare and most common after fire, at least one patch of small plants observed onsite appeared to be a different cohort than the majority of plants onsite. The presence of potential sites for recruitment should be a component of healthy, functioning Dehesa beargrass habitat, regardless of the frequency with which sexual reproduction takes place.

Another invasive species of concern is sweet fennel (*Foeniculum vulgare*). A patch of approximately 50 plants occurs in the western portion of Skeleton Flats in the vicinity of NOIN_57 (Figure 2-14). This species has the potential to impact Dehesa beargrass by competition and displacement.

Genetic Diversity. Dehesa beargrass is a clonal species that also reproduces sexually through a dioecious breeding system. Flowering is extremely sporadic and appears to be enhanced by fire. Several researchers have investigated genetic diversity in this species (Rombouts 1996; Heaney pers. comm.). Dehesa beargrass exhibits moderate clonal diversity and extremely low genetic variation. It is hypothesized that the dioecious mating system, which usually maintains high levels of polymorphism and heterozygosity, may have evolved *after* low levels of genetic diversity were established and may be preventing further loss of genetic variation (Rombouts 1996). Genetic sampling studies currently in progress will provide measures of genetic diversity at the population level, an estimate of effective population size, and the geographic distribution of genetic populations to infer whether ecological or geographic barriers are isolating mechanisms (CDFG 2009). These results, along with field studies to assess flowering frequency and sex ratios onsite, will be used to determine whether low genetic diversity is a threat to the long-term persistence of the Dehesa beargrass population onsite.

Recreational Use. The Skeleton Flats area of South Crest is subject to both authorized and unauthorized recreational uses. A number of trails traverse the area. Community members use the site for passive recreation such as hiking. Evidence of geocaching activities have been found onsite, and off-highway vehicles have been observed on both well-defined trails and cutting new trails through undisturbed habitat. Impacts to Dehesa beargrass from this latter activity are of greatest concern, since plants can be trampled or killed. In addition, all access into the site has the potential to introduce or spread invasive species.

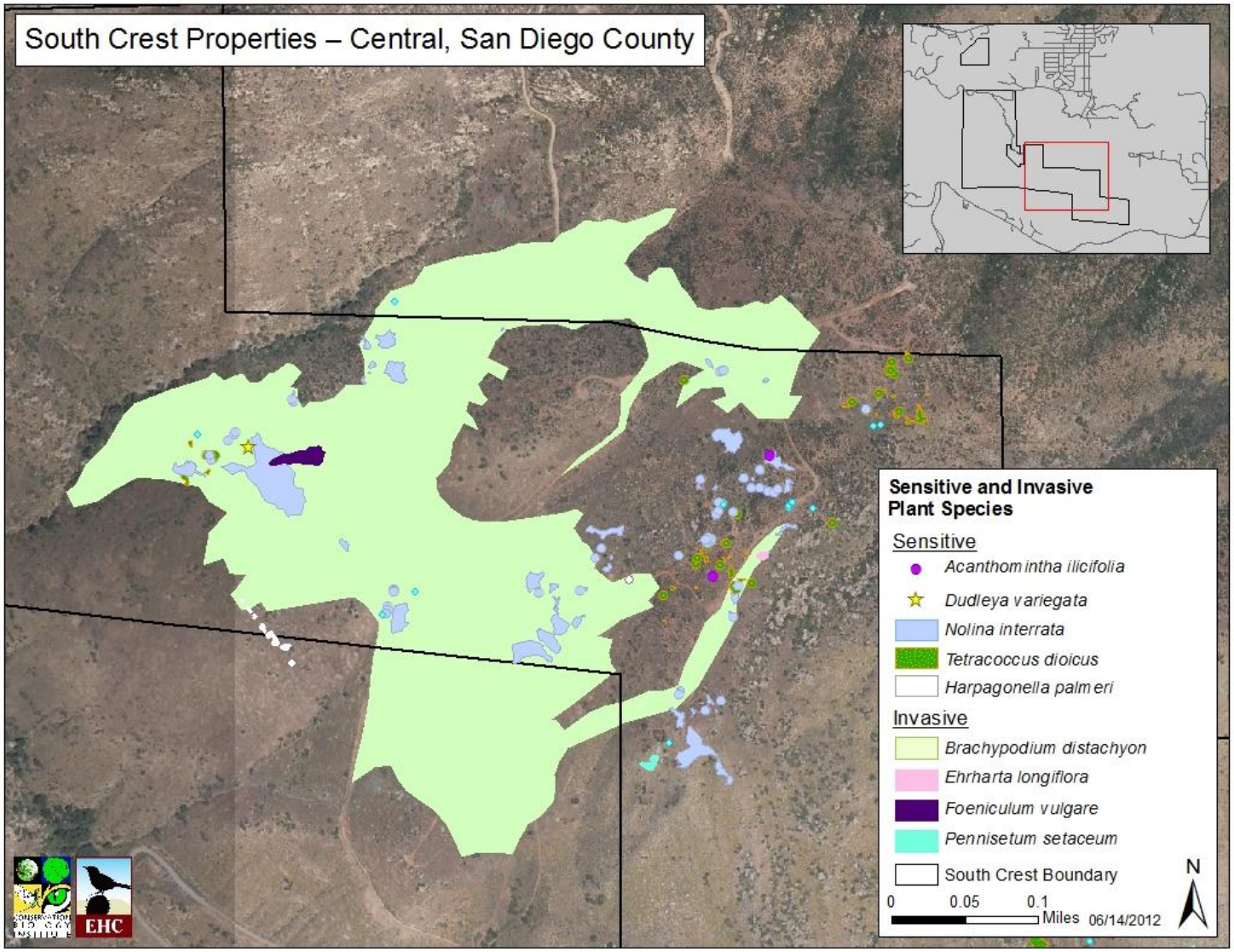


Figure 2-14. Distribution of Sensitive and Invasive Species, Skeleton Flats, South Crest Properties, 2011-2012.

Recreational Use. The Skeleton Flats area of South Crest is subject to both authorized and unauthorized recreational uses. A number of trails traverse the area. Community members use the site for passive recreation such as hiking. Evidence of geocaching activities have been found onsite, and off-highway vehicles have been observed on both well-defined trails and cutting new trails through undisturbed habitat. Impacts to Dehesa beargrass from this latter activity are of greatest concern, since plants can be trampled or killed. In addition, all access into the site has the potential to introduce or spread invasive species.

***Tetracoccus dioicus* (Parry's tetracoccus)**

Parry's tetracoccus was placed in Risk Group 3 by Regan et al. (2006), who identified the following risk factors for this species across the region:

- Altered fire regime (high risk)
- Habitat loss (moderate risk)
- ORVs (low risk)

Based on field mapping, the population of Parry's tetracoccus on South Crest generally appears to be stable or expanding. Potential threats to this population include altered fire frequency, invasive species, and recreational impacts.

Fire. Altered fire regimes have been identified as a risk to Parry's tetracoccus (Regan et al. 2006). In particular, increased fire frequency may result in plant mortality, soil seed bank depletion, and habitat type conversion with a concomitant increase in nonnative invasive species. The potential scenarios would likely result in population decline or extirpation.

Invasive Plant Species. The majority of Parry's tetracoccus stands on South Crest are not currently impacted by invasive plant species. Exceptions include those stands in the western portion of Skeleton Flats (TEDI_72-77), which occur in *Brachypodium*-dominated habitat (Figure 2-14). Potential impacts from this invasive species include reduced sites for germination and recruitment, alterations to the nutrient cycling process, and increased fire frequency and/or intensity.

Recreational Use. As discussed above, the Skeleton Flats area of South Crest is subject to both authorized and unauthorized recreational uses. Impacts to Parry's tetracoccus from unauthorized off-highway vehicle use may damage individual plants. In addition, all access into the site has the potential to introduce or spread invasive species.

***Acanthomintha ilicifolia* (San Diego thornmint)**

San Diego thornmint was placed in Risk Group 1 by Regan et al. (2006), who identified the following risk factors for this species across the region:

- Invasive species (high risk)
- Habitat loss (high risk)
- ORVs (low risk)

- Grazing (low risk)
- Pollution (low risk)

The latter two risk factors are not expected to be a concern on South Crest at this time. Based on field mapping, the extant population of San Diego thornmint on South Crest is threated by invasive species, altered fire regime, and recreational use. In addition, areas of formerly suitable habitat have been degraded by invasive species.

Fire. An increased fire frequency may result in plant mortality, soil seed bank depletion, and habitat type conversion with a concomitant increase in nonnative invasive species. These scenarios would likely result in population decline or extirpation.

Invasive Plant Species. The larger stand of San Diego thornmint (ACIL_02) occurs in association with a number of invasive plant species including tocalote (*Centaurea melitensis*), low levels of *Brachypodium*, and crete weed (*Hedypnois cretica*) (not mapped). Potential impacts from these species include reduced sites for germination and recruitment, competition for resources, alterations to the nutrient cycling process, and increased fire frequency and/or intensity.

Recreational Use. As discussed above, the Skeleton Flats area of South Crest is subject to both authorized and unauthorized recreational uses. Impacts to San Diego thornmint from unauthorized off-highway vehicle use may damage individual plants and destroy habitat. In addition, all access into the site has the potential to introduce or spread invasive species.

***Dudleya variegata* (Variegated dudleya)**

Variegated dudleya was placed in Risk Group 2 by Regan et al. (2006), who identified the following risk factors for this species across the region:

- Invasive species (moderate risk)
- Recreation/human disturbance (moderate risk)
- Habitat loss (moderate risk)
- ORVs (moderate risk)
- Grazing (low risk)

The latter risk factor is not expected to be a concern on South Crest at this time. Based on field mapping, the extant population of variegated dudleya on South Crest is threated by invasive species, altered fire regime, and recreational use (including ORV activity). In addition, areas of formerly suitable habitat have been degraded by invasive species.

Fire. An increased fire frequency may result in plant mortality, soil seed bank depletion, and habitat type conversion with a concomitant increase in nonnative invasive species. These scenarios would likely result in population decline or extirpation.

Invasive Plant Species. The population of variegated dudleya mapped in 2012 occurs in association with *Brachypodium* (Figure 2-14). Potential impacts from this species include reduced sites for germination

and recruitment, competition for resources, alterations to the nutrient cycling process, and increased fire frequency and/or intensity.

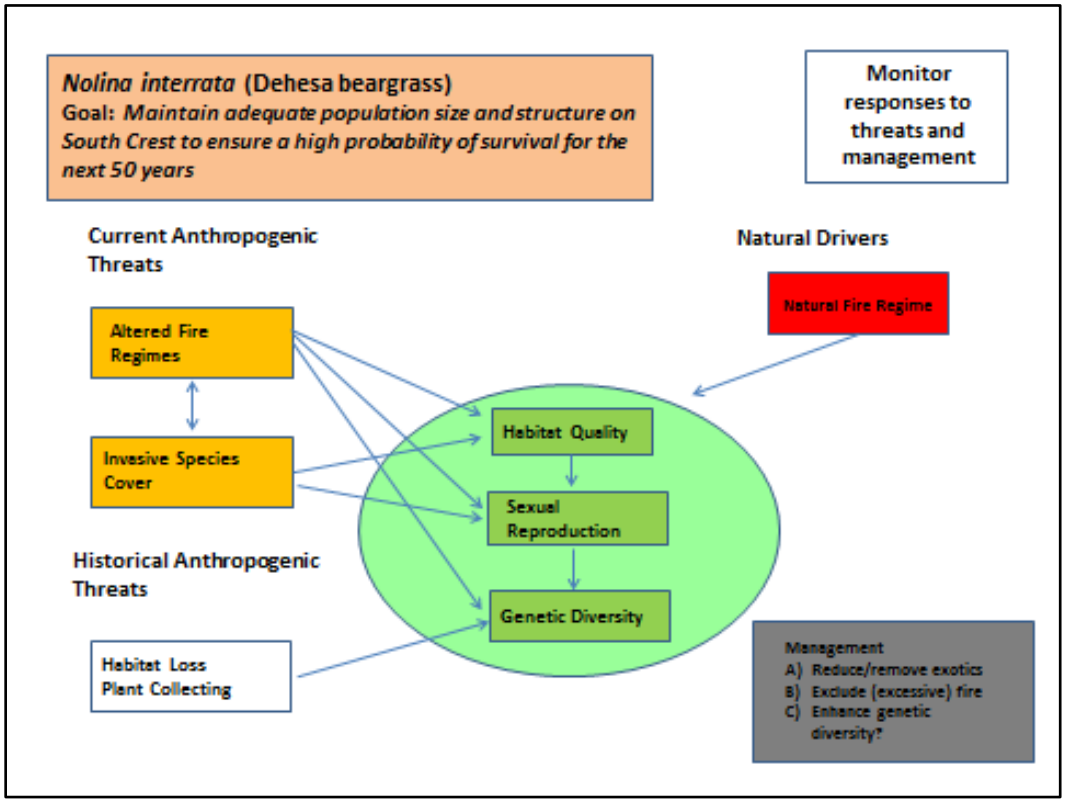
Recreational Use. As discussed above, the Skeleton Flats area of South Crest is subject to both authorized and unauthorized recreational uses. Impacts to variegated dudleya from unauthorized off-highway vehicle use may damage individual plants and destroy habitat. In addition, all access into the site has the potential to introduce or spread invasive species.

DISCUSSION

Nolina interrata (Dehesa beargrass)

Information from field studies and literature was used to develop a draft conceptual model for Dehesa beargrass (Figure 2-15). This model includes current and historical anthropogenic threats, natural drivers, and potential management actions. The model will be refined as additional information (e.g., genetic diversity studies) becomes available. Based on this model, management actions on South Crest should focus initially on invasive species control, as outlined in the following section.

Figure 2-15. *Draft* Conceptual Model for *Nolina interrata* (Dehesa beargrass)



***Tetracoccus dioicus* (Parry's tetracoccus)**

Because of the lower sensitivity status of this species and baseline information that suggests the population is stable or expanding onsite, a conceptual model was not developed for this species. Management actions recommended for Dehesa beargrass are expected to benefit Parry's tetracoccus.

***Acanthomintha ilicifolia* (San Diego thornmint)**

A draft conceptual model for San Diego thornmint will be developed under a Local Assistance Grant (LAG) from CDFG and will inform future management and monitoring of this species at the landscape level. Baseline data collected in this study indicates that invasive species management in occupied and potentially suitable habitat is an appropriate long-term goal for this species on South Crest. Protection of habitat from frequent fires and recreational use is also warranted.

***Dudleya variegata* (Variegated dudleya)**

Baseline data collected in this study indicates that invasive species management in occupied and potentially suitable habitat is an appropriate long-term goal for variegated dudleya on South Crest. Protection of habitat from frequent fires and recreational use is also warranted.

RECOMMENDATIONS

An initial step in formulating management and monitoring recommendations is to develop goals and objectives. Goals are broad, visionary statements that set the overall direction for monitoring and management, while objectives provide the specifics on how to achieve those goals. Multiple objectives may be required to meet a single goal (Lewison et al. 2011). Preliminary management goals and objectives for covered species on South Crest are presented below; it is anticipated that objectives will be refined with additional data or during development of specific management plans.

***Nolina interrata* (Dehesa beargrass)**

Dehesa beargrass is a state-endangered species that is endemic to southern San Diego County and northwestern Baja California. There are an estimated 10 populations in San Diego County, all in the vicinity of Dehesa Valley. The MSCP specified that 90% of major populations should be conserved in a configuration that supports appropriate pollinators (Ogden 1988). The population on South Crest is part of a major population and may be part of the type locality population for which the species was identified. An assessment of risk factors identified the following threats to this population onsite:

- Altered fire regimes
- Invasive plant species
- Low genetic variation
- Recreational use

Based on the overarching MSCP conservation objective, we propose the following goal for this species on South Crest:

Goal: Maintain adequate population size and structure of Dehesa beargrass on South Crest to ensure a high probability of survival for the next 50 years.

The following objectives are recommended in support of this management goal. Each objective is accompanied by a number of tasks or actions that are required to meet that objective. Based on results of these tasks, additional management or monitoring may be required.

Objective 1: Determine whether the population of Dehesa beargrass onsite is stable, increasing, or declining by assessing the population structure over a 10-year time period.

Tasks under Objective 1:

1. Establish a minimum of 3 permanent index plots in or adjacent to Skeleton Flats in 2012.
2. Develop a standardized protocol for counting or otherwise assessing ramet growth.
3. Monitor index plots at 2-year intervals to assess growth; collect data on vegetative production, ramet growth/morality, and associated species.
4. Analyze monitoring data to assess trends; implement adaptive management measures where data indicates population declines.

Additional Management or Monitoring:

1. Where data indicate a population decline, implement adaptive management measures, as appropriate (e.g., additional invasive species control).

Objective 2: Determine whether low genetic diversity or an unbalanced sex ratio threatens the persistence of the population of Dehesa beargrass on South Crest.

Tasks under Objective 2:

1. Collect population structure data (size class, frequency of flowering, sex ratios) yearly in the 3 index plots over a 10-year time period. Use these data to assess the need for augmentation if the population is monomorphic; the assessment of genetic threats will be informed by independent research efforts.

Additional Management or Monitoring:

1. Where population augmentation is indicated, work with the resource agencies to procure necessary permission and permits for procuring offsite material and introducing it onto South Crest.
2. Where threats from low genetic diversity are indicated, develop a seed collection program for Dehesa beargrass to procure source material to enhance the natural seed bank and/or increase genetic diversity (note: seed collection will require appropriate permits).

Objective 3: Reduce potential fire intensity and competition for resources from nonnative plants, increase suitable sites for germination, and maintain/enhance habitat for pollinators by reducing or eradicating selected nonnative species within 10 acres of habitat on Skeleton Flats over a 2-year time period.

Tasks under Objective 3:

1. Develop an invasive control plan for Skeleton Flats by December 2012 that targets invasive species (particularly, *Brachypodium*) that impact Dehesa beargrass *and* other covered or sensitive species on South Crest.
2. Based on the invasives control plan, eliminate or reduce dense stands of nonnative grasses (particularly, *Brachypodium*) that may contribute to increased fire intensity and plant mortality and/or a reduction in bare ground for seed germination and seedling recruitment by 25-50% within 10 acres of habitat over a 5-year time period. It is acknowledged that invasives control and monitoring may be required beyond this 5-year time period.
3. Reintroduce native grassland or scrub components, as appropriate, into selected *Brachypodium*-treated habitat. The species mix will be based on habitat assessments and detailed in the invasive control plan.
4. Eradicate other high priority invasive species that occur in or near Dehesa beargrass habitat on Skeleton Flats, such as sweet fennel and artichoke thistle (see Section 1) within a 2-year time period.

Additional Management or Monitoring:

1. Monitor the effectiveness of invasive control and habitat restoration efforts in the Skeleton Flats area in the 3 permanent index plots (e.g., species cover, richness) over a 2-year time period.

2. Based on monitoring results, implement adaptive management.

Objective 4: Reduce or eliminate incidental habitat damage or direct impacts to individual Dehesa beargrass plants by eliminating all vehicular access and limiting access by bicycles and human foot traffic.

Tasks under Objective 4:

1. Install signage to discourage unauthorized off-highway vehicle usage on Skeleton Flats and direct recreational users away from populations of Dehesa beargrass and other covered species.
2. Increase community outreach and education through signage, field trips, and volunteer participation in monitoring or restoration activities.
3. Increase enforcement activities if signage is not effective in eliminating unauthorized vehicle from Skeleton Flats.

Tetracoccus dioicus (Parry's tetracoccus), *Acanthomintha ilicifolia* (San Diego thornmint), and *Dudleya variegata* (Variegated dudleya)

Based on information collected to date, onsite threats to all three species are concentrated in the Skeleton Flats area and include:

- Altered fire regimes
- Invasive plant species
- Recreational use

These species will benefit directly from management actions implemented for Dehesa beargrass as described in Objectives 3 and 4, above. Goals and objectives for San Diego thornmint and variegated dudleya will be refined based on information collected in 2012 under a separate contract. The management goal and objectives for Parry's tetracoccus are detailed below.

Goal: Maintain adequate population size on South Crest to ensure a high probability of survival for the next 50 years.

Objective 1: Reduce potential fire intensity and competition for resources from nonnative plants, increase suitable sites for germination, and maintain/enhance habitat for pollinators by reducing or eradicating selected nonnative species within 10 acres of habitat on Skeleton Flats over a 2-year time period.

Tasks under Objective 1:

Refer to Dehesa beargrass, Objective 3, for task specifics. It is presumed that invasive control measures for Dehesa beargrass will benefit other covered species on Skeleton Flats, including Parry's tetracoccus.

Objective 2: Reduce or eliminate incidental habitat damage or direct impacts to individual Parry's tetracoccus plants by eliminating all vehicular access and limiting access by bicycles and human foot traffic.

Tasks under Objective 2: Refer to Dehesa beargrass, Objective 4, for task specifics. It is presumed that invasive control measures for Dehesa beargrass will benefit other covered species on Skeleton Flats, including Parry's tetracoccus.

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TASK 3. INVASIVE SPECIES CONTROL

PURPOSE AND BACKGROUND

As discussed in Task 1, invasive plant species pose one of the greatest threats to biological resources on CER and South Crest, and invasive species control is expected to be a long-term management issue. The objective of this task was to implement focused invasive plant control efforts on CER and South Crest. Prior invasive species mapping on CER (CBI and EHC 2009; CBI 2009; CBI 2011a, b) identified the need for invasives control in four specific areas: (1) a 10-acre grassland restoration site; (2) 5 acres of coastal sage scrub undergoing post-fire restoration; and (3) 5 acres of a coast live oak/Engelmann oak grove; and (4) San Diego thornmint habitat on Thornmint Hill. The former 3 areas are all in the vicinity of the Horsemill Road entrance. In addition, invasive species mapping on both CER and South Crest (Task 1) identified a large number of invasive species of concern. Invasive control treatments were initiated for a number of these species; refer to Task 1 for treatment recommendations for all species detected during this project. Appendix I provides a complete list of invasive control treatments conducted on CER and South Crest in 2010-2012. Treatments within the four focused habitat areas are summarized below. All invasive control treatments were conducted by SERG or EHC.

GRASSLAND RESTORATION SITE

This site had a history of livestock grazing and was dominated by nonnative forbs and grasses prior to treatment. Focused invasive control efforts, in conjunction with multiple years of planting (*Nassella pulchra* plugs), have shifted the species dominance toward a native grassland. Target species for control included long-beak filaree (*Erodium botrys*), red brome (*Bromus rubens*), rattail fescue (*Vulpia myuros* var. *hirsuta*), black mustard (*Brassica nigra*), tocalote (*Centaurea melitensis*), and additional non-native grasses. Invasives control, conducted at least 6 times yearly, has greatly decreased invasive species, but a number of these species are still germinating from the soil seed bank. The most problematic species for control are mustard, tocalote, and nonnative grasses. Species emergence is highly dependent on precipitation although mustard, in particular, appears to germinate with little to no moisture. Treatments conducted under this contract decreased nonnative species cover in this area by an estimated 50%. Native grass plantings are thriving, in general, with the older planting areas approaching 75% cover. In newer planting areas, the grasses are surviving well, but only approach about 15% cover. Emergence of native annual species from the soil seed bank has increased over the past two years; the most common native forbs are dove weed (*Croton setigerus*), canchalagua (*Centaurium venustum*), toad flax (*Linaria canadensis*), and milkweed (*Asclepias fascicularis*).

Based on results to date, we recommend continued treatment in this area, particularly for mustard. Control will allow native grasses to continue to thrive and expand their cover, allow for emergence of a native herbaceous component, and prevent nonnative species from contributing to the soil seed bank. Invasives control should include a minimum of five site-wide spot applications per year, with a focus on preventing mustard from flowering and going to seed.

COASTAL SAGE SCRUB RESTORATION SITE

This site is adjacent to and upslope from the grassland restoration site, and has the same history of disturbance. In Appendix I, treatments for the grassland restoration site generally include this area, as well. Soil testing indicated that this area was not suitable for native grassland restoration; therefore, no grass plantings were introduced into this area and native coastal sage scrub species have been allowed to colonize naturally from surrounding habitat. The most prominent native volunteer is California sagebrush (*Artemisia californica*); native shrub cover is currently estimated at about 75% in this area.

Invasives control efforts in the coastal sage scrub restoration site has focused primarily on nonnative forbs in open areas, particularly mustard and tocalote. In understory areas, horehound (*Marrubium vulgare*) is a common species and has been subjected to treatment. Overall, invasives control in this area is estimated at 90%, although no invasive species has yet been eliminated completely.

Based on results, we recommend continued surveillance of this area for invasive plants and spot-treatments, as necessary, to control emerging nonnative species. However, invasives treatment in the coastal sage scrub site is expected to be much less intensive going forward due to the high shrub cover and success of control efforts to date.

HORSEMILL ROAD OAK WOODLAND

The Horsemill Road oak grove is dominated by an open to closed canopy of coast live oak (*Quercus agrifolia*) and Engelmann oak (*Quercus engelmannii*). The understory is sparse, and ranges from a dense cover of leaf litter to scattered native and nonnative species, such as poison-oak (*Toxicodendron diversilobum*), delicate clarkia (*Clarkia delicata*), common bedstraw (*Galium aparine*), and brome grasses (*Bromus* spp.), among others. Poison-oak is dense in some locations, such as the western edge of the oak grove. In 2009, CBI biologists detected the annual invasive grass species, long-flowered veldt grass (*Ehrharta longiflora*), in the oak understory. At the time, the species occurred in patches throughout the grove, and appeared to be spreading.

The invasives control effort in the Horsemill Road oak grove focused primarily on long-flowered veldt grass. At the onset of this project, this species formed dense stands in the understory of this oak grove. During this project, long-flowered veldt grass was treated multiple times in 2011 and 2012 (Appendix I). Control is currently estimated at 70%; however, the seed bank continues to express itself. For this reason, it is recommended that treatments in this area continue until the species is eradicated. It is important to note that treating this area in consecutive years offers the best chance for control since the species produces a large amount of seed and can easily replenish the seed bank if treatment is temporarily halted or discontinued. Additional invasive species treated in or adjacent to the oak grove include umbrella sedge (*Cyperus involucratus*), periwinkle (*Vinca* aff. *major*), Italian thistle (*Carduus pycnocephalus*), and other nonnative grasses.

THORNMINT HILL

Invasive control treatment on Thornmint Hill focused primarily on the nonnative invasive grass, *Brachypodium*. This species has invaded clay soils in this area, forming near monospecific stands that displace both native and nonnative annual species, including habitat occupied by the federally and state-endangered San Diego thornmint (see Tasks 1 and 2). The long-term goal for Thornmint Hill is to control *Brachypodium* in thornmint habitat. Because of uncertainties regarding *Brachypodium* control methods and the effects these treatments on desirable native species, we implemented a pilot program, or experimental design, to investigate alternative treatments prior to widespread application. Results of this pilot program are detailed below and will be used to formulate and implement widespread *Brachypodium* control measures on both CER and South Crest. Additional invasive species treated on Thornmint Hill included fountain grass and tanglehead.

BACKGROUND

Brachypodium forms a dense, persistent thatch layer that suppresses germination of other species. This thatch layer may benefit some native shrubs and geophytes by retaining moisture (Wolkovich et al. 2009b, Vinje pers. comm.); however, it may also prevent recruitment of these species, thus altering population structure(s) and resulting in a loss of genetic diversity over time. On CER, geophytes appeared to coexist with *Brachypodium*, although flowering decreased with an increase in *Brachypodium* density. In addition to its effects on recruitment and annual species diversity, the dense thatch layer may also alter soil ecology and ground-dwelling arthropod populations (Wolkovich et al. 2010, Wolkovich et al. 2009a), and promote a grass-fire cycle by adding a fine fuel layer in habitats previously characterized by bare interspaces between shrubs. This dense thatch layer may benefit *Brachypodium* germination by reducing light at the soil surface. In studies on diploid accessions of *Brachypodium* from the Middle East region (California populations are tetraploids), germination of fresh seed was strongly inhibited by blue light (found at the soil surface), while red light (found in the soil layer immediately below the surface) strongly promoted germination. This controlling effect of light on dormancy eventually faded in after-ripened seed (Barrero et al. 2011).

The *Brachypodium* infestation on Thornmint Hill appears to have increased dramatically in extent and density since the 2003 Cedar fire, and is presumably a factor in the decline of San Diego thornmint in this location. In heavily invaded areas, other clay-endemic native forbs (e.g., *Harpagonella palmeri, Plantago erecta*, *Convolvulus simulans*) also appear to have declined. In 2011, an estimated 68 acres of *Brachypodium*-dominated habitat were mapped on Thornmint Hill (Task 1, Appendix C, Figure C-1).

Initial herbicide treatments of *Brachypodium* on CER by CDFG (2009-2010) showed some reduction in *Brachypodium* cover and an increase in geophytes in the treatment area; however, *Brachypodium* rebounded quickly with a concomitant decrease in geophyte flowering (observational). There also appeared to be a loss of annual species diversity in the treatment area. Because these initial treatments did not include an experimental design, the effectiveness of the treatment and cause of reduction in

annual species diversity cannot be determined. Therefore, we implemented an experimental pilot program that focused on the following questions:

Question 1: Does thatch removal prior to treatment significantly improve *Brachypodium* control methods, as measured by a decrease in *Brachypodium* cover?

Removal of thatch prior to herbicide treatment is a common practice; however, thatch removal is time-intensive and there are contradicting opinions among practitioners as to its efficacy. (note: this study did not address nutrient inputs to the system if thatch is left in place).

Question 2: Which treatment (control, herbicide, mechanical) is most effective in reducing cover of *Brachypodium*?

The grass-specific herbicide, Fusilade II, has been shown to be moderately to highly effective against *Brachypodium*, and does not appear to negatively affect native grass and bulb species (Ekhoff pers. comm., Kelly pers. comm., Vinje pers. comm.). However, effects on other species and resources (e.g., sensitive annual plants, ground-dwelling pollinators, soil microbial community, butterfly larvae, etc.) are unknown. These same practitioners also report an increase in exotic forbs following treatment with the grass-specific herbicide. Further, *Brachypodium* has developed some herbicide resistance in other parts of its range (Gressel et al. 1983; Gressel and Kleifeld 1994). Because of the unknown effects of herbicide on some resources of concern, the relatively large treatment area, and the potential for herbicide resistance, we wanted to investigate alternative treatment methods and efficacy prior to widespread application.

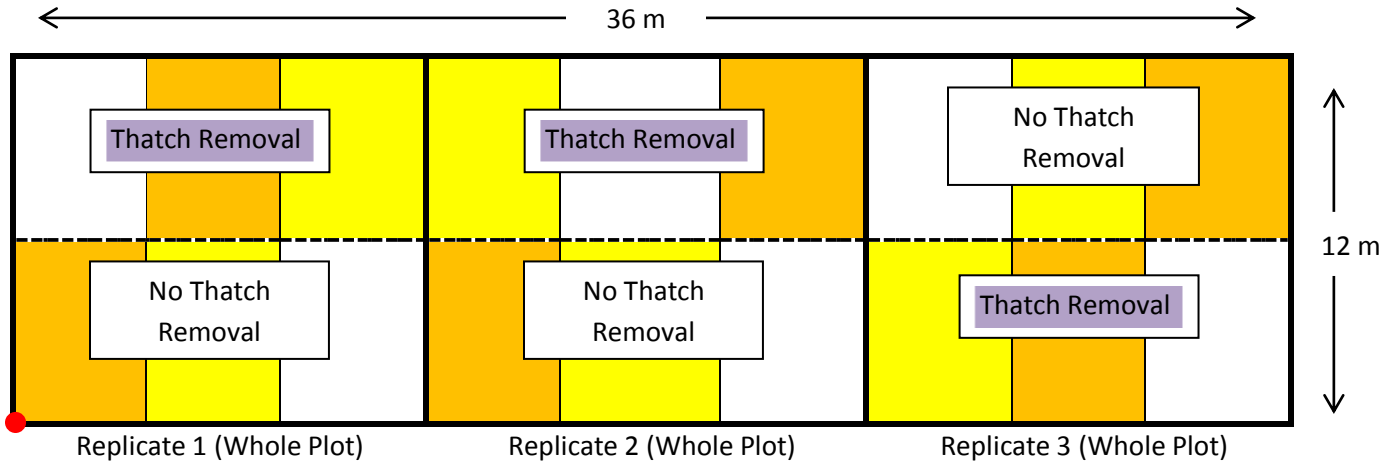
EXPERIMENTAL DESIGN METHODOLOGY

The *Brachypodium* control experiment utilized a split plot design. The split plot design is a randomized complete block design in which there are two levels of experimental units: whole plots and subplots, each with their own level of randomization and precision. In addition, the size of these experimental units differs. In our design, the whole plot factor was thatch/no thatch while the subplot factors were the treatments (control, herbicide, mechanical). Split plot designs have been traditionally used in agricultural experiments (Jones and Nachtsheim 2009, Federer and King 2007), and are used to test the effects of two treatments.

We established three experimental plots (blocks) on Thornmint Hill in January 2011. Each block consisted of 3 replicates (whole plots). Each whole plot consisted of 6 subplots; thus, there were 18 subplots per block. The block/plot dimensions are presented below; an example of the plot layout is presented in Figure 3-1.

- Block = 36 m x 12 m [118 ft x 39.4 ft]
- Whole plot (3 whole plots/block) = 12 m x 12 m [39.4 ft x 39.4 ft)
- Subplots (18 subplots/whole plot) = 4 m x 6 m [13 ft x 20 ft]
- Treatment area = whole plot (thatch removal) and subplots (control, herbicide, mechanical)
- Assessment area = inner 2 m [6.6 ft] x 4 [13 ft] m (leaving a 1 m [3.3 ft] border)

Figure 3-1. Experimental Plot Layout.



Whole Plot Treatments

= No thatch removal (A)

= Thatch removal (B)

Subplot Treatments:

= Control (no treatment) (1)

= Herbicide treatment (2)

= Mechanical treatment

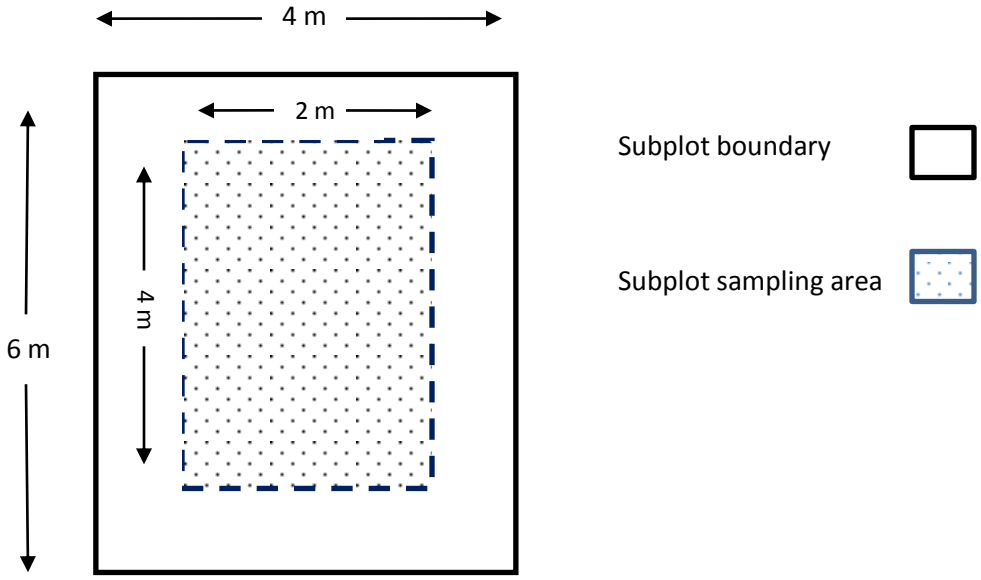
EXPERIMENTAL TREATMENTS

The experimental plots were treated in 2011 and 2012. Whole plot factors were randomly assigned at the start of the experiment, and were either thatch removal or no thatch removal. In thatch removal plots, thatch was raked from the plots, bagged, and disposed of offsite. Subplot factors were the *Brachypodium* control treatments. Each subplot was randomly assigned a control, herbicide, or mechanical treatment. Control subplots received no action. Herbicide subplots were treated at least one time during the growing season with Fusilade II. Mechanical subplots were weed-whipped when *Brachypodium* was 6-8" high and/or before it flowered, and litter was raked, bagged, and disposed of offsite.

SAMPLING

In 2011 and 2012, cover and species richness data were collected pre- and post-treatment using a 0.5 x 1 m quadrat in each subplot. Pre-treatment data were collected in January; post-treatment data were collected in May. Quadrat placement in subplots was random (i.e., random numbers table). Cover measurements were taken at 36 points within the quadrat at the intersection of a wire grid. Species richness data were collected within the entire quadrat. In addition, species richness data were collected within entire subplots in May 2012. Figure 3-2 depicts the subplot sampling area.

Figure 3-2. Subplot Dimensions and Sampling Area.



RESULTS

The analysis of a split plot experiment is more complicated than for a completely randomized experiment due to both whole plot and subplot effects. All analyses for this study were conducted by Dr. Douglas Deutschman at San Diego State University (SDSU), Institute of Ecological Monitoring and Management (IEMM). Data were analyzed by year and over 2 seasons. Findings are presented below.

Species Cover

An Analysis of Variance (ANOVA) table and a graphic representation of treatment effects for 2011 cover data are presented in Table 3-1 and Figure 3-3, respectively. The same information for 2012 cover data are presented in Tables 3-2 and Figure 3-4, respectively. Tables and figures were prepared by Dr. Deutschman, SDSU, IEMM. The ANOVA analyses indicate that only the subplot (treatment) effects were significant in controlling *Brachypodium*, although these analyses do not indicate which treatments were

Table 3-1. ANOVA , *Brachypodium* Cover Data (2011).[1]

Between Subjects

Source	SS	df	MS	F-Ratio	p-Value
BLOCK$	896.926	2	448.463	1.565	0.284
Error	1,719.44	6	286.574		

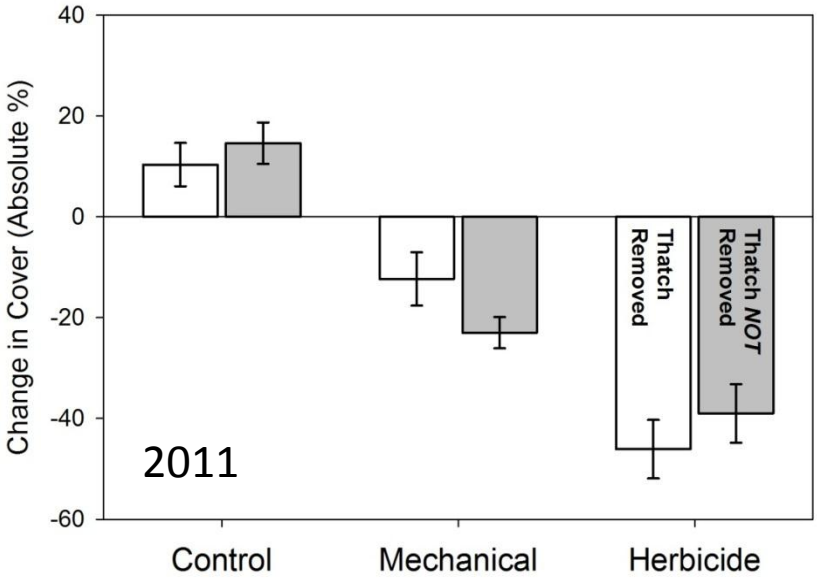
Within Subjects

Source	SS	df	MS	F-Ratio	p-Value
Thatch or NTR	0.667	1	0.667	0.004	0.952
Thatch or NTR*BLOCK$	49	2	24.5	0.144	0.869
Error	1,024.33	6	170.722		

Source	SS	df	MS	F-Ratio	p-Value
Treat (C,H,M)	27,306.82	2	13,653.41	50.879	<.001
Treat (C,H,M)*BLOCK$	877.296	4	219.324	0.817	0.538
Error	3,220.22	12	268.352		

Source	SS	df	MS	F-Ratio	p-Value
Thatch or NTR*Treat	819.111	2	409.556	2.604	0.115
Thatch or NTR*Treat	414.556	4	103.639	0.659	0.632
Error	1,887.33	12	157.278		

Figure 3-3. Treatment Effectiveness in *Brachypodium* Experimental Plots (2011).[1]



[1] Table and graph prepared by Dr. Douglas Deutschman, SDSU, IEMM.

Table 3-2. ANOVA , 2012 *Brachypodium* Cover Data.[1]

Between Subjects

Source	SS	df	an Squares	F-ratio	p-value
BLOCK$	2,295.82	2	1,147.91	4.671	0.06
Error	1,474.44	6	245.741		

Within Subjects

Source	SS	df	an Squares	F-ratio	p-value
Thatch	13.5	1	13.5	0.052	0.828
Thatch*Block	477.444	2	238.722	0.914	0.45
Error	1,567.56	6	261.259		

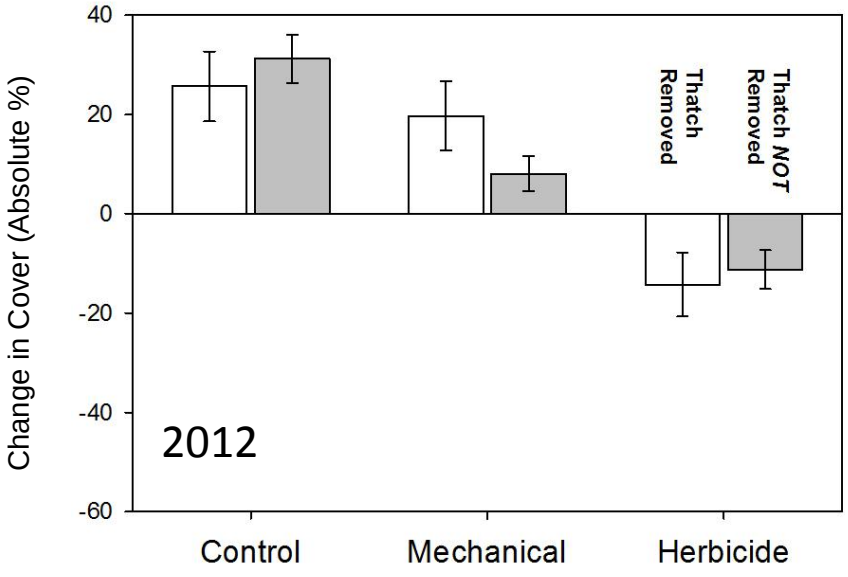
Within Subjects

Source	SS	df	an Squares	F-ratio	p-value
Treatment	15,688.26	2	7,844.13	30.395	<.001
Treatment* Block	863.185	4	215.796	0.836	0.528
Error	3,096.89	12	258.074		

Within Subjects

Source	SS	df	an Squares	F-ratio	p-value
Thatch*Treatment	766.778	2	383.389	1.388	0.287
Thatch*Treatment*Block	651.778	4	162.944	0.59	0.676
Error	3,314.44	12	276.204		

Figure 3-4. Treatment Effectiveness in *Brachypodium* Experimental Plots (2012).[1]



[1] Table and graph prepared by Dr. Douglas Deutschman, SDSU, IEMM.

significant. Therefore, a paired t-test was used to test for significance among treatments. In 2012, significant differences in *Brachypodium* control were detected between the herbicide treatment and the control, and between the herbicide and mechanical treatments. Differences between the mechanical treatment and the control appeared to be slightly significant, and there is weak evidence to suggest that the mechanical treatment is more effective in the absence of thatch removal. The same types of effects were observed in 2011, although all effects were amplified. This may be due, in part, to seasonal differences in temperature and precipitation, but also because an additional treatment was applied in 2011. The paired t-test detected highly significant differences between the herbicide treatment and the control, a significant (but smaller) difference between the mechanical treatment and control, and a significant difference between herbicide and mechanical controls. Overall, the herbicide treatment was the most effective by far in controlling *Brachypodium*. The mechanical treatment was more effective than the control and appeared to be most effective when thatch was left in place. Both treatments appear to have been more effective when applied more than once during a growing season, although these results may have been influence by climatic conditions, as well.

The ANOVA analysis indicated that the whole plot factor, thatch removal, was not significant. Further, there was no interaction between thatch removal and treatment. As noted above, a weak (but not quite significant) interaction may exist between thatch and the mechanical treatment (i.e., the effectiveness of the mechanical treatment may be increased where thatch is left in place, or not removed).

Species Richness

Because of the small number of species detected in quadrats, the analysis of species richness focused only on the 2012 post-treatment data in subplots, rather than in quadrats. The ANOVA table for species richness is presented in Table 3-3. This analysis looked at *all* species within the subplots, including *Brachypodium*. Results indicate that the treatment was a significant factor in overall species richness; however, this analysis does not indicate which treatments were significant. Therefore, a paired t-test was used to test for differences among treatments; this test indicated that in thatch removal plots, there was a significant increase in species richness with the herbicide treatment, as compared to both the mechanical and control treatments, and there was no significant difference between the mechanical and control treatments. Where thatch was left in place, the herbicide treatment resulted in significantly more species than the control. Evidence for significant differences between the mechanical treatment and other treatments was unclear, possibly due to the small number of species present and/or small sample size.

Table 3-3. ANOVA, Species Richness (2012).[1,2,3]

Within Subjects					
Source	SS	df	Mean Squares	F-ratio	p-value
THATCH_REMOVAL	3.63	1	3.63	0.862	0.38
Error	33.704	8	4.213		
Within Subjects					
Source	SS	df	Mean Squares	F-ratio	p-value
BRDI_CONTROL	40.704	2	20.352	9.78	0.002
Error	33.296	16	2.081		
Within Subjects					
Source	SS	df	Mean Squares	F-ratio	p-value
THATCH_REMOVAL*BRDI_CONTROL	4.926	2	2.463	1.242	0.315
Error	31.741	16	1.984		

1 Analysis conducted by Dr. Douglas Deutschman, San Diego State University, Institute for Ecological Monitoring and Management.
2 Includes all species (including *Brachypodium*).
3 The treatment effect is significant (see arrow).

From paired t-tests:

Thatch	Control	Mechanical	Herbicide
Removed	a	a	b
Not Removed	a	ab	b

A second analysis was conducted that examined exotic forb species richness in the subplots. The ANOVA table for exotic forb species richness is presented in Table 3-4. Again, significant differences were observed between treatments, and paired t-tests were run to detect which treatments were significant. In thatch removal plots, the herbicide treatment had significantly more exotic forbs than the other two treatments; there were no significant differences between the herbicide and control plots with respect to exotic forb richness. Where thatch was left in place, the herbicide treatment had significantly more exotic forbs than the other two treatments. The mechanical treatment also showed a smaller, but significant increase in exotic forbs compared to the control.

A final analysis examined species richness for all species except exotic forbs in the subplots. The ANOVA table indicates that there may be an interaction between thatch removal and species richness in the control plot; however, this may or may not be significant (Table 3-5).

Table 3-4. ANOVA, Exotic Forb Richness (2012).[1,2,3]

Within Subjects					
Source	SS	df	Mean Squares	F-ratio	p-value
THATCH_REMOVAL	0.019	1	0.019	0.033	0.86
Error	4.481	8	0.56		
Within Subjects					
Source	SS	df	Mean Squares	F-ratio	p-value
BRDI_CONTROL	34.259	2	17.13	30.204	<.001
Error	9.074	16	0.567		
Within Subjects					
Source	SS	df	Mean Squares	F-ratio	p-value
THATCH_REMOVAL*BRDI_CONTROL	2.259	2	1.13	2.335	0.129
Error	7.741	16	0.484		

1 Analysis conducted by Dr. Douglas Deutschman, San Diego State University, Institute for Ecological Monitoring and Management.

2 Includes only exotic forbs.

3 The treatment effect is significant (see arrow).

From paired t-tests:

Thatch	Control	Mechanical	Herbicide
Removed	a	a	b
Not Removed	a	b	c

Table 3-5. ANOVA, Species Richness, Excluding Exotic Forbs (2012).[1,2,3]

Within Subjects					
Source	SS	df	Mean Squares	F-ratio	p-value
THATCH_REMOVAL	3.13	1	3.13	0.815	0.393
Error	30.704	8	3.838		
Within Subjects					
Source	SS	df	Mean Squares	F-ratio	p-value
BRDI_CONTROL	1.444	2	0.722	0.405	0.674
Error	28.556	16	1.785		
Within Subjects					
Source	SS	df	Mean Squares	F-ratio	p-value
THATCH_REMOVAL*BRDI_CONTROL	13.593	2	6.796	5.701	0.014
Error	19.074	16	1.192		

1 Analysis conducted by Dr. Douglas Deutschman, San Diego State University, Institute for Ecological Monitoring and Management

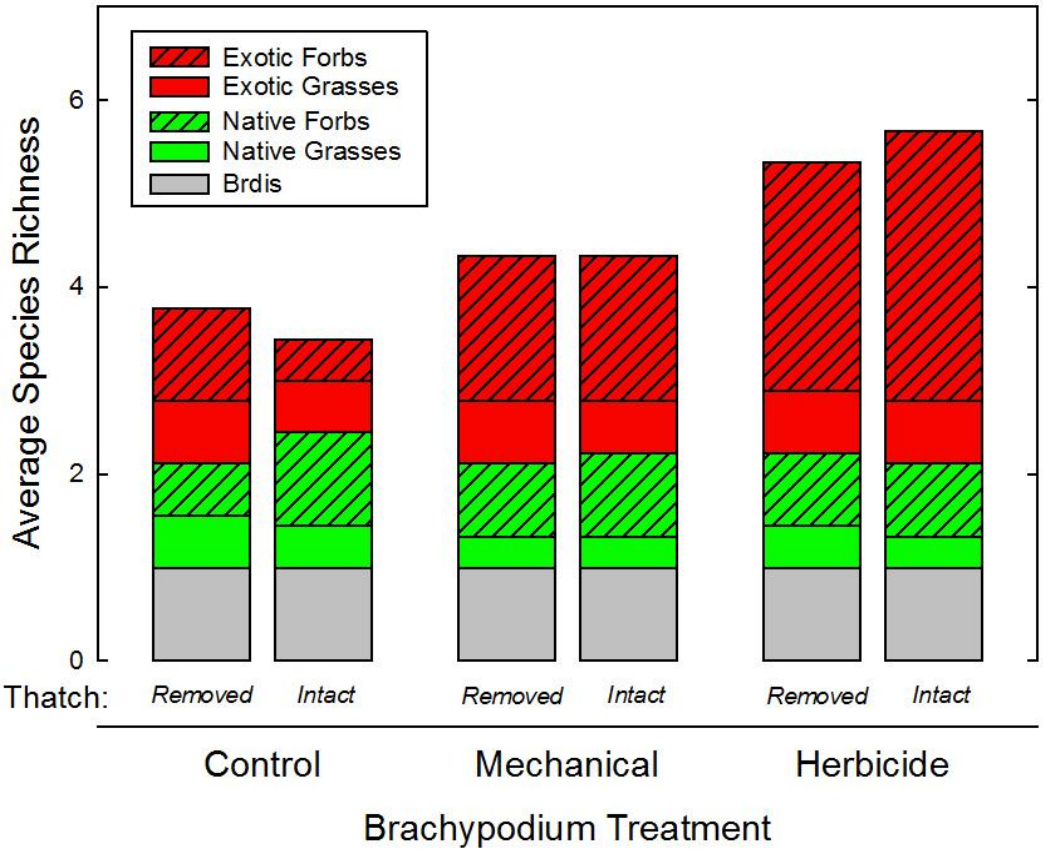
2 Includes all species except exotic forbs.

3 The interaction effect between thatch removal and the control may or may not be significant.

of: THATCH_REMOVAL*BRDI_CONTROL					
Statistic	Value	Hypothesis df	Error df	F-ratio	p-value
Wilks's Lambda	0.493	2	7	3.605	0.084

Figure 3-5 presents a summary of the species richness data. Clearly, exotic forbs are the largest contributors to species richness at the subplot level.

Figure 3-5. Species Richness in *Brachypodium* Treatment Subplots (2012).[1]



1 Figure prepared by Dr. Douglas Deustchman and Dr. Patrick McIntyre, San Diego State University, Institute for Ecological Monitoring and Management.

SUMMARY

Based on results to date, the following conclusions can be made:

1. The grass-specific herbicide, Fusilade II is more effective than mechanical or control treatments in reducing *Brachypodium* cover.
2. Thatch removal does not appear to increase the effectiveness of herbicide or mechanical treatments.
3. The effectiveness of mechanical removal may be enhanced slightly where thatch is left in place.
4. The effects of both herbicide and mechanical treatments on *Brachypodium* cover may be amplified when treatments are applied more than once during the growing season.
5. The herbicide treatment results in significantly more species richness than the other treatments, and this increase in species richness is driven by exotic forbs. The mechanical treatment showed

a significant increase in exotic forb richness only where thatch was left in place, although this effect was smaller than observed with the herbicide treatment.

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TASK 4. EARLY DETECTION PLAN

INTRODUCTION

Detailed baseline maps of invasive species occurrences have been prepared for CER and South Crest (Task 1) and invasive species control efforts have been initiated on these sites (Task 3). However, both properties are subject to continual infestations due to their proximity to development and accessibility to recreational users. The Early Detection Plan (EDP) establishes a system of surveillance (early detection), assessment, and action (rapid response) to (1) prevent the introduction and spread of new invasive plant species on CER and South Crest, (2) prevent the spread of existing invasive plant species into new locations on these sites, and (3) respond quickly to identified invasive species threats. Early detection and rapid response is widely acknowledged as the most effective strategy for invasive species management in terms of cost, feasibility, and long-term resource protection (Wittenberg and Cock 2001; FICMNEW 2003; NISC 2003; Simberloff 2003; Westbrooks 2004; Schoenig 2005; Lodge et al. 2006; and many others).

The EDP includes the following components:

- a target list of species for surveillance;
- the surveillance team (including training and education);
- a map of suitable surveillance locations;
- a species-specific schedule for surveillance activities;
- reporting procedures; and
- a plan for rapid response

Each component is described below.

SURVEILLANCE LIST

A target list of invasive plant surveillance species was developed from several sources, including onsite surveys and the California Invasive Plant Council (Cal-IPC) online mapping tool, CalWeedMapper (http://calweedmapper.calflora.org/about/). Selection of species focused on:

- Species that currently occur on CER or South Crest as small and/or highly restricted infestations.
- Species that have been reported in proximity to the sites and which have a reasonable potential for occurrence based on geographic or ecological factors.
- Species not reported in proximity to the sites but which could represent a serious threat to conservation targets if present. This includes fast-spreading species with spotty distributions in or adjacent to San Diego County (e.g., *Euphorbia terracina*).

Table 4-1 presents a *preliminary* list of surveillance species. The invasive species most likely to be detected during surveillance surveys are those found onsite presently or previously known from the site (eradicated), and species that occur in proximity to the site. This list is not necessarily comprehensive and should be re-evaluated and updated, as necessary, on a yearly basis.

SURVEILLANCE TEAM

An effective surveillance team includes different types of participants for maximum effect. Professionals (botanists, invasives control personnel) have a high level of expertise in species identification, threat assessment, treatment, and monitoring, but may be limited in the amount of time they can spend on a site. Volunteers typically have a lesser degree of training, but more flexibility in schedule, including the ability to access/survey areas at different times of the year. With adequate training and resources, citizen volunteers can supplement the activities of on-the-ground professionals and provide an effective first line of defense against new infestations. Reserve neighbors play a critical role in invasives control by limiting the introduction and spread of invasives onto reserve lands through appropriate landscaping, as well as appropriate disposal of yard waste material. Outreach and coordination efforts are particularly valuable for this last group of team members. Roles and responsibilities of team member are described below.

- Professionals – professional botanists, invasive control specialists, GIS personnel, and land manager(s) will be responsible for invasive species surveys, invasive species reporting, data management, risk assessment and treatment prioritization, treatment, and effectiveness monitoring. It is anticipated that invasive species surveys will occur annually or semi-annually in areas with a high potential for infestation. Botanists will also provide materials and training for volunteers, verify volunteer findings, prepare voucher specimens, and coordinate with the land manager on volunteer survey efforts. With appropriate training and a dedicated volunteer patrol, the role of professional botanists in invasive plant surveys may decrease over time, at least in some locations.
- Volunteers – EHC has recruited a volunteer citizen patrol, the Reserve Rangers, for participation in various monitoring and management activities on CER and South Crest, including invasive species detection. Continued training and support of a dedicated group of volunteers would greatly increase invasive species detection capabilities.
- Volunteer efforts may follow two tracks: (1) sightings may occur during the course of other volunteer work or as volunteers use the sites recreationally or (2) sightings may occur as part of systematic survey efforts that direct volunteers to specific localities. The focus of these efforts should be to spot new infestations.

Table 4-1. Target Invasive Species for Surveillance.

Scientific Name	Common Name	Cal-IPC Rating[1]	Status Onsite[2]
Aegilops triuncialis	Barb goatgrass	High	Not Detected
Ailanthus altissima	Tree-of-heaven	Moderate	Not Detected
Arundo donax	Giant reed	High	Detected
Asparagus asparagoides	Bridal creeper	Moderate[2]	Not Detected
Asphodelus fistulosus	Onionweed	Moderate[2]	Not Detected
Brassica tournefortii	Sahara mustard	High	Detected
Carpobrotus spp.	Iceplant	High	Detected
Centaurea calcitrapa	Purple starthistle	Moderate	Not Detected
Centaurea solstitialis	Yellow starthistle	High	Not Detected
Conium maculatum	Poison-hemlock	Moderate	Not Detected
Cortaderia selloana	Pampas grass	High	Detected
Cynara cardunculus	Artichoke thistle	Moderate	Not Detected
Cytisus scoparius	Scotch broom	High	Not Detected
Delairea odorata	Cape-ivy	High	Not Detected
Dittrichia graveolens	Stinkwort	Moderate[2]	Detected
Ehrharta calycina	Purple veldtgrass	High	Not Detected
Elymus caput-medusae	Medusahead	High	Not Detected
Emex spinosa	Spiny emex, devil's-thorn	Moderate[2]	Detected, not mapped
Euphorbia terracina	Carnation spurge	Moderate[2]	Not Detected
Gazania linearis	Gazania	---	Detected; not mapped
Genista monspessulana	French broom	High	Not Detected
Glebionis coronaria	Garland chrysanthemum	Moderate	Detected
Heteropogon contortus	Tanglehead	---	Detected
Lepidium chalepense	Hoary cress	Moderate	Not Detected
Lepidium latifolium	Perennial pepperweed	High	Not Detected
Oxalis pes-caprae	Bermuda buttercup	Moderate	Detected
Spartium junceum	Spanish broom	High	Not Detected
Tamarix spp.	Tamarisk	High	Detected
Vinca aff. *major*	Periwinkle	Moderate	Detected

[1] Cal-IPC rating: High = severe ecological impacts on physical processes, plant and animal communities, and vegetation structure, high rates of dispersal and establishment, and generally widely distributed ecologically; Moderate = substantial and apparent – but generally not severe – ecological impacts on physical processes, plant and animal communities, and vegetation structure, moderate dispersal rates, establishment dependent on

disturbance, distribution limited to widespread; Limited = invasive but with minor ecological impacts on a statewide level or impacts unknown, low to moderate rates of invasiveness, generally limited in distribution but may be locally persistent and problematic (Cal-IPC 2006).

[2] Alert status: indicates species with potential for invading new ecosystems (Cal-IPC 2006).

[3] Species that were 'detected but not mapped' were detected during floristic surveys of CER by Jon Rebman of the San Diego Natural History Museum (2003-2005), but not observed during 2011-2012 surveys.

Reserve Rangers involved in the EDP will require training and education on invasive species identification and reporting. A yearly training session should be provided by botanists and/or the land manager that focuses on the need for invasive species management, survey protocol, species identification, and reporting procedures. Each volunteer should be provided with an invasive species detection package that includes:

- Maps of invasive species occurrences
- Target list of surveillance species
- Invasive species fact sheets
- Reporting form (including instructions for use)
- Invasive species survey protocol
- A list of resources (including websites) for photographs or additional information on invasive species

Invasive species fact sheets and a volunteer reporting form are included in Appendix J. The package currently contains fact sheets for 21 species, including a number of species that are onsite but are too common to be included on the target list. It is anticipated that additional invasive species fact sheets may be prepared and added to this package over time.

Additional products that may be useful to volunteers and the general public (but which are not yet available) are a site-specific poster of common invasive species and a site-specific website for reporting invasive species occurrences.

- Neighbors– Outreach & Coordination

Outreach and coordination to neighbors and recreational users of CER and South Crest will be critical in limiting the spread of invasives onto the reserve. The focus of these efforts is on managing properties appropriately to discourage the establishment or spread of invasive species. Outreach materials may include invasive species fact sheets or brochures, a list of problematic landscape species (and acceptable substitutes), and articles in the EDI newsletter that highlight selected invasive species and their effects. In addition to educating neighbors, the professional team may also serve as a resource for technical knowledge and assistance on weed prevention, eradication, and control techniques.

SURVEILLANCE LOCATIONS

Results of the invasive species mapping indicate that the primary areas of concern for invasive species surveillance are in and around important conservation targets (e.g., Thornmint Hill on CER, Skeleton Flats on South Crest), and along natural conduits for dispersal, such as roads or trails, drainages, and disturbed areas. On CER, the other area of concern is around the Horsemill Road entrance, which is the main entry point into CER for recreational visitors and students. The focus of surveillance in these areas will be to identify new infestations when they are small and presumably, manageable. Figures 4-1 and 4-2 depict high priority surveillance areas for CER and South Crest, respectively. In general, the professional team will focus on conservation targets and drainages, while volunteer efforts will focus on roads, trails, disturbed areas, and the Horsemill Road entrance area.

SURVEILLANCE SCHEDULE

An effective EDP requires regular and systematic surveys to detect new infestations of invasive species at the earliest stage. High priority areas, as described above, should be surveyed annually for new invasive species and satellite populations of existing invasive species. Ideally, surveys should be conducted at the optimal time for detection and/or treatment. For some species, detection at an early stage (e.g., rosettes, seedlings) provides the best opportunity for control but is contingent upon familiarity with the species of concern. Where resources (personnel) are available, multiple surveys of priority locations will allow for detection of early *and* late season invasive species.

Table 4-2 presents a schedule of optimal survey periods for target species, based on flowering (all species) and vegetative growth (species that are easily identifiable throughout the year, such as large perennials). The professional team may be able to identify species outside of these time windows. It should be noted that the survey schedule is based on generalized flowering periods throughout the species' range in California (Baldwin et al. 2012), and may vary on the subject properties depending on climatic conditions and location.

REPORTING PROCEDURES

CBI biologists have developed a standardized data form for recording invasive species occurrences (Appendix K), and this form will continue to be used by the professional team. The form incorporates all elements on the Calflora weed observation (http://www.calflora.org/entry/wentry.html) and plant observation entry forms (http://www.calflora.org/entry/occentry.html). All invasive plant data collected on CER and South Crest is submitted to Calflora. These data are also incorporated into Cal-IPC's CalWeedMapper database, which is an online tool for mapping invasive plant distribution at the landscape level.

For the professional team, the invasive species database should be updated yearly. This includes collection and organization of data forms, updating the spatial dataset and the invasive species maps, and submitting new data to Calflora and/or Cal-IPC.

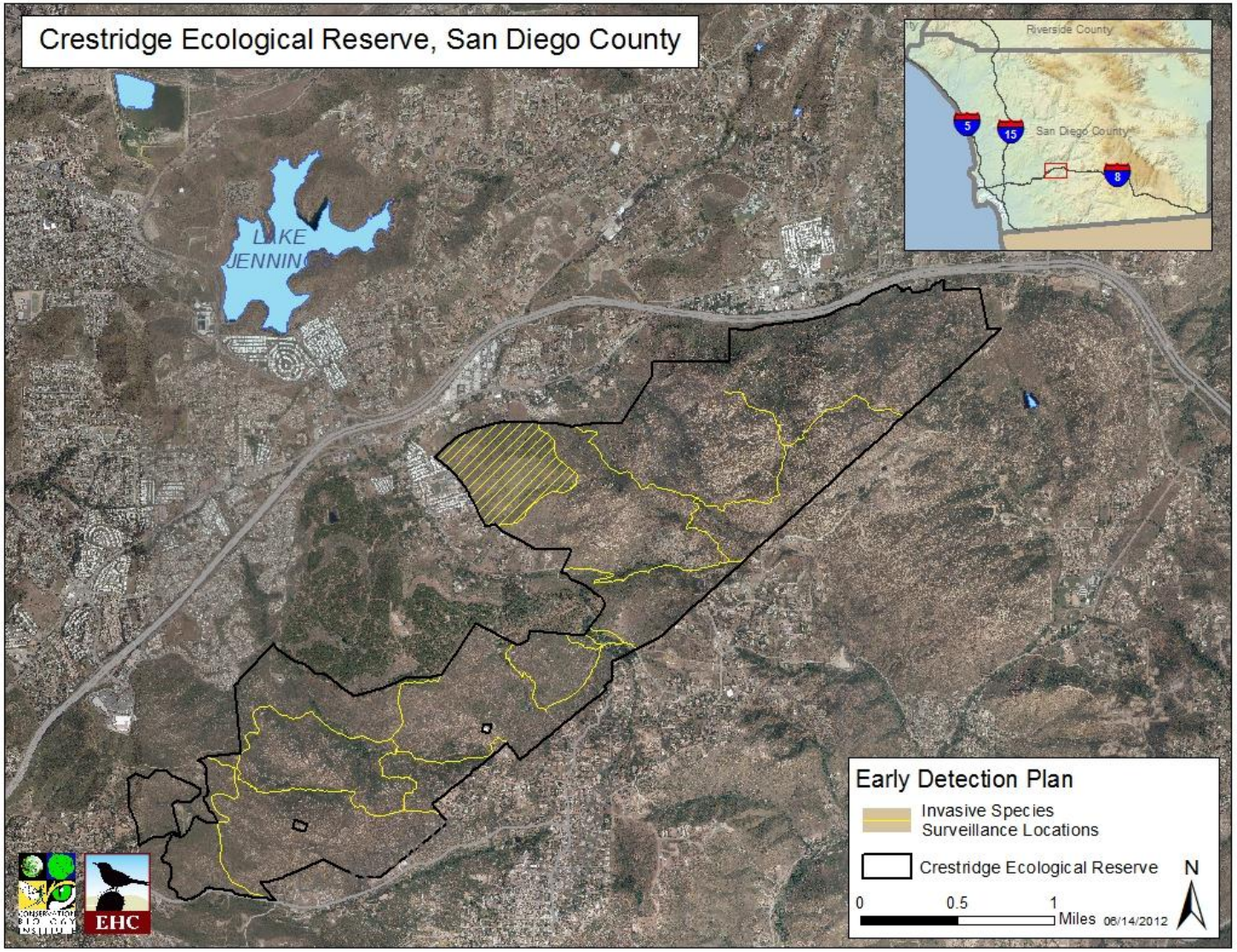

Figure 4-1. High Priority Surveillance Areas for Invasive Plant Species, Crestridge Ecological Reserve.

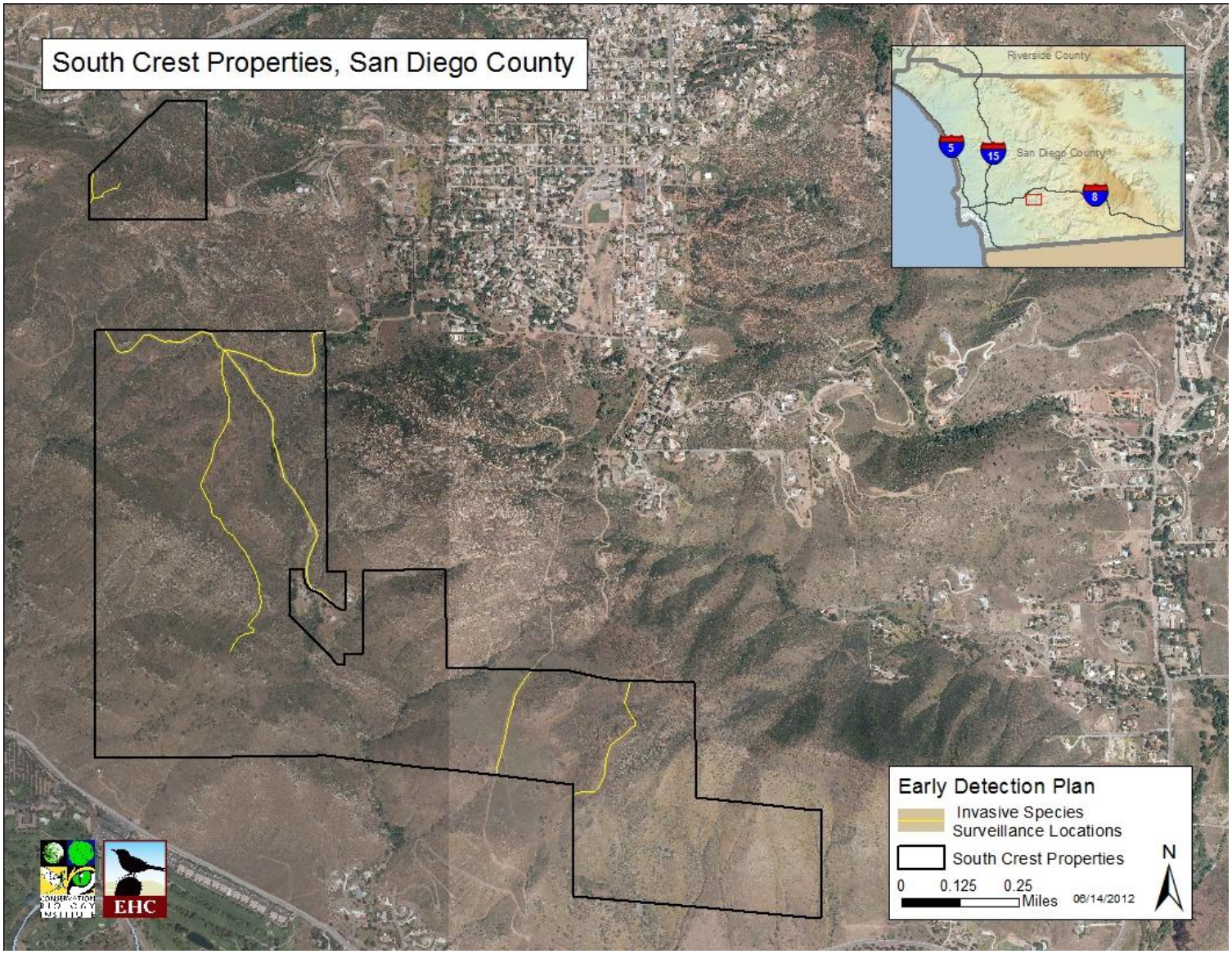

Figure 4-2. High Priority Surveillance Areas for Invasive Plant Species, South Crest Properties.

Table 4-2. Surveillance Schedule for Target Invasive Plant Species.[1,2,3]

Scientific Name	Common Name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Aegilops triuncialis	Barb goatgrass												
Ailanthus altissima	Tree-of-heaven												
Arundo donax	**Giant reed**												
Asparagus asparagoides	Bridal creeper												
Asphodelus fistulosus	Onionweed												
Brassica tournefortii	**Sahara mustard**												
Carpobrotus spp.	**Iceplant**												
Centaurea calcitrapa	Purple starthistle												
Centaurea solstitialis	Yellow starthistle												
Conium maculatum	Poison-hemlock												
Cortaderia selloana	**Pampas grass**												
Cynara cardunculus	**Artichoke thistle**												
Cytisus scoparius	Scotch broom												
Delairea odorata	Cape-ivy												
Dittrichia graveolens	**Stinkwort**												
Ehrharta calycina	Purple veldtgrass												
Elymus caput-medusae[4]	Medusa head												
Emex spinosa	**Spiny emex, devil's-thorn**												
Euphorbia terracina	Carnation spurge												
Gazania linearis	**Gazania**												
Genista monspessulana	French broom												
Glebionis coronaria[5]	**Garland chrysanthemum**												
Heteropogon contortus	**Tanglehead**												
Lepidium chalepense	Hoary cress												
Lepidium latifolium	Perennial pepperweed												
Oxalis pes-caprae	**Bermuda buttercup**												
Spartium junceum	Spanish broom												

Table 4-2. Surveillance Schedule for Target Invasive Plant Species.[1,2,3]

Scientific Name	Common Name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Tamarix spp.	**Tamarisk**												
Vinca* aff. *major	**Periwinkle**												

[1] Source for flowering periods: Baldwin et al. 2012.

[2] = Flowering; = Vegetative Growth.

[3] Species in bold have been detected on or near CER and/or South Crest and currently have the highest surveillance priority.

[4] *Elymus caput-medusae* was formerly *Taeinatherum caput-medusae* (Baldwin et al. 2012).

[5] *Glebionis coronaria* was formerly *Chrysanthemum coronarium* (Baldwin et al. 2012).

An additional invasive species data form has been prepared for the volunteer patrol (Appendix J). This form includes some of the information on the professional form, but is intended for use by personnel that might not have the level of training or equipment needed to fill out the professional form. Information on this form will be sufficient to map the population (point locality) or at a minimum, direct the professional team to the location to collect additional information. Volunteer data forms should be submitted to the land manager directly or online through the Earth Discovery Institute (EDI) website for CER. The land manager will forward invasive forms to the professional team for cataloguing and action. The reporting pathway is presented in Figure 4-3.

RESPONSE PLAN

The objective of the EDRRP is to detect *and treat* new invasions before they are able to spread and establish on the reserve. However, this does not necessarily mean that all new invasions will be prioritized for immediate treatment. This plan sets forth a protocol for the responding to new invasive species occurrences (Table 4-3). In general, small populations of high priority species or species new to the reserve will be prioritized for immediate treatment. Treatment priorities for other species will depend upon extent, invasiveness, and threats to conservation targets (using ranking criteria in Task 1, Table 1-5), as well as funding and feasibility of management.

Figure 4-3. Reporting Pathway for Invasive Plants.

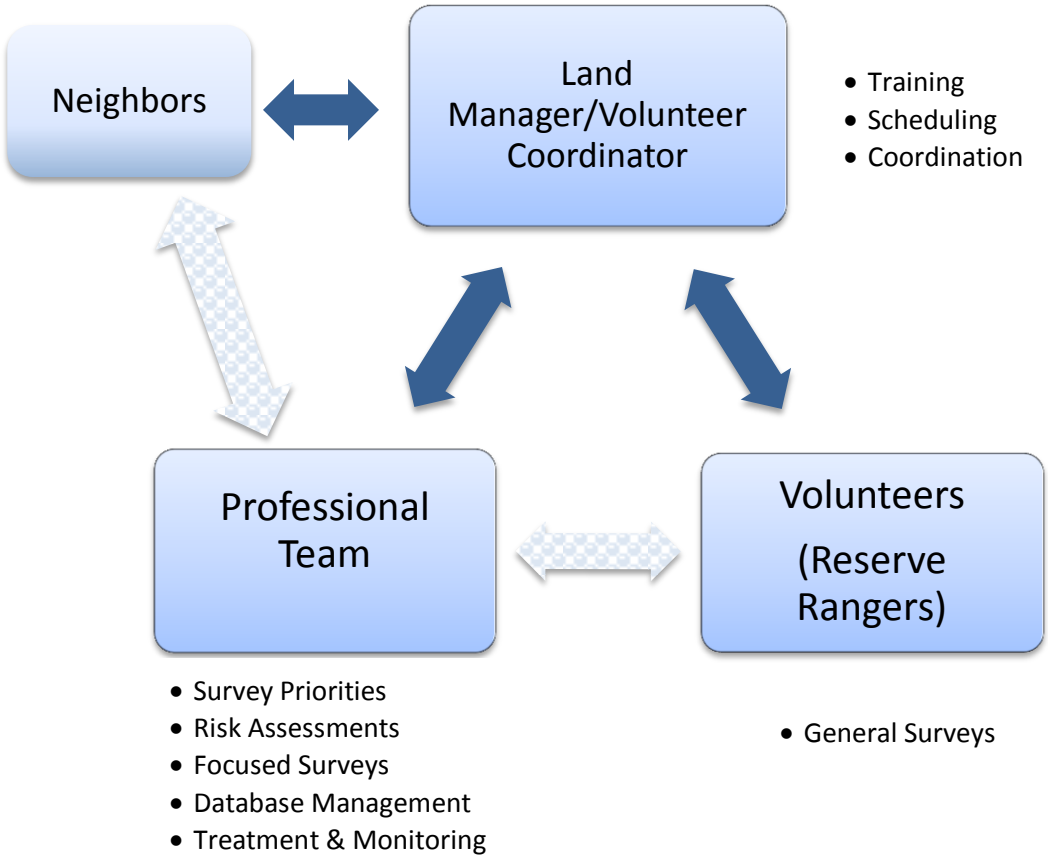

Table 4-3. Decision Tree for Rapid Response.

1. Species previously documented onsite

    2. New infestations or satellite infestations of high priority species

        3. Eradicate

    2.' New infestations of moderate or low priority species, or large populations of high priority species

        4. Refer to Tables 1-8 and 1-9 (Task 1) for appropriate treatment strategies and schedules

1.' Species not previously documented onsite

    5. Verify identification

    6. Map population size and extent, if collected data are not adequate

    7. Prioritize according to ranking criteria in Task 1

        8. Small populations of high priority species

            9. Eradicate

        8.' Larger populations of high priority species, or low or moderate priority species

            10. Determine appropriate treatment strategies and schedules; consult with professional team and/or state or regional invasive control experts, if necessary

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