# APPENDICES

APPENDIX A CONCEPTUAL MODEL DOCUMENTATION

APPENDIX B HABITAT ASSESSMENTS

APPENDIX C RESTORATION PLANS

APPENDIX D PHOTODOCUMENTATION (DETHATCHING)

APPENDIX E HERBICIDE LOGS

APPENDIX F SEED INFORMATION

APPENDIX G MONITORING DATA AND ANALYSIS

APPENDIX H BEST MANAGEMENT PRACTICES

# APPENDIX A

# CONCEPTUAL MODEL DOCUMENTATION

Appendix A.1 Life History Model Components

Appendix A.2 Ecological and Management Model Components

Table A-1

Life History Model Elements

| | | |
|---|---|---|
| **Current Status** | | |
| Taxonomy | A new species was recently recognized, *B. hybridum*, which may include California plants. | Catalan et al. 2012. |
| History of Invasion | Introduced in multiple regions in California from different source populations; no hybridization noted to date. First introduction was in 1929 in northern California; has experienced continued, steady spread. First report in San Diego County was 1950 (Carlsbad); reported as uncommon in the County in 1986. | Beauchamp 1986, Bakker et al. 2009, CCH 2014. |
| **General Characteristics** | | |
| Habit | Erect, loosely tufted annual grass to 0.15-.5 m high at maturity. | Draper et al. 2001, Benson and McDougall 2005, Opanowicz et al. 2008, Vogel and Bragg 2009, Brown and Bettink 2010, Baldwin et al. 2010. |
| Life Cycle | Short life cycle, with a minimum of 6 weeks from seed to seed and the potential for > 1 cohort/season. | Garvin et al. 2008, Mur et al. 2011. |
| **Germination and Growth** | | |
| Germination Pattern | Little seed dormancy, high seed viability, observed germinating through its own dense litter. Reports of asynchronous germination. | Mockler and Michael unpublished data *in* Bakker et al. 2009, Gordon-Reedy personal observation. |
| Germination Rate | High germination rates in the wild and under controlled conditions. Published reports indicate emergence of radicle takes ca. 2-5 days; however, some seed from the Crestridge Ecological Reserve in San Diego County showed radicle emergence in 1 day. | Garvin et al. 2008, Vogel et al. 2009, Hong et al. 2011; Gordon-Reedy personal observation. |
| Growth Rate | Rapid growth (often > 1 cohort/season). | Opanowicz et al. 2008. |
| Root System | Fibrous root system; primary axile root can reach 12.85 m, but is primarily within 42 cm of soil surface. Roots descend initially at 0.86 cm per day until 4-5 leaf stage, then at double | Watt et al. 2009. |

Table A-1

Life History Model Elements

| | | |
|---|---|---|
| | that rate (2.45 cm per day) to 6-7 leaf and flowering stage. During grain fill, descent slows to 0.15 cm per day. Compared to other grasses (e.g., *Avena sativa*), young root systems are simpler with fewer numbers and types of axile roots; mature systems are dominated by branch roots. | |
| Growth Requirements | Simple (minimal) growth requirements; grows well in different soils types in a nursery setting, but develops disease symptoms if overwatered or left in standing water; forms robust mycorrhizal interactions. | Opanowicz et al. 2008, Vogel and Bragg 2009, Brkljacic et al. 2011. |
| **Seed Biology** | | |
| Seed Production | High seed production, with 100-1,000 seeds/plant under controlled conditions and an estimated 36,000 seeds per $m^2$ under optimal field conditions. Lack of seed head shatter. | Draper et al. 2001, Brkljacic et al. 2011. Gordon-Reedy personal observation. |
| Seed Viability | High seed viability; seed from Crestridge Ecological Reserve had >90% viability in freshly collected and stored seed. | Gordon-Reedy personal observation. |
| Seed Longevity | Conflicting reports; seedbank persistence has been reported as < 1 year, but a study in Israel found that while the majority of germination (85-90%) from the seedbank occurred in the first year after shedding, small germination rates were observed in the second and third consecutive growing seasons, particularly under semi-arid conditions. Under controlled conditions, seed showed minimal reduction in viability over 15 years and 95-100% germination in a variety of conditions. Seed collected on Crestridge Ecological Reserve in San Diego County had high germination rates (ca. 90%) after 4 years and after overwintering in field for1 year, respectively. | Royal Botanic Gardens Kew 2010, Brown and Bettink 2010, Harel et al. no date, Gordon-Reedy personal observation. |
| Seed Bank | Study in France showed majority of seed was on surface, and very little of the seed rain (<1%) ended up in deep seed bank. Study in Iran indicated majority of seed (84%) was in upper layer (0-5 cm) of soil seed bank rather than deeper layer (5-10 cm). | Jalili et al. 2003, Buisson et al. 2006. |

Table A-2

Conceptual Ecological and Management Model Elements

| | | |
|---|---|---|
| **Goals:** | | |
| Management | Reduce or eliminate *Brachypodium* where it forms dense stands on conserved lands and threatens sensitive species and habitats, and restore habitat to prevent future invasions by this species. | |
| Monitoring | Monitor control and restoration effects, and *Brachypodium* and native species responses. | |
| **Anthropogenic Drivers (Change Agents or Stressors):** | | |
| Direct Impacts & Disturbance | Direct impacts and disturbance (e.g., agriculture, development, off-highway vehicles) that create bare soil or 'gaps' appear to be important for colonization. | CBI 2012a. |
| Fire Response | Killed by fire, but may recolonize relatively quickly from adjacent sites. Increased in cover following summer and late fall prescribed burns in northern California, although increase was not considered a direct result of the burns. Summer and fall fires may have little direct effect on reducing populations. | Sawyer et al. 2009, Brown and Bettink 2010, Bartolome et al. 2013, Gordon-Reedy personal observation. |
| **Natural Drivers:** | | |
| Vegetation Community | Grassland, coastal sage scrub, margins of chaparral and woodlands; dense stands alter vegetation community composition and form unique vegetation association. May attain strong dominance in years of high precipitation. | DiTomaso and Healy 2007; Sawyer et al. 2009, Sproul et al. 2011, Gordon-Reedy personal observation. |
| Abiotic Niche | Abiotic factors appear to influence distribution and density, with highest density stands in San Diego County occurring on clay soils, mid- to lower slopes, and below 900 m elevation. | Sproul et al. 2011. |
| Climate (Precipitation and Temperature) | Likely influence by the quantity and timing of rainfall and temperature trends. | Cal-IPC 2012, Gordon-Reedy personal observation. |
| Pollinators and Dispersers | Self-compatible grass; dense stands likely impact native plant pollinators by displacing host plants; primarily gravity-dispersed, but can be spread to greater distances by animals and wind. In some areas, vertebrate-dispersal may be the primary mode of spread, including deer. Also spread by vehicle tires, on clothing, and by human activities | Draper et al. 2001, DiTomaso and Healy 2007, Bakker et al. 2009, Brown and Bettink 2010, Crossman et al. 2011, CBI 2011. |

Table A-2

Conceptual Ecological and Management Model Elements

| | | |
|---|---|---|
| | (including hiking and mountain biking. | |
| Herbivory | No reports of herbivory. | |
| ***Brachypodium distachyon* Variables (Measurable Aspects of Species Response):** | | |
| Population Structure | Species forms dense, nearly monotypic stands that reduce native species biodiversity. Includes density, cover, and seed bank viability. | Brown and Bettink 2010, Gordon-Reedy personal observation. |
| Biomass | Species forms a persistent thatch layer that may alter soil ecology, suppress germination of other species, and eliminate habitat for wildlife and native plant pollinators. Includes cover and depth of thatch layer. | DiTomaso and Healy 2007, Wolkovich et al. 2009, Gordon-Reedy personal observation. |
| Reproduction | Seed production, inputs to seed bank, seed germination rates. | Draper et al. 2001, Garvin et al. 2008, Vogel et al. 2009, Hong et al. 2011, Brkljacic et al. 2011, Gordon-Reedy personal observation. |
| **Critical Uncertainties (Process):** | | |
| Grassland Conceptual Model (Natural Process) | No *Brachypodium*-specific literature. Includes effects of the grass-fire cycle (e.g., habitat alteration/type conversion, altered fire regimes, altered soil chemistry). | D'Antonio and Vitousek 1992, Brooks et al. 2004, Reiner 2007, and others. |
| Climate Change (Anthropogenic Process) | Climate change modeling indicates that while suitable *Brachypodium* habitat in southern California will decline by 2050 (Climate Change Scenario A2), suitable habitat will persist throughout much of cismontane San Diego County and the species will expand its distribution into mountainous areas of the county where it currently does not occur. | Cal-IPC 2012. |
| Altered Fire Regime (Anthropogenic Process) | Anecdotal evidence that frequent, large fires contribute to establishment and spread; forms dense, monotypic or near-monotypic stands that build up thick litter layers that may contribute fine fuel for fires (e.g., grass-fire cycle). | D'Antonio and Vitousek 1992, DiTomaso personal observation 2007, Gordon-Reedy |

Table A-2

Conceptual Ecological and Management Model Elements

| | | |
|---|---|---|
| | | personal observation. |
| Nitrogen Deposition (Anthropogenic Process) | No *Brachypodium distachyon*-specific literature. N deposition favors nonnative grass invasion. | Weiss 1999, Brooks 2003, Fenn et al. 2010. |
| Nutrient Cycling (Anthropogenic Process) | Thick thatch layer may alter nutrient loads, organic material, and soil chemistry; forms robust mycorrhizal interactions. | Vogel and Bragg 2009. |
| **Other** | | |
| Competition | Produces dense thatch that suppresses germination of many species and lowers biodiversity; likely germinates earlier and/or quicker than other species; dense stands may alter soil properties and soil microbial communities; alters vegetation community composition; may displace host plants for pollinators; litter may increase fungal resources, leading to a decline in detritus-based arthropod taxa. | DiTomaso and Healy 2007, Wolkovich et al. 2009, Gordon-Reedy personal observation. |

# APPENDIX B

# HABITAT ASSESSMENTS

Appendix B.1 Habitat Assessment Form

Appendix B.2 Habitat Assessment Data

# Appendix B.1

## Habitat Assessment Form

A standardized form was used for habitat assessment data collection for the *Brachypodium* Removal project on the Crestridge Ecological Reserve (CER) and South Crest properties in San Diego County, California. One data form was filled out for each mapped polygon. A description of each field on the habitat assessment form is provided below.

Unique ID

Assign a unique, three-part identification (ID) number (XX-X-XX) to each grassland polygon, as follows:

- the first 2 digits refer to the survey year (13 for 2013);
- the second digit classifies the polygon as to site (CER=1, South Crest=2;
- the third 2 digits represent the unique location number.

For example 12-1-01 is polygon number 1, documented on CER in 20112. Unique ID numbers were assigned in the office after completion of the assessment, and were recorded in the upper right-hand corner of each field form.

Investigators(s)

Record the name(s) of individuals conducting the habitat assessment.

Date

Record the date of the habitat assessment.

Planning Area/Site Name

Record the planning area/site name. Each study site has a unique site code and number; the site code is recorded on the habitat assessment form; the site number is indicated in the Excel database. Site names, codes, and numbers are indicated below for each site:

| **Site Name** | **Site Code** | **Site Number** |
|---|---|---|
| Crestridge Ecological Reserve | CER | 1 |
| South Crest | SC | 2 |

Photo Number

Document each polygon with one or more photographs. Record the photo number on the habitat assessment form and in the jpeg (or other) photo file name. Number photos consecutively or using the investigators' photo numbering system (e.g., roll number, frame number).

Photo Reference

Record the location and view direction from compass bearings for each photograph (e.g., southwest corner, view to northeast; northwest to southeast).

Polygon Numeric ID

Assign a unique number to each polygon in the field. Numbering for each site should start at 01 and run consecutively (*note*: occasionally, polygons will be aggregated or dropped, which may result in gaps in numbering).

Site Preparation (Prep) Access

Indicate the type of vehicle that would be needed and/or appropriate to access the site for restoration purposes. Choices include:

| Type of Access | Description |
|---|---|
| 2-WD vehicle | Site generally accessible by any vehicle; well-maintained roads adjacent or in proximity to site. |
| 4-WD vehicle | Site accessible by 4-WD vehicle; roads may be present but in poor condition and/or steep. |
| Tractor | Site accessible by vehicle but would likely require large-scale disking or plowing as part of overall restoration effort. |
| ATV | Site generally accessible only by all-terrain vehicle; not in proximity to roads. |
| None | Site accessible by foot only. |

Slope Aspect

Indicate the predominant aspects(s) of the slope on which the polygon is located, i.e., north, northeast, northwest, south, southeast, southwest, west, or east. A polygon may include more than one aspect. Aspect can be estimated or recorded in degrees, as measured with a compass.

Soil Texture

Record the soil texture of the upper soil horizon. Record soil series, if known.

Existing Vegetation Classification

Assign vegetation categories to polygons based on visual assessments and vegetative cover estimates. In general, field-assessed categories will follow the more generalized Holland vegetation codes (Holland 1986; Oberbauer et al. 2008), while office-assessed categories will follow the more detailed San Diego Vegetation Classification (Sproul et al. 2011) and utilize

estimates of species cover. The latter are accurate to the degree that cover estimates are accurate and complete. Vegetation classification is intended to guide restoration efforts and does not replace the need for detailed and focused vegetation mapping using standard methods such as the CNPS Rapid Assessment Protocol (CNPS 2004).

Cover Classes

Record cover class data for five functional groups, based on visual estimates:

- Exotic forbs
- Exotic grasses
- Native forbs
- Native grasses
- Native shrubs

Use the following cover classes (CC) for estimates of cover:

| Cover Class Category | Estimated Percent (%) Cover |
|---|---|
| Trace (TR) | <1% |
| 1 | 1-5% |
| 2 | 5-10% |
| 3 | 10-25% |
| 4 | 25-50% |
| 5 | 50-75% |
| 6 | 75-90% |
| 7 | 90-95% |
| 8 | 95-99% |
| 9 | 99-100% |

Individual species cover class is based on the estimated percent cover of the identified species in the functional group. Record cover class estimates for the most prevalent species; all species present in the functional group may be recorded on the back of the assessment form.

Total cover class is based on the estimated percent cover of all species in the functional group; individual species cover classes do not necessarily add to this total.

Bare Ground/Rock cover is the estimated percent cover (expressed as a cover class) of bare ground and rocks within the polygon.

Thatch cover is the estimated percent cover (expressed as a cover class) of thatch within the polygon.

Thatch Depth

Record depth of thatch (cm) measured vertically from the soil surface.

Clay Soil Indicator Plants Present

Record the presence of any clay soil indicator plant species in the study area. Potential indicators plants include:

- *Plantago erecta*
- *Harpagonella palmeri*
- *Convolvulus simulans*

Cryptogamic Crusts

Record the presence of cryptogamic crusts, as well as the estimated percent cover (expressed as a cover class) of cryptogamic crust within the polygon. Cryptogamic crusts are defined as a soil surface crust of various cyanobacteria, lichens, mosses, and fungi.

*Acanthomintha ilicifolia* Present

Record the presence of any San Diego thornmint (*Acanthomintha ilicifolia*) present in the polygon, as well as total estimated number of plants present.

Standing Biomass Height

Record the height of herbaceous vegetation within the polygon, as measured vertically from the soil surface.

Dead Standing Biomass, if present (Species and Cover Class)

Record the species and estimated percent cover (expressed as a cover class) of dead, standing plant material within the polygon, excluding dead material from the current year's growth.

Remnant Native Habitat Type(s)

Identify any remnant native habitat type(s) within the polygon based on species composition and disturbance factors; types are generally assigned a Holland vegetation classification.

Overall Existing Native Habitat Quality

Rank the existing native habitat quality, *generally* using the following scale (based on modified Trudgen & Keighery vegetation condition scale):

| Habitat Quality | Description |
|---|---|
| Poor | Native vegetation structure lacking; few or no native species; cover/abundance of weeds 60-80%; disturbance incidence high |
| Fair | Vegetation structure modified or somewhat modified; native species present but not dominant; cover/abundance of weeds 20-60%; disturbance incidence high |
| Good | Vegetation structure modified or somewhat modified; native species = or > nonnative species; cover/abundance of weeds 5-20%; minor signs of disturbance |
| Very Good | Vegetation structure intact or nearly so; native species dominant; cover/abundance of weeds <5%; no disturbance or minimal signs of disturbance |

Disturbances

Identify and rank disturbances within the polygon; rankings indicate the percentage of the site impacted and generally correspond to the following:

| Disturbance Rank | Description |
|---|---|
| High | Disturbance occurs over >50% of polygon |
| Moderate | Disturbance occurs over 10-50% of polygon |
| Low | Disturbance occurs over <10% of polygon |

Notes

Provide additional observations about the site, wildlife occurrences, or deviations from the assessment protocol.

## References

California Native Plant Society (CNPS). 2004. Vegetation rapid assessment protocol. CNPS Vegetation Committee. Revised September 20. http://cnps.org/cnps/vegetation/pdf/rapid_assessment_protocol.pdf

Holland, R.F. 1986. Preliminary descriptions of the terrestrial natural communities of California. State of California, The Resources Agency, Department of Fish and Game. 156 pp.

Oberbauer, T, M. Kelly, and J. Buegge. 2008. Draft vegetation communities of San Diego County. Based on Holland, R.F. 1986. Preliminary descriptions of the terrestrial natural communities of California. State of California, The Resources Agency, Department of Fish and Game. 156 pp.

Sproul, F., T. Keeler-Wolf, P. Gordon-Reedy, J. Dunn, A. Klein, and K. Harper. 2011. Vegetation classification manual for western San Diego County, first edition. Prepared by AECOM, California Department of Fish and Game, and Conservation Biology Institute. Prepared for San Diego Association of Governments.

# 2012 Brachypodium Habitat Assessment Form

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Investigators_____ Date (mm/dd/yy):_____

Planning Area/Site Name (i.e., Crestridge): _____Photo Number_____

Polygon Numeric ID (000): ___ ___ Photo Reference:_____

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**Site Prep Access:** 2WD 4WD Tractor ATV None

**Slope Aspect:** N NE NW S SE SW W E

**Soil Texture:** _____

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**Existing Vegetation Classification:** SDVC: _____

Field Assessment:_____

_____

**Cover Classes (CC): TR (<1) 1** (1-5%); **2** (5-10%); **3** (10-25%); **4** (25-50%); **5**(50-75%); **6** (75-90%) **7** (90-95%) **8** (95-99) **9** (99-100%)

**Total Exotic Forb Cover Class:** TR 1 2 3 4 5 6 7 8 9

Exotic #1: Sp:_____ CC_____ Exotic #2: Sp:_____ CC: _____

Exotic #3: Sp:_____CC_____ Exotic #4: Sp:_____ CC:_____

Other Exotic Forbs:_____

**Total Exotic Grass Cover Class:** TR 1 2 3 4 5 6 7 8 9

Ex Grass #1: Sp:_____ CC_____ Ex Grass #2: Sp:_____CC: ____

Ex Grass #3: Sp:_____ CC_____ ExGrass#4: Sp_____CC:____

Other Exotic Grasses:_____

**Total Native Forb Cover Class:** TR 1 2 3 4 5 6 7 8 9

Native Forb#1: Sp:_____ CC_____ Native Forb #2: Sp:_____ CC: _____

Native Forb #3: Sp:_____CC_____ Native Forb#4: Sp: _____ CC:_____

Other Native Forbs:_____

**Total Native Grass Cover:** TR 1 2 3 4 5 6 7 8 9

Native Grass#1: Sp:_____ CC_____ Native Grass #2: Sp:_____ CC: _____

Native Grass #3: Sp:_____CC_____ Native Grass#4: Sp: _____ CC:_____

Other Native Grasses:_____

**Total Native shrub cover:** TR 1 2 3 4 5 6 7 8 9

Native shrubs (CC):_____

**Bare Ground/Rock Cover Class:** TR 1 2 3 4 5 6 7 8 9

**Thatch Cover Class:** TR 1 2 3 4 5 6 7 8 9

**Thatch Depth (cm):**_____

**Circle Clay/Indicator Species Present:** *Plantago erecta, Harpagonella palmeri, Convolvulus simulans*

**Cryptogamic Crusts** (circle one): Y N If yes, est. Cover Class? _____

**Acanthomintha ilicifolia Present** (circle one): Y N If yes, total estimated number of plants?_____

**Standing biomass height** (cm)_____

**Dead Standing Biomass, if present (spp and CC)**_____

**Remnant Native Habitat Type**(s):_____Cover Class_____:_____

**Overall Existing Native Habitat Quality (circle):** _____Poor_____ Fair _____Good _____Very Good

**Disturbances** (Rank each H,M,L, with rankings representing percentage of site impacted)

ORV_____ Dumping/Trash_____Erosion _____Altered Fire Regime_____ Gophers_____

Soil Compaction _____ Altered hydrology_____Recreation_____ Human Disturbance_____Historic Grazing/Ag_____other_____

**Notes**_____

_____

# Appendix B.2 - Habitat Assessment Database

| DATE | SITE NAME | OWNER | POLYGON NO. | UNIQUE ID | INVESTIGATORS | PHOTO # | PHOTO REFERENCE | PHOTO POINT | SITE PREP ACCESS | ASPECT | SOIL TEXTURE | SOIL SERIES | HOLLAND | SDVC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 01/30/2012 | CER | CDFG | 001 | 12-1-01 | PGR/CB | | | | NONE | S, SE | STONY FINE SANDY LOAM | LAS POSAS | DCSS/NNGL | Brachypodium distachyon Semi-Natural Stand |
| 01/30/2012 | CER | CDFG | 002 | 12-1-02 | PGR/CB | | | | NONE | S, SE | STONY FINE SANDY LOAM | LAS POSAS | CSS | Malosma laurina-Lotus scoparius Association |
| 01/30/2012 | CER | CDFG | 003 | 12-1-03 | PGR/CB | | | | NONE | S, SW | MODERATELY FINE CLAY LOAM | LAS POSAS | CSS | Artemisia californica-Erigonum fasciculatum-Malasoma laurina Association |
| 01/30/2012 | CER | CDFG | 004 | 12-1-04 | PGR/CB | | | | NONE | SW | STONY FINE SANDY LOAM | LAS POSAS | CSS | Malosma laurina-Lotus scoparius Association |
| 01/30/2012 | CER | CDFG | 005 | 12-1-05 | PGR/CB | | | | NONE | S | STONY FINE SANDY LOAM | LAS POSAS | CSS | Salvia apiana-Artemisia californica Association |
| 01/30/2012 | CER | CDFG | 006 | 12-1-06 | PGR/CB | | | | NONE | S | STONY FINE SANDY LOAM | LAS POSAS | CSS | Malosma laurina-Lotus scoparius Association |
| 05/11/12 | SC | EHC | 001 | 12-2-01 | PGR/CB | SC_001 | East-West | | ATV | W | SANDY LOAM | LAS POSAS | CSS | Salvia apiana-Artemisia californica Association |

| EX. FORB 1 | EX. FORB 1 COVER CLASS | EX. FORB 2 | EX. FORB 2 COVER CLASS | EX. FORB 3 | EX. FORB 3 COVER CLASS | EX. FORB 4 | EX. FORB 4 COVER CLASS | EX. FORB 5 | EX. FORB 5 COVER CLASS | EX. FORB 6 | EX. FORB 6 COVER CLASS | EX. FORB 7 | EX. FORB 7 COVER CLASS | TOTAL EX. FORB COVER CLASS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ERCI | TR | ERBO | TR | | | | | | | | | | | TR |
| CEME | 1 | HIIN | TR | ERCI | TR | ERBO | TR | | | | | | | 1 |
| CEME | 1 | ERCI | TR | ERBO | TR | HIIN | TR | | | | | | | 1 |
| | | | | | | | | | | | | | | 0 |
| | | | | | | | | | | | | | | 0 |
| CEME | 1 | ERCI | TR | HIIN | TR | | | | | | | | | 1 |
| CEME | 1 | HYCR | 1 | ANAR | TR | LASE | TR | HIIN | TR | ERCI | TR | LOGA | TR | 1 |

| EX. GRASS 1 | EX. GRASS 1 COVER CLASS | EX. GRASS 2 | EX. GRASS 2 COVER CLASS | EX. GRASS 3 | EX. GRASS 3 COVER CLASS | EX. GRASS 4 | EX. GRASS 4 COVER CLASS | EX. GRASS 5 | EX. GRASS 5 COVER CLASS | EX. GRASS 6 | EX. GRASS 6 COVER CLASS | EX. GRASS 7 | EX. GRASS 7 COVER CLASS | EX. GRASS 8 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BRDIS | 5 | AVBA | 2 | BRRU | TR | | | | | | | | | |
| BRDIS | 5 | AVBA | 1 | PESE | 1 | BRRU | TR | | | | | | | |
| BRDIS | 5 | AVBA | 1 | BRRU | 1 | | | | | | | | | |
| BRDIS | 6 | AVBA | 1 | BRRU | 1 | | | | | | | | | |
| BRDIS | 5 | PESE | TR | BRRU | TR | HECO | TR | | | | | | | |
| BRDIS | 6 | | | | | | | | | | | | | |
| BRDIS | 4 | AVBA | TR | VUMY | TR | | | | | | | | | |

| EX. GRASS 8 COVER CLASS | TOTAL EX. GRASS COVER CLASS | NATIVE FORB 1 | NATIVE FORB 1 COVER CLASS | NATIVE FORB 2 | NATIVE FORB 2 COVER CLASS | NATIVE FORB 3 | NATIVE FORB 3 COVER CLASS | NATIVE FORB 4 | NATIVE FORB 4 COVER CLASS | NATIVE FORB 5 | NATIVE FORB 5 COVER CLASS | NATIVE FORB 6 | NATIVE FORB 6 COVER CLASS | NATIVE FORB 7 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 6 | DICA | TR | CHPA | TR | PSCA | TR | CASP | TR | SEBI | TR | | | |
| | 6 | CAMA | 1 | SEBI | TR | LENI | TR | CHPA | TR | MILA | TR | | | |
| | 5 | CHPA | TR | CASP | TR | DICA | TR | ALHA | TR | PSCA | TR | | | |
| | 6 | CAMA | 1 | CASP | 1 | CICA | TR | CHPA | TR | | | | | |
| | 5 | ALHA | 1 | CAMA | 1 | CHPA | TR | DICA | TR | | | | | |
| | 6 | CAMA | 1 | CASP | TR | | | | | | | | | |
| | 4 | COFI | 1 | CAMA | 1 | ERCO | 1 | SIBE | 1 | CASP | TR | AL(SP) | TR | DAPU |

| NATIVE FORB 7 COVER CLASS | TOTAL NATIVE FORB COVER CLASS | NATIVE GRASS 1 | NATIVE GRASS 1 COVER CLASS | NATIVE GRASS 2 | NATIVE GRASS 2 COVER CLASS | NATIVE GRASS 3 | NATIVE GRASS 3 COVER CLASS | TOTAL NATIVE GRASS COVER | NATIVE SHRUB 1 | NATIVE SHRUB 1 COVER CLASS | NATIVE SHRUB 2 | NATIVE SHRUB 2 COVER CLASS | NATIVE SHRUB 3 | NATIVE SHRUB 3 COVER CLASS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | TR | NAPU | 1 | | | | | 1 | MALA | 1 | HEAR | 1 | ERFA | 1 |
| | 1 | NAPU | TR | | | | | TR | MALA | 3 | ARCA | 2 | ERFA | TR |
| | TR | NAPU | 1 | | | | | 1 | MALA | 1 | ARCA | 1 | ISME | 1 |
| | 1 | ARAD | 1 | NAPU | TR | | | 1 | MALA | 2 | SAAP | 1 | RHCR | 1 |
| | 1 | NAPU | 2 | ARAD | TR | | | 2 | SAAP | 3 | MALA | 1 | ARCA | 1 |
| | 1 | NAPU | 2 | | | | | 2 | MALA | 2 | SAAP | 1 | ARCA | 1 |
| TR | 1 | NAPU | TR | NALE | TR | | | TR | NOIN | 3 | SAAP | 2 | MALA | 1 |

| NATIVE SHRUB 4 | NATIVE SHRUB 4 COVER CLASS | NATIVE SHRUB 5 | NATIVE SHRUB 5 COVER CLASS | NATIVE SHRUB 6 | NATIVE SHRUB 6 COVER CLASS | NATIVE SHRUB 7 | NATIVE SHRUB 7 COVER CLASS | NATIVE SHRUB 8 | NATIVE SHRUB 8 COVER CLASS | NATIVE SHRUB 9 | NATIVE SHRUB 9 COVER CLASS | NATIVE SHRUB 10 | NATIVE SHRUB 10 COVER CLASS | TOTAL NATIVE SHRUB COVER CLASS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SAAP | 1 | ARCA | 1 | BALA | TR | CNDU | TR | | | | | | | 2 |
| HEAR | TR | SAAP | TR | GUSA | TR | BALA | TR | | | | | | | 3 |
| SAAP | 1 | CAMA | 1 | ERFA | 1 | | | | | | | | | 3 |
| HEAR | 1 | ERFA | TR | BALA | TR | HEWH | TR | GUSA | TR | | | | | 2 |
| BASA | TR | CNDU | TR | ERFA | TR | HEWH | TR | RHCR | TR | LOSU | TR | OP(SP) | TR | 4 |
| HEWH | TR | HEAR | TR | | | | | | | | | | | 3 |
| ISME | 1 | ARCA | 1 | GUSA | 1 | HEAR | 1 | LOSC | 1 | ADFA | TR | | | 4 |

| BARE/ROCK COVER CLASS | THATCH COVER CLASS | THATCH DEPTH (CM) | CLAY INDICATOR PLANTS? (1=Y,2=N) | LIST CLAY INDICATOR PLANTS | CRYPTOBIOTIC CRUST (1=Y,2=N) | CRYPT CRUST COVER CLASS | SAN DIEGO THORNMINT PRESENT? (1=Y,2=N) | # THORNMINT PLANTS | OTHER CLAY/GABBRO SENSITIVE PLANTS | STANDING BIOMASS HT (M) | DEAD STAND BIOMASS COVER CLASS | DEAD STANDING BIOMASS SP #1 | DEAD STANDING BIOMASS SP #2 | DEAD STANDING BIOMASS SP #3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 6 | 5 | 2 | | 1 | 1 | 2 | | | 0.75 | HIIN | TR | CEME | TR |
| 1 | 6 | 10 | 2 | | 1 | 1 | 2 | | | 0.75 | CEME | 1 | | |
| 1 | 6 | 10 | 2 | | 1 | 1 | 2 | | | 0.75 | CEME | 2 | DEFA | TR |
| TR | 4 | 5 | 2 | | 2 | 0 | 2 | | | 1.50 | CEME | TR | | |
| 1 | 5 | 10-15 | 2 | | 1 | TR | 2 | | | 2.00 | CASP | TR | | |
| 1 | 6 | 25 | 2 | | 2 | 0 | 2 | | | 1.50 | BRDIS | 2 | CEME | 1 |
| 1 | 5 | 2-4 | 2 | | 2 | 0 | 2 | | NOIN | 1.00 | | | | |

| REMNANT NATIVE HABITAT TYPE | REMNANT NATIVE HABITAT COVER CLASS | GOPHER ACTIVITY (H,M,L,0) | OVERALL NATIVE HABITAT QUALITY (VERY GOOD, GOOD, FAIR, POOR) | THREAT ID 1 | THREAT 1 H,M,L | THREAT ID 2 | THREAT 2 H,M,L | THREAT ID 3 | THREAT 3 H,M,L | THREAT ID 4 | THREAT 4 H,M,L | WILDLIFE SPECIES OBSERVED | NOTES |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CSS | 2 | L | FAIR | ALTERED FIRE REGIME | H | GOPHERS | L | | | | | | |
| CSS | 3 | L | GOOD | ALTERED FIRE REGIME | H | GOPHERS | L | | | | | | |
| CSS | 3 | M | FAIR | ALTERED FIRE REGIME | H | GOPHERS | M | | | | | | Fresh gopher diggings |
| CSS | 2 | L | FAIR | ALTERED FIRE REGIME | H | GOPHERS | L | | | | | | |
| CSS | 4 | L | GOOD | ALTERED FIRE REGIME | H | GOPHERS | L | | | | | | |
| CSS | 3 | L | FAIR | ALTERED FIRE REGIME | H | GOPHERS | L | | | | | | |
| CSS | 4 | M | GOOD | ALTERED FIRE REGIME | H | GOPHERS | M | | | | | | Large stand of NOIN; CEME and HECR will be a problem when BRDIS is treated; good collecting spot for SIBE |

# Appendix B.2 - Habitat Assessment Database

| DATE | SITE NAME | OWNER | POLYGON NO. | UNIQUE ID | INVESTIGATORS | PHOTO # | PHOTO REFERENCE | PHOTO POINT | SITE PREP ACCESS | ASPECT | SOIL TEXTURE | SOIL SERIES | HOLLAND | SDVC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 05/11/12 | SC | EHC | 002 | 12-2-02 | PGR/CB | SC_002a,b | a: North-South; b: East-West | a. 32°46'44"N, 116°53'5"W; b. 32°46'54"N, 116°53'40"W; | ATV | W | STONY CLAY | AULD | DCSS/NNGL | Avena (barbata) fatua) Semi-Natural Stand |
| 05/11/12 | SC | EHC | 003 | 12-2-03 | PGR/CB | SC_003 | East-West | 32°46'52"N, 116°51'25"W | ATV | W | ROCKY COARSE SANDY LOAM | VISTA | DCSS/NNGL | Avena (barbata) fatua) Semi-Natural Stand |
| 05/11/12 | SC | EHC | 004 | 12-2-04 | PGR/CB | SC_004 | North-South | 32°47'4"N, 116°53'3"W | ATV | SW, W | SILT LOAM? | CHINO | CSS | Salvia apiana-Artemisia californica Association |
| 05/11/12 | SC | EHC | 005 | 12-2-05 | PGR/CB | SC_005 | North-South | 32°46'39"N, 116°53'11"W | ATV | S, SW | SANDY LOAM | VISALIA | CSS | Artemisia californica Association |
| 05/11/12 | SC | EHC | 006 | 12-2-06 | PGR/CB | SC_006 | East-West | 32°46'52"N, 116°51'25"W | ATV | W, FLAT | STONY CLAY | AULD | DNGL | Nassella pulchra Association |
| 05/11/12 | SC | EHC | 007 | 12-2-07 | PGR/CB | SC_007 | Southwest-Northeast | 32°46'44"N, 116°53'5"W | ATV | SW | STONY CLAY | AULD | CSS/NGL | Nassella pulchra Association |
| 05/11/12 | SC | EHC | 008 | 12-2-08 | PGR/CB | SC_008a,b | a: South-North; b: Northeast-Southwest | a. 32°46'35"N, 116°52'58"W; b. 32°46'50", 116°53'40"W | ATV | NW, W | SANDY LOAM | LAS POSAS | CSS | Salvia apiana-Artemisia californica Association |

| EX. FORB 1 | EX. FORB 1 COVER CLASS | EX. FORB 2 | EX. FORB 2 COVER CLASS | EX. FORB 3 | EX. FORB 3 COVER CLASS | EX. FORB 4 | EX. FORB 4 COVER CLASS | EX. FORB 5 | EX. FORB 5 COVER CLASS | EX. FORB 6 | EX. FORB 6 COVER CLASS | EX. FORB 7 | EX. FORB 7 COVER CLASS | TOTAL EX. FORB COVER CLASS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| HECR | TR | LASE | TR | | | | | | | | | | | TR |
| LASE | TR | CEME | TR | HIIN | TR | | | | | | | | | TR |
| HECR | TR | SOOL | TR | HIIN | TR | CEME | TR | | | | | | | TR |
| LASE | TR | CEME | TR | | | | | | | | | | | TR |
| LASE | TR | | | | | | | | | | | | | TR |
| FOVU | 1 | CEME | TR | HIIN | TR | LASE | TR | | | | | | | 1 |
| CEME | TR | HECR | TR | LASE | TR | ERCI | TR | | | | | | | TR |

| EX. GRASS 1 | EX. GRASS 1 COVER CLASS | EX. GRASS 2 | EX. GRASS 2 COVER CLASS | EX. GRASS 3 | EX. GRASS 3 COVER CLASS | EX. GRASS 4 | EX. GRASS 4 COVER CLASS | EX. GRASS 5 | EX. GRASS 5 COVER CLASS | EX. GRASS 6 | EX. GRASS 6 COVER CLASS | EX. GRASS 7 | EX. GRASS 7 COVER CLASS | EX. GRASS 8 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AVBA | 4 | BRDIS | 4 | | | | | | | | | | | |
| AVBA | 5 | BRDIS | 3 | | | | | | | | | | | |
| BRDIS | 4 | AVBA | 3 | | | | | | | | | | | |
| BRDIS | 4 | AVBA | 4 | BRDI | TR | | | | | | | | | |
| BRDIS | 4 | AVBA | 4 | PHAQ | TR | | | | | | | | | |
| BRDIS | 4 | AVBA | 4 | | | | | | | | | | | |
| BRDIS | 4 | AVBA | TR | | | | | | | | | | | |

| EX. GRASS 8 COVER CLASS | TOTAL EX. GRASS COVER CLASS | NATIVE FORB 1 | NATIVE FORB 1 COVER CLASS | NATIVE FORB 2 | NATIVE FORB 2 COVER CLASS | NATIVE FORB 3 | NATIVE FORB 3 COVER CLASS | NATIVE FORB 4 | NATIVE FORB 4 COVER CLASS | NATIVE FORB 5 | NATIVE FORB 5 COVER CLASS | NATIVE FORB 6 | NATIVE FORB 6 COVER CLASS | NATIVE FORB 7 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 6 | COFI | 1 | CAMA | 1 | CASP | TR | DEFA | TR | | | | | |
| | 6 | COFI | TR | CASP | TR | SIBE | TR | GRCA | TR | GAAN | TR | ERCO | TR | |
| | 5 | COFI | 1 | CAMA | 1 | HEGR | TR | ERCO | TR | GAAN | TR | CASP | TR | SIBE |
| | 5 | CAMA | TR | CASP | TR | COFI | TR | ERCO | TR | BRCA | TR | SIBE | TR | GAAN |
| | 6 | SIBE | 1 | CASP | 1 | BRCA | 1 | CAMA | TR | ERCO | TR | | | |
| | 6 | CASP | 1 | CAMA | TR | GRCA | TR | SIBE | TR | | | | | |
| | 4 | COFI | 1 | CAMA | 1 | SIBE | 1 | CASP | TR | PSCA | TR | GAAN | TR | ERCO |

| NATIVE FORB 7 COVER CLASS | TOTAL NATIVE FORB COVER CLASS | NATIVE GRASS 1 | NATIVE GRASS 1 COVER CLASS | NATIVE GRASS 2 | NATIVE GRASS 2 COVER CLASS | NATIVE GRASS 3 | NATIVE GRASS 3 COVER CLASS | TOTAL NATIVE GRASS COVER | NATIVE SHRUB 1 | NATIVE SHRUB 1 COVER CLASS | NATIVE SHRUB 2 | NATIVE SHRUB 2 COVER CLASS | NATIVE SHRUB 3 | NATIVE SHRUB 3 COVER CLASS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | NAPU | TR | | | | | TR | MALA | 1 | ARCA | 1 | BALA | TR |
| | 1 | NAPU | TR | | | | | TR | ISME | 1 | SAAP | 1 | ARCA | 1 |
| TR | 1 | NAPU | TR | | | | | TR | ARCA | 2 | NOIN | 1 | ISME | 1 |
| TR | TR | NAPU | 1 | NALE | 1 | | | 1 | ARCA | 3 | ISME | 1 | OPLI | 1 |
| | 1 | NAPU | 2 | | | | | 2 | NOIN | 1 | ARCA | 1 | GUSA | 1 |
| | 1 | NAPU | 2 | NALE | TR | | | 2 | ARCA | 1 | NOIN | 1 | ISME | 1 |
| TR | 2 | NAPU | 1 | NALE | 1 | | | 2 | NOIN | 3 | ARCA | 1 | SAAP | 1 |

| NATIVE SHRUB 4 | NATIVE SHRUB 4 COVER CLASS | NATIVE SHRUB 5 | NATIVE SHRUB 5 COVER CLASS | NATIVE SHRUB 6 | NATIVE SHRUB 6 COVER CLASS | NATIVE SHRUB 7 | NATIVE SHRUB 7 COVER CLASS | NATIVE SHRUB 8 | NATIVE SHRUB 8 COVER CLASS | NATIVE SHRUB 9 | NATIVE SHRUB 9 COVER CLASS | NATIVE SHRUB 10 | NATIVE SHRUB 10 COVER CLASS | TOTAL NATIVE SHRUB COVER CLASS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LOSC | TR | | | | | | | | | | | | | 2 |
| LOSC | 1 | BASA | TR | BALA | R | MALA | TR | | | | | | | 2 |
| SAAP | 1 | RHIN | 1 | OPLI | 1 | MALA | 1 | BALA | TR | LOSC | TR | RHCR | TR | 4 |
| LOSC | 1 | ERFA | TR | | | | | | | | | | | 3 |
| BASA | 1 | LOSC | 1 | ERFA | TR | | | | | | | | | 2 |
| BASA | 1 | LOSC | 1 | ERFA | TR | | | | | | | | | 2 |
| MALA | 1 | RHCR | 1 | LOSC | 1 | MIAU | TR | | | | | | | 4 |

| BARE/ROCK COVER CLASS | THATCH COVER CLASS | THATCH DEPTH (CM) | CLAY INDICATOR PLANTS? (1=Y,2=N) | LIST CLAY INDICATOR PLANTS | CRYPTOBIOTIC CRUST (1=Y,2=N) | CRYPT CRUST COVER CLASS | SAN DIEGO THORNMINT PRESENT? (1=Y,2=N) | # THORNMINT PLANTS | OTHER CLAY/GABBRO SENSITIVE PLANTS | STANDING BIOMASS HT (M) | DEAD STAND BIOMASS COVER CLASS | DEAD STANDING BIOMASS SP #1 | DEAD STANDING BIOMASS SP #2 | DEAD STANDING BIOMASS SP #3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 7 | 4-6 | 2 | | 2 | 0 | 2 | | | 1.50 | HIIN | TR | | |
| 1 | 6 | 4-6 | 2 | | 2 | 0 | 2 | | | 1.75 | GRCA | TR | | |
| 2 | 5 | 4-6 | 2 | | 2 | 0 | 2 | | NOIN | 1.50 | | | | |
| 1 | 5 | 2-6 | 2 | | 2 | 0 | 2 | | | 1.50 | | | | |
| 1 | 7 | 6-8 | 2 | | 2 | 0 | 2 | | NOIN | 1.50 | GRCA | TR | | |
| 1 | 6 | 2-6 | 2 | | 2 | 0 | 2 | | NOIN | 1.50 | | | | |
| 1 | 5 | 2-4 | 2 | | 2 | 0 | 2 | | NOIN | 1.50 | | | | |

| REMNANT NATIVE HABITAT TYPE | REMNANT NATIVE HABITAT COVER CLASS | GOPHER ACTIVITY (H,M,L,0) | OVERALL NATIVE HABITAT QUALITY (VERY GOOD, GOOD, FAIR, POOR) | THREAT ID 1 | THREAT 1 H,M,L | THREAT ID 2 | THREAT 2 H,M,L | THREAT ID 3 | THREAT 3 H,M,L | THREAT ID 4 | THREAT 4 H,M,L | WILDLIFE SPECIES OBSERVED | NOTES |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CSS | 2 | L | POOR | ALTERED FIRE REGIME | H | GOPHERS | L | HUMAN DISTURBANCE | M | | | | Potential for CSS restoration (full restoration) |
| CSS | 2 | L | FAIR | ALTERED FIRE REGIME | H | GOPHERS | L | HUMAN DISTURBANCE | M | | | | Avena-dominated; good area for full restoration; does have native elements, including forb |
| CSS | 4 | L | FAIR | ALTERED FIRE REGIME | H | GOPHERS | L | | | | | | West-facing slope above Skeleton Flats; some rock outcrops, mature shrubs (invasive |
| CSS | 3 | L | FAIR | ALTERED FIRE REGIME | H | GOPHERS | L | | | | | | Good stands of native grasses (invasives control; possibly native forb introduction) |
| CSS/NGL | 2 | L | FAIR-GOOD | ALTERED FIRE REGIME | H | GOPHERS | L | ALTERED HYRDOLOGY | M | | | | AVBA dense by road, while BRDIS dominates to west; good stands of NAPU, SIBE; may need |
| CSS/NGL | 2 | L | FAIR | ALTERED FIRE REGIME | H | GOPHERS | L | | | | | | Lots of NAPU, SIBE, CASP (invasives control) |
| CSS | 4 | L | GOOD | ALTERED FIRE REGIME | H | GOPHERS | L | | | | | | Good shrub cover; BRDIS is problem (so, invasives control, but no restoration); good area for |

# APPENDIX C

# RESTORATION PLANS

Appendix C.1 *Brachypodium* Removal: Treatment and Restoration Plan, Crestridge Ecological Reserve

Appendix C.2 *Brachypodium* Removal: Treatment and Restoration Plan, South Crest Properties

Appendix C.1

# *Brachypodium* Removal: Treatment & Restoration Plan, Crestridge Ecological Reserve


*Prepared by*

Conservation Biology Institute

SANDAG Contract No. 5001965

# *Brachypodium* Treatment & Restoration Plan: Crestridge Ecological Reserve

## Introduction

The Crestridge Ecological Reserve is an approximately 2,660-acre ecological reserve as designated by the California Fish and Game Commission and a unit of the Multiple Species Conservation Program (MSCP) in San Diego County (Figure 1). Central to the MSCP is the maintenance of ecosystems and vegetation communities that support sensitive species and fragile, regionally declining resources. The MSCP's goal is to prevent future endangerment of the plants and animals that are dependent on these habitats.

The federally threatened and state-endangered plant species, San Diego thornmint (*Acanthomintha ilicifolia*) occurs in the north-central portion of the reserve, in an area designated as 'Thornmint Hill (Figure 2).' This area, like much of the reserve, burned in the 2003 Cedar Fire. Subsequent to the burn, the nonnative annual grass, purple falsebrome (*Brachypodium distachyon*) aggressively invaded habitat on Thornmint Hill. Although *Brachypodium* is not the only invasive species in this area, it poses a particular threat because it forms nearly monotypic stands that inhibit germination and growth of San Diego thornmint and other native, annual forbs.

To date, an estimated 68 acres of *Brachypodium*-invaded habitat has been mapped on Crestridge (Figure 3). Although *Brachypodium* is not the only invasive plant in this area, it poses a particular threat because it forms nearly monotypic stands that inhibit germination and growth of San Diego thornmint and other native, annual forbs. Its effect on perennial bulbs and shrubs is not as clear. While there may be a short-term, beneficial effect on vegetative growth due soil shading and/or water retention, *Brachypodium* may pose long-term, adverse impacts to these species through increased fire frequency and/or intensity, alteration of soil nutrients, and reduced opportunities for regeneration through sexual reproduction.

In an effort to reduce the threat to these species from *Brachypodium* and improve habitat for San Diego thornmint, habitat enhancement/restoration is proposed over an estimated 10.5 acres on Thornmint Hill. Target restoration areas were selected because (1) they historically supported thornmint; (2) they are adjacent to historic thornmint localities and possess many of the same habitat attributes; and/or (3) they are adjacent to or in proximity to historic thornmint localities and currently function as a source of invasive seed propagules. It should be noted that as these areas are rehabilitated, restoration efforts may expand outward to encompass additional degraded habitat; however, additional restoration is not included in this plan.

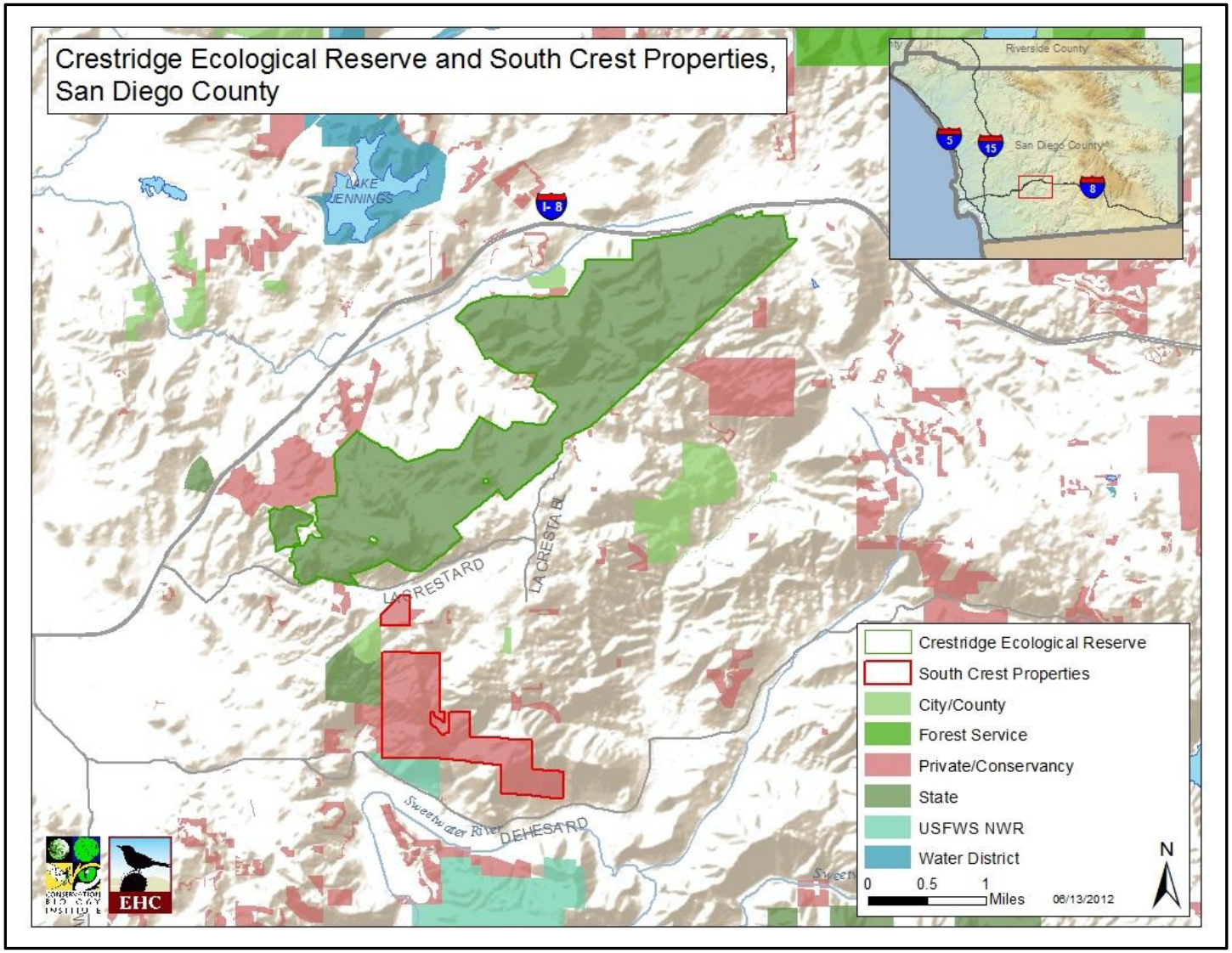


Figure 1. Location of South Crest properties, San Diego County, California.

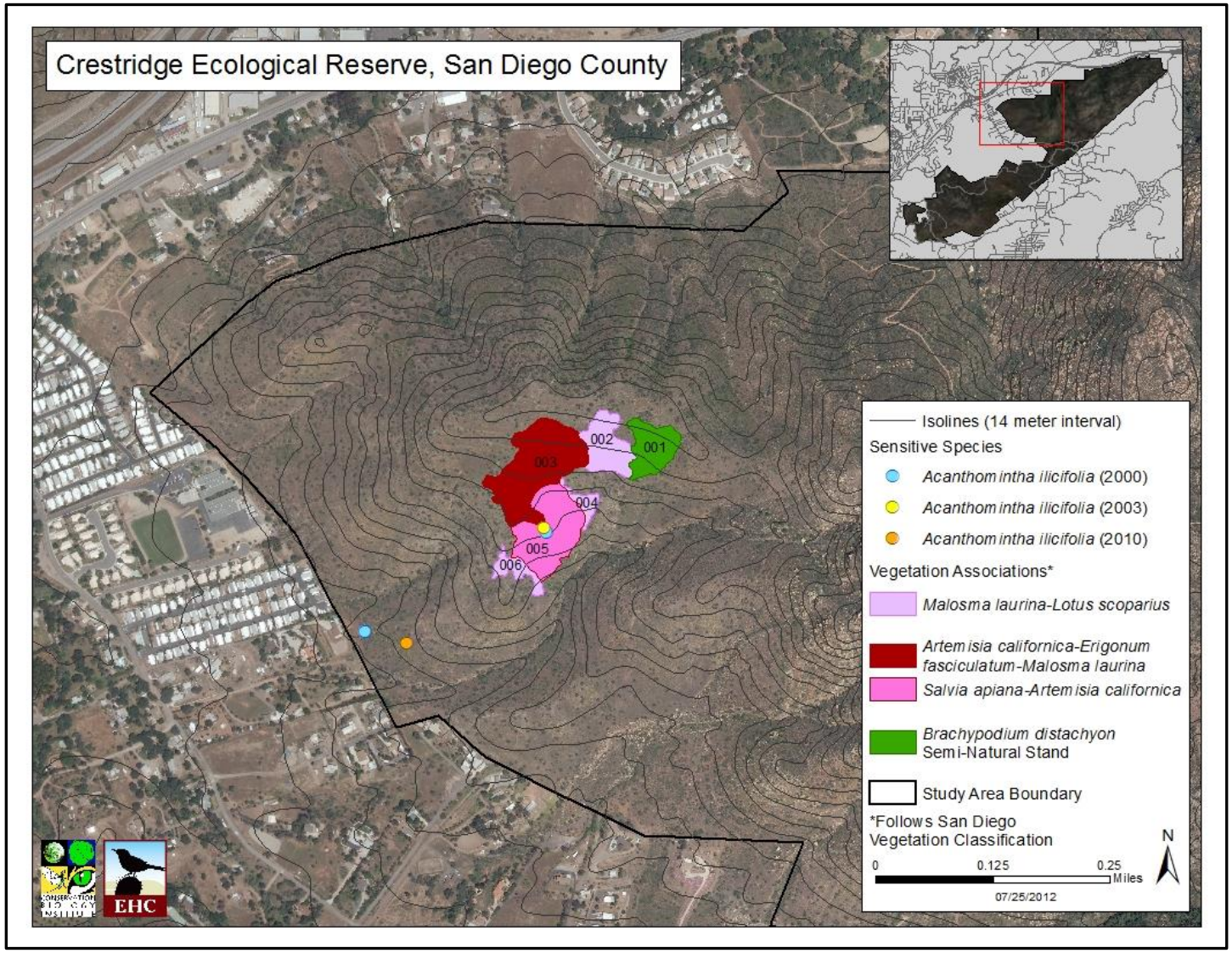


Figure 2. San Diego thornmint and habitat assessment polygons, 'Thornmint Hill,' Crestridge Ecological Reserve.

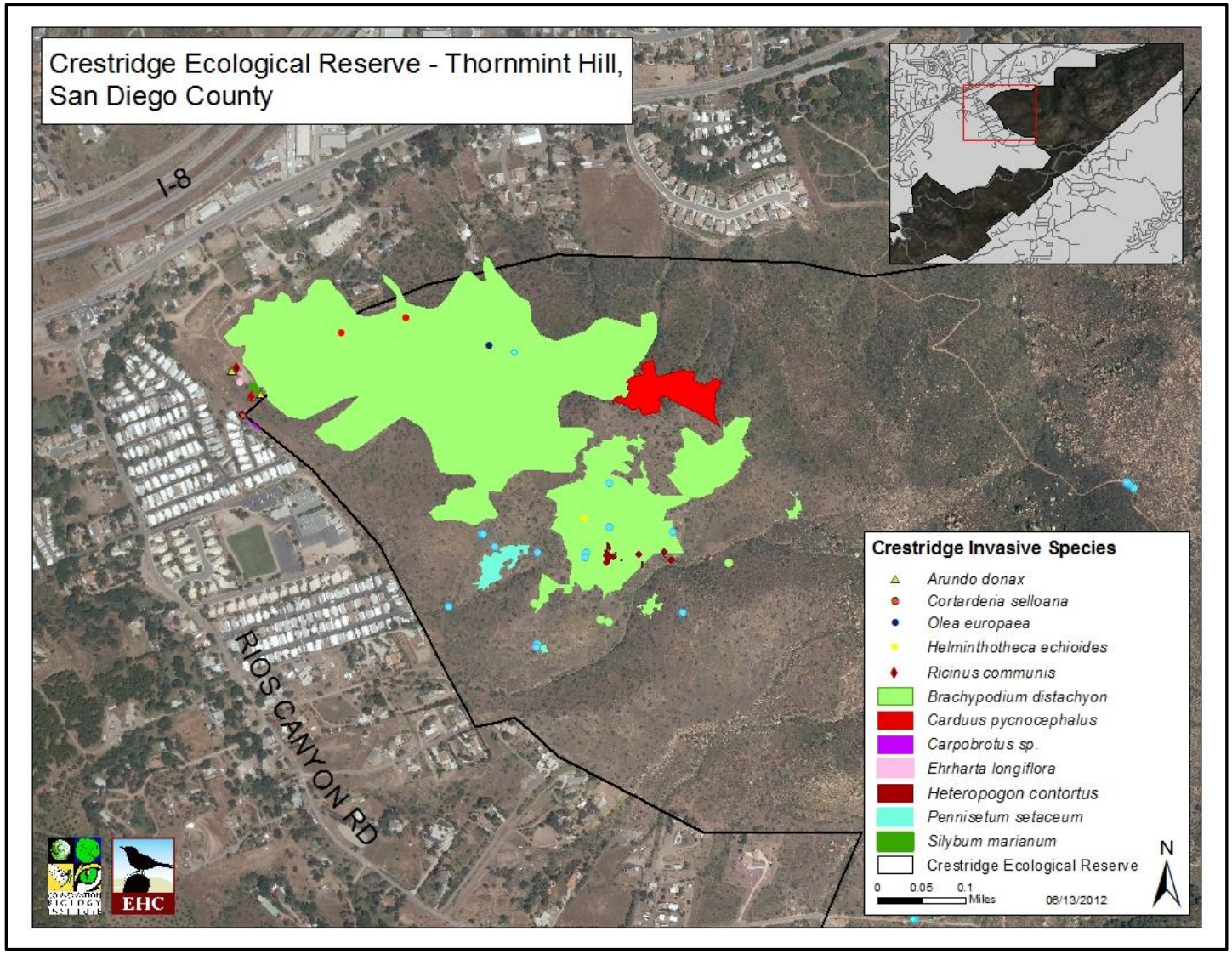


Figure 3. Extent of *Brachypodium distachyon* on Thornmint Hill, Crestridge Ecological Reserve.

# Approach

*Brachypodium* is a widely distributed species that forms dense stands on clay soils and appears to exact the most detrimental effects on annual species. Although published sources indicate that seed bank longevity is relatively short (1-2 years), seed from the site exhibits high viability after 2 years (testing will continue to determine whether or not seed viability drops over time). Regardless, it is not yet known whether seed bank management is a viable means of eradication or control. Removal of *Brachypodium* will likely release additional invasive species from the soil seed bank; thus, the treatment approach includes both grass and broadleaf forb control. Grass-specific herbicides have been shown to be effective in controlling *Brachypodium* and will be used except where native grasses occur in relatively high densities. In those cases, mechanical removal will be substituted. Experimental treatments indicate that while herbicides result in the greatest decrease in *Brachypodium* cover, they can also result in a significant increase in exotic forb species. Conversely, mechanical removal is less effective than herbicide treatment but more effective than no treatment, and appears to release fewer exotic forbs from the seed bank (CBI 2012). Because of the extensive weed seed bank, the overarching goal of this program is to allow plant communities to shift in a favorable direction, with the realization that 100% control of invasive species is unlikely within the 2-year timeframe of this project. The following principles will be followed in implementing this shift:

- Remove nonnative, invasive plants to create conditions under which native species can flourish; minimize potential for reinvasion of restored habitat; and increase *potential* habitat for San Diego thornmint.
    - Decrease growth, propagule production, and frequency of dispersal of invasive species
    - Manage seed bank of invasive species
- Establish desirable (native) species that are functionally similar to invader
    - Increase propagule production and frequency of dispersal of native species
    - Alter frequency and timing of native seeding
    - Alter seeding rate of native species

In 2012, we mapped 6 habitat polygons on Thornmint Hill (Figure 2), using a qualitative habitat assessment methodology. Data from this mapping effort has been used to develop polygon-specific restoration plans. Table 1 summarizes size and biotic and abiotic conditions of each polygon, Table 2 summarizes restoration treatments for each polygon, and Table 3 provides an implementation schedule. Restoration plans are detailed below for each polygon, and include polygon-specific restoration strategies, management goals and objectives, and restoration specifications.

Table 1
Summary of Polygon Attributes

| Polygon | Attribute | | | | |
|---|---|---|---|---|---|
| | Size (acres) | Slope | Soil Type[1] | Vegetation Association[2] | Target Species[3] |
| 1 | 1.56 | South, Southeast | Clay (Las Posas) | *Brachypodium distachyon* Semi-Natural Stand | --- |
| 2 | 1.66 | South, Southeast | Clay (Las Posas) | *Malosma laurina-Lotus scoparius* | --- |
| 3 | 4.20 | South, Southeast | Clay (Las Posas) | *Artemisia californica-Eriogonum fasciculatum-Malosma laurina* | --- |
| 4[4] | 0.38 | Southwest | Clay (Las Posas) | *Malosma laurina-Lotus scoparius* | --- |
| 5 | 3.09 | South, Southwest | Clay (Las Posas) | *Salvia apiana-Artemisia californica* | *Acanthomintha ilicifolia* |
| 6[4] | 0.59 | South | Clay (Las Posas) | *Malosma laurina-Lotus scoparius* | --- |

[1] Clay soils are in the Las Posas series (USDA-SCS 1973).
[2] Vegetation associations follow Sproul et al. 2011.
[3] Target species indicates focus of habitat restoration effort; species may or may not be present in polygon.
[4] No management actions are planned in these polygons during this project; however, actions are specified in this table and in the text in the event that funding becomes available to extend treatments into these areas in the future.

Table 2
Crestridge Ecological Reserve: Restoration Tasks[1]

| Enhancement/Restoration Tasks | Polygon Number | | | | | |
|---|---|---|---|---|---|---|
| | 1 | 2[1] | 3 | 4[1] | 5 | 6[1] |
| Seed Collection[2] | X | X | X | X | X | X |
| Site Preparation | | | | | | |
| • Stake polygons[2] | X | | X | X | X | X |
| • Dethatch using line trimmers; leave thatch in place | X | | | | | |
| • Treat nonnative grasses by mowing | X | | | | | |
| • Treat nonnative grasses with a grass-specific herbicide (i.e., Fusilade II) | | | X | X | X | X |
| • Treat nonnative forbs with a broad-spectrum herbicide (i.e., glyphosate-based herbicide) | X | | X | X | X | X |
| Installation | | | | | | |
| • Scarify soil, add native seed, and tamp soil | X | | | | | |
| Performance Monitoring[2] | X | X | X | X | X | X |

[1] Management actions are not planned in these polygons during this project; however, actions are specified in this table and in the text in the event that funding becomes available to extend treatments into these areas in the future.
[2] Tasks to be conducted by CBI.

Table 3
Implementation, Maintenance, and Monitoring Schedule

| Restoration Task | 2012 | | 2013 | | | | 2014 |
|---|---|---|---|---|---|---|---|
| | Fall | Winter | Spring | Summer | Fall | Winter | Spring |
| Seed collection | X | X | X | X | X | | |
| Seed bulking | X | X | X | X | X | X | |
| Dethatching | X | X | | | | | |
| Weed Control[1] | | X | X | X | X | X | |
| Seeding | | | | | X | X | X |
| Performance monitoring | | | X | X | | | X |

[1] Herbicide and/or mechanical control.

# Restoration Plans

## Polygon 001

### Existing Conditions

Polygon 001 lies on south- and southeast-facing slopes in clay soils (Las Posas series). This polygon is 1.56 acres in size and situated at the eastern end of the restoration area; vegetation is classified as *Brachypodium distachyon* Semi-Natural Stand Type. Although a shrub stratum is present, it comprises <10% absolute cover. The herb stratum is continuous (>66% absolute cover) and dominated by nonnative grasses.

Although shrub cover is low, shrub diversity is relatively high. Laurel sumac (*Rhus laurina*) is the most common shrub species within this polygon. Additional shrubs present in low or trace amounts include toyon (*Heteromeles arbutifolia*), California buckwheat (*Eriogonum fasciculatum*), matchweed (*Gutierrezia* sp.), bushrue (*Cneoridium dumosum*), white sage (*Salvia apiana*), California sagebrush (*Artemisia californica*), goldenbush (*Isocoma menziesii*), redberry (*Rhamnus crocea*), Our Lord's candle (*Hesperoyucca whipplei*), and San Diego viguiera (*Bahiopsis laciniata*).

The herbaceous stratum is dominated by the nonnative grass, *Brachypodium*, which comprised an estimated 75% of the absolute cover in 2012. Additional nonnative grasses present in trace amounts include wild oats (*Avena barbata*) and red brome (*Bromus rubens*). Purple needlegrass (*Stipa* [formerly *Nassella*] *pulchra*) is also present, but encompasses <1% of the cover. Exotic forbs present in trace amounts include red-stem filaree (*Erodium cicutarium*) and long-beaked

filaree (*Erodium botrys*). Native forbs are also present in trace amounts and are primarily perennial species, such as red-skin onion (*Allium haematochiton*), bindweed (*Calystegia macrostegia*), soap plant (*Chlorogalum parviflorum*), blue dicks (*Dichelostemma capitatum*), splendid mariposa lily (*Calochortus splendens*), ladies' tobacco (*Pseudognaphalium* sp.), and spike-moss (*Selaginella bigelovii*). Small areas supporting a cryptogamic crust were noted in 2012, and generally had a lower cover of *Brachypodium* than surrounding habitat.

## Restoration Strategy

Within this polygon, the restoration strategy will focus on (1) reducing the cover of nonnative species, particularly grasses and (2) augmenting both native shrub and forb species through the introduction of propagules. The desired habitat condition is a native shrub matrix with openings that support a native forb component and/or bare ground. Existing, remnant shrub vegetation suggests that suitable post-restoration habitat may fall into the *Malosma laurina-Lotus scoparius* Association.

## Management Goals and Objectives

**Goal**: Enhance habitat for native species by decreasing cover of nonnative plants and introducing native shrub and forb propagules.

*Objective 1*: Decrease cover of nonnative grasses, particularly *Brachypodium*, to ≤10-25%[1] within 2 years through a combination of dethatching and a grass-specific herbicide (e.g., Fusilade II).

*Objective 2*: Decrease cover of exotic forbs to ≤10-25%[1] cover within 2 years through spot-treatments with herbicide (e.g., glyphosate-based herbicide).

*Objective 3*: Augment the native shrub matrix to at least 15-25%[1] absolute cover by introducing propagules (i.e., native seed) into the soil seed bank within 2 years of initiating nonnative grass and forb treatments.

*Objective 4*: Increase native forb percent cover to at least 5-10% of the absolute cover by introducing early-, mid-, and late-blooming native forb species into the soil seed bank within 2 years of initiating nonnative grass and forb treatments.

## Restoration Specifications

1. Dethatch polygon in Fall 2012 using line trimmers. All dethatch material will be left in place.

[1] Percentages may be modified based on reference transects.

2. Treat nonnative grass with a grass-specific herbicide (e.g., Fusilade II) twice a year for one year; treatments will be initiated in late January or early February 2013. Applications will be made using a backpack sprayer following label directions (i.e., Fusilade II label directions = 0.4-0.6 ounce per 1000 square feet). Although the entire polygon will be treated, native bunchgrasses will be avoided to the degree practicable.
3. Spot-treat nonnative forbs with herbicides twice a year for two years after initial application of the grass-specific herbicide. The first forb treatment will occur in mid-to late March 2013. Herbicide(s) chosen for nonnative forb control will be species-specific, and treatment times will be determined by species phenology, as assessed by CBI and SERG during site visits. Line trimmers may be used to cut nonnative forbs if deemed more appropriate than herbicide application, and should be used prior to seed set. If seed set has already occurred, cut vegetation will be placed in compost piles downslope and outside of polygon 001. Compost pile location will be determined by CBI in consultation with the restoration subcontractor.
4. Introduce native shrub, grass and forb seeds into this polygon in Fall 2013 and Winter 2014. Prior to seeding, soil will be scarified using garden rakes; scarification will avoid established vegetation to the degree practicable. Seed will be hand broadcast and then tamped down into the scarified soil. The forb component of the seed mix should be proportionally skewed towards early-germinating species to compete with early-germinating nonnative grasses (Table 4). No supplemental watering will occur after seeding, unless water can easily be conveyed to the site.

## Polygon: CER_002

### Existing Conditions

Polygon 002 is adjacent to and west of 001 and shares the same abiotic conditions with respect to soil and slope. The polygon is 1.66 acres in size; vegetation is the *Malosma laurina-Lotus scoparius* Association. The shrub stratum comprises between 10-25% of the total cover, and is dominated by laurel sumac and California sagebrush. Shrubs present in trace amounts include California buckwheat, toyon, white sage, matchweed, and San Diego viguiera. The herb stratum is dominated by nonnative grasses.

The herb stratum is continuous (>66% absolute cover); *Brachypodium* is the dominant herb component. Other nonnative grasses include wild oats, red brome, and fountain grass (*Pennisetum setaceum*). Trace amounts of purple needlegrass are present. Exotic forbs make up less than 3% of the total cover, and include tocalote (*Centaurea melitensis*), short-podded mustard (*Hirschfeldia incana*), red-stemmed filaree, and long-beak filaree. Native forbs are also present in trace amounts and include bindweed, wishbone bush (*Mirabilis laevis*), soap plant,

Table 4
Proposed Native Seed[1] Mix for Polygon 001

| Scientific Name | Common Name | Forb Flowering Period | Forb Phenology | Source[2] | Pounds/Acre |
|---|---|---|---|---|---|
| *Acmispon glaber* | Deerweed | --- | --- | Commercial | 2 |
| *Aristida adscensionis*[1] | Six weeks three-awn | January-November | Early | Bulk | 2 |
| *Artemisia californica* | California sagebrush | --- | --- | Commercial | 4 |
| *Bahiopsis laciniata* | San Diego viguiera | --- | --- | Commercial | 2 |
| *Cryptantha intermedia* | Cryptantha | March-July | Mid | Bulk | 2 |
| *Deinandra fasciculata* | Fascicled tarweed | May-October | Late | Commercial | 3 |
| *Eriogonum fasciculatum* | California buckwheat | --- | --- | Commercial | 8 |
| *Plantago erecta* | Plantain | March-April | Early | Bulk | 4 |
| *Salvia apiana* | White Sage | --- | --- | Commercial | 2 |
| *Salvia columbariae* | Chia | March-June | Mid | Bulk | 1 |
| Total Pounds/Acre | | | **28** | | |

[1] Inclusion of native forbs will be subject to onsite and/or commercial availability.
[2] Source: collect = seed collected by CBI and volunteers; bulk = seed bulked by RECON; commercial = seed purchased through S & S Seeds, RECON, or other native plant nurseries.

spike-moss, and shining peppergrass (*Lepidium nitidum*). Small areas supporting a cryptogamic crust were noted in 2012; these areas generally had a lower cover of *Brachypodium* than surrounding habitat.

## Restoration Strategy

Restoration for polygon 002 **will not** be implemented during this program; however, the restoration strategy, and goals and objectives are presented here in case funding becomes available for restoration of this polygon in the future. Within this polygon, the restoration strategy will focus on reducing the cover of nonnative species, particularly grasses. The desired habitat condition is a native shrub matrix with openings that support a native forb component and/or bare ground.

## Goals and Objectives

**Goal**: Enhance habitat (within this polygon and adjacent polygons) for native species by decreasing cover of nonnative plant species.

*Objective 1*: Decrease cover of nonnative grasses, particularly *Brachypodium*, to ≤10-25%[2] within 2 years by applying a grass-specific herbicide (e.g., Fusilade II).

*Objective 2*: Decrease cover of exotic forbs to ≤10-25%[2] cover within 2 years through spot-treatments with herbicide (e.g., glyphosate-based herbicide).

## Restoration Specifications:

1. Treat nonnative grass with a grass-specific herbicide (e.g., Fusilade II) once a year for two years; treatments will be initiated in late January or early February. Applications will be made using a backpack sprayer following label directions (i.e., Fusilade II label directions = 0.4-0.6 ounce per 1000 square feet). Although the entire polygon will be treated, native bunchgrasses will be avoided to the degree practicable.
2. Spot-treat nonnative forbs with herbicides twice a year for two years after initial application of the grass-specific herbicide. The first forb treatment should occur in mid-to late March. Herbicide(s) chosen for nonnative forb control will be species-specific, and treatment times will be determined by species phenology, as assessed during site visits. Line trimmers may be used to cut nonnative forbs if deemed more appropriate than herbicide application, and should be used prior to seed set. If seed set has already occurred, cut vegetation will be placed in a location outside of polygon 002.

# Polygon: CER_003

## Existing Conditions

Polygon 003 is the largest polygon in the restoration area (4.20 acres), and is situated directly upslope from 005, which contains the historic San Diego thornmint location. Polygon 003 occurs on south- and southeast-facing slopes and supports clay soils (Las Posas series). Vegetation within this polygon is mapped as the *Artemisia californica-Eriogonum fasciculatum-Malosma laurina* Association. Shrub cover in this polygon is roughly 15% of the total cover; laurel sumac, California sagebrush, and goldenbush, are the most prevalent species. Additional shrubs include white sage, California buckwheat, and San Diego viguiera.

The herbaceous stratum is dominated by the nonnative grass, *Brachypodium*, which comprised an estimated 70% of the absolute cover in 2012. Additional nonnative grasses present in trace

[2] Percentages may be modified based on reference transects.

amounts include wild oats and red brome. Purple needlegrass (*Stipa* [formerly *Nassella*] *pulchra* is present in several well-developed patches. Exotic forbs are present only in low or trace amounts, and include tocalote, red-stemmed filaree, long-beaked filaree, and short podded-mustard. Native herbaceous perennials or geophytes are also present in trace amounts, including red-skin onion, bindweed (*Calystegia macrostegia*), soap plant (*Chlorogalum parviflorum*), mariposa lily, wishbone bush (*Mirabilis laevis*), common sand-aster (*Corethrogyne filaginifolia*), and blue dicks (*Dichelostemma capitatum*).

## Restoration Strategy

Within this polygon, the restoration strategy will focus on reducing the cover of nonnative species, particularly grasses, to create a native plant vegetative buffer above the historic San Diego thornmint occurrence located in Polygon 005. The desired habitat condition is a native shrub matrix with openings that support a native forb component and/or bare ground.

## Management Goals and Objectives

**Goal**: Enhance habitat for native species and decrease nonnative seed source by decreasing cover of nonnative plants.

*Objective 1*: Decrease cover of nonnative grasses, particularly *Brachypodium*, to ≤10-25%[3] within 2 years through use of a grass-specific herbicide (e.g., Fusilade II).

*Objective 2*: Decrease cover of exotic forbs to ≤10-25%[3] cover within 2 years through spot-treatments with herbicide (e.g., glyphosate-based herbicide).

## Restoration Specifications:

1. Treat nonnative grass with a grass-specific herbicide (e.g., Fusilade II) once a year for two years; treatments will be initiated in late January or early February 2013. Applications will be made using a backpack sprayer following label directions (i.e., Fusilade II label directions = 0.4-0.6 ounce per 1000 square feet). Although the entire polygon will be treated, native bunchgrasses will be avoided to the degree practicable.
2. Spot-treat nonnative forbs with herbicides twice a year for two years after initial application of the grass-specific herbicide. The first forb treatment is scheduled for mid-to late March 2013. Herbicide(s) chosen for nonnative forb control will be species-specific, and treatment times will be determined by species phenology, as assessed during site visits. Line trimmers may be used to cut nonnative forbs if deemed more appropriate than herbicide application, and should be used prior to seed set. If seed set has already occurred, cut vegetation will be

[3] Percentages may be modified based on reference transects.

placed in a location outside of polygon 003, as identified by CBI in consultation with the restoration subcontractor.

## Polygon: CER_004

### Existing Conditions

Polygon 004 is the smallest polygon in the restoration area (0.38 acre) and adjacent to and east of Polygon 005. This polygon is on a southwest-facing slope and supports clay soils (Las Posas series). Vegetation falls into the *Malosma laurina-Lotus scoparius* Association. The shrub stratum comprises between 5-10% of the total cover, and is dominated by laurel sumac with lesser amounts of white sage, redberry, toyon, California buckwheat, and San Diego County viguiera.

The herb stratum is continuous (>66% absolute cover) and *Brachypodium* is the dominant herb component, comprising between 75-90% of the total cover. Other nonnative grasses include wild oats and red brome. Both six-weeks awn-grass and purple needlegrass are present in low amounts. No exotic forbs were present in 2012, although dried remnants of tocalote were observed. Native forbs present in low or trace amounts include bindweed, mariposa lily, blue-dicks, and soap plant.

### Restoration Strategy

Restoration for polygon 004 **will not** be implemented during this program; however, the restoration strategy, and goals and objectives are presented here in case funding becomes available for restoration of this polygon in the future. Within this polygon, the restoration strategy will focus on reducing the cover of nonnative species, particularly grasses. The desired habitat condition is a native shrub matrix with openings that support a native forb component and/or bare ground.

### Management Goals and Objectives

**Goal**: Enhance habitat (within this polygon and adjacent polygons) for native species by decreasing cover of nonnative plant species.

*Objective 1*: Decrease cover of nonnative grasses, particularly *Brachypodium*, to ≤10-25%[4] within 2 years by applying a grass-specific herbicide (e.g., Fusilade II).

*Objective 2*: Decrease cover of exotic forbs to ≤10-25%[4] cover within 2 years through spot-treatments with herbicide (e.g., glyphosate).

[4] Percentages may be modified based on reference transects.

### Restoration Specifications:

1. Treat nonnative grass with a grass-specific herbicide (e.g., Fusilade II) once a year for two years; treatments will be initiated in late January or early February. Applications will be made using a backpack sprayer following label directions (i.e., Fusilade II label directions = 0.4-0.6 ounce per 1000 square feet). Although the entire polygon will be treated, native bunchgrasses will be avoided to the degree practicable.
2. Spot-treat nonnative forbs with herbicides twice a year for two years after initial application of the grass-specific herbicide. Herbicide(s) chosen for nonnative forb control will be species-specific, and treatment times will be determined by species phenology, as assessed during site visits. Line trimmers may be used to cut nonnative forbs if deemed more appropriate than herbicide application, and should be used prior to seed set. If seed set has already occurred, cut vegetation will be placed in a location outside of polygon 004.

## Polygon: CER_005

### Existing Conditions

Polygon 005 occupies south- and southwest-facing slopes in clay soils (Las Posas series), and lies directly south of Polygon 003. This site supports an historic occurrence of San Diego thornmint and is the key polygon in this restoration effort. The polygon is 3.09 acres, and vegetation is mapped the *Salvia apiana-Artemisia californica* Association. The shrub stratum comprises about 30% cover, and white sage (*Saliva apiana*) is the dominant shrub species. Associated shrubs include laurel sumac and California sagebrush (*Artemisia californica*); shrubs present in trace amounts include broom baccharis (*Baccharis sarothroides*), bushrue (*Cneoridium dumosum*), California buckwheat (*Eriogonum fasciculatum*), redberry (*Rhamnus crocea*), Our Lord's candle (*Hesperoyucca whipplei*), and honeysuckle (*Lonicera subspicata*).

The herbaceous stratum is dominated by the nonnative grass, *Brachypodium*, which comprised an estimated 50-75% of the absolute cover in 2012. Additional nonnative grasses present in trace amounts include fountain grass (*Pennisetum setaceum*) and tanglehead (*Heteropogon contortus*). Purple needlegrass (*Stipa* [formerly *Nassella*] *pulchra* and six-weeks three-awn (*Aristida adscencionis*) are also present, the latter on dryer slopes. No exotic forbs were observed in 2012. Native forbs include herbaceous perennials or geophytes, such as red-skin onion (*Allium haematochiton*), bindweed (*Calystegia macrostegia*), soap plant (*Chlorogalum parviflorum*), and blue dicks (*Dichelostemma capitatum*).

### Restoration Strategy

Within this polygon, the restoration strategy will focus on reducing the cover of nonnative species, particularly grasses. The desired habitat condition for this polygon is the *Salvia apiana-*

*Artemisia californica* Association, with the herbaceous stratum dominated by native geophytes and annual species (including San Diego thornmint). Depending on results of the restoration process, augmentation with San Diego thornmint seed and other native forbs may be necessary at a later date.

### Management Goals and Objectives

**Goal**: Enhance habitat for San Diego thornmint by decreasing cover of nonnative species and increasing bare ground (opportunities) for native shrub and forb germination and pollinators.

*Objective 1*: Decrease cover of nonnative grasses, particularly *Brachypodium*, to ≤10-25%[5] within 2 years by applying a grass-specific herbicide (e.g., Fusilade II).

*Objective 2*: Decrease cover of exotic forbs to ≤10-25%[5] cover within 2 years through spot-treatments with herbicide (e.g., glyphosate-based herbicide).

### Restoration Specifications:

1. Treat nonnative grass with a grass-specific herbicide (e.g., Fusilade II) twice a year the first year (2013) and once a year the second year (2014); treatments will be initiated in late January or early February. Applications will be made using a backpack sprayer following label directions (i.e., Fusilade II label directions = 0.4-0.6 ounce per 1000 square feet). Although the entire polygon will be treated, native bunchgrasses will be avoided to the degree practicable.
2. Spot-treat nonnative forbs with herbicides twice a year for two years after initial application of the grass-specific herbicide. The first forb treatment is scheduled for mid-to late March 2013. Herbicide(s) chosen for nonnative forb control will be species-specific, and treatment times will be determined by species phenology, as assessed during site visits. Line trimmers may be used to cut nonnative forbs if deemed more appropriate than herbicide application, and should be used prior to seed set. If seed set has already occurred, cut vegetation will be placed in a location outside and downslope of polygon 005, as identified by CBI in consultation with the restoration subcontractor.

## Polygon: CER_006

### Existing Conditions

Polygon 006 lies on a south-facing slope and supports clay soils (Las Posas series). This polygon is relatively small (0.58 acre); vegetation is mapped as the *Malosma laurina-Lotus scoparius* Association. The shrub stratum comprises between 10-25% of the total cover, and is

[5] Percentages may be modified based on reference transects.

dominated by laurel sumac, white sage, and California sagebrush, with trace amounts of toyon and our Lord's candle.

The herb stratum is continuous (>66% absolute cover) and *Brachypodium* is the dominant herb component, comprising between 75-90% of the total cover. Exotic forbs are also present in low amounts this polygon, and tocalote, red-stem filaree, and short-pod mustard. Numerous stands of purple needlegrass were noted. Native forbs present in low or trace amounts include bindweed and mariposa lily.

## Restoration Strategy

Restoration for polygon 006 **will not** be implemented during this program; however, the restoration strategy, and goals and objectives are presented here in case funding becomes available for restoration of this polygon in the future. Within this polygon, the restoration strategy will focus on reducing the cover of nonnative species, particularly grasses. The desired habitat condition is a native shrub matrix with openings that support a native forb component and/or bare ground.

## Management Goals and Objectives

**Goal**: Enhance habitat (within this polygon and adjacent polygons) for native species by decreasing cover of nonnative plant species.

*Objective 1*: Decrease cover of nonnative grasses, particularly *Brachypodium*, to ≤10-25%[6] within 2 years by applying a grass-specific herbicide (e.g., Fusilade II).

*Objective 2*: Decrease cover of exotic forbs to ≤10-25%[6] cover within 2 years through spot-treatments with herbicide (e.g., glyphosate).

## Restoration Specifications:

1. Treat nonnative grass with a grass-specific herbicide (e.g., Fusilade II) once a year for two years; treatments will be initiated in late January or early February. Applications will be made using a backpack sprayer and following label directions (i.e., Fusilade II label directions = 0.4-0.6 ounce per 1000 square feet). Although the entire polygon will be treated, native bunchgrasses will be avoided to the degree practicable.
2. Spot-treat nonnative forbs with herbicides twice a year for two years after initial application of the grass-specific herbicide. Herbicide(s) chosen for nonnative forb control will be species-specific, and treatment times will be determined by species phenology, as assessed during site visits. Line trimmers may be used to cut nonnative forbs if deemed more appropriate than herbicide application, and should be used prior to seed set. If seed set has

[6] Percentages may be modified based on reference transects.

already occurred, cut vegetation will be placed in a location outside and downslope of polygon 006.

## Summary

Table X presents a summary of treatments to be implemented on CER (polygons 1,3,5).

Table X
*Brachypodium* Control/Habitat Restoration Treatments

| Polygon | 2012 | 2013 | | | | 2014 | | |
|---|---|---|---|---|---|---|---|---|
| | Dethatch | Mowing | Fusilade | Glyphosate | Seed | Mowing | Fusilade | Glyphosate |
| 001 | 1x | 1x | --- | 2x | 1x | 1x | --- | 2x |
| 003 | --- | --- | 1x | 2x | --- | --- | 1x | 2x |
| 005 | --- | --- | 2x | 2x | --- | --- | 1x | 2x |

# References

Conservation Biology Institute (CBI). 2012. 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. Prepared for San Diego Association of Governments (SANDAG). Contract no. 5001586. June.

Sproul, F., T. Keeler-Wolf, P. Gordon-Reedy, J. Dunn, A. Klein, and K. Harper. Vegetation classification manual for western San Diego County. First edition. Prepared by AECOM, California Department of Fish and Game Vegetation Classification and Mapping Program, and Conservation Biology Institute. Prepared for San Diego Association of Governments. February.

United States Department of Agriculture, Natural Resources Conservation Service (USDA, NRCS). 2007. Soil survey geographic (SSURGO) database for San Diego County, California, USA. Accessed February 22, 2011.

Appendix C.2

# *Brachypodium* Removal: Treatment & Restoration Plan, South Crest Properties

*Prepared by*

Conservation Biology Institute

SANDAG Contract No. 5001965

# *Brachypodium* Treatment & Restoration Plan: South Crest Properties

## Introduction

The South Crest properties are located within the San Diego National Wildlife Refuge (SDNWR) acquisition boundary in San Diego County, and are owned and managed by the Endangered Habitats Conservancy (EHC). South Crest, along with the Crestridge Ecological Reserve to the north, forms a core block of habitat that serves as a landscape linkage between the northern and southern parts of the Multiple Species Conservation Program (MSCP) in San Diego County (Figure 1). Central to the MSCP is the maintenance of ecosystems and vegetation communities that support sensitive species and fragile, regionally declining resources. The MSCP's goal is to prevent future endangerment of the plants and animals that are dependent on these habitats. Thus, management of South Crest is also critical to conservation resources in South County managed by the Bureau of Land Management, U.S. Fish and Wildlife Service, California Department of Fish and Game, County of San, City of San Diego, and The Nature Conservancy.

The central portion of South Crest currently supports four sensitive plant species: large populations of the state-endangered Dehesa beargrass (*Nolina interrata*) and the sensitive Parry's tetracoccus (*Tetracoccus dioicus*), and smaller populations of the federally- and state-endangered San Diego thornmint (*Acanthomintha ilicifolia*) and the sensitive variegated dudleya (*Dudleya variegata*) (Figure 2). Habitat in this area, and particularly in the low-lying portion of the site known as 'Skeleton Flats,' has a history of disturbance, including dryland farming in the 1950s and early 1960s, at least 30 years of off-highway vehicle use (www.historicaerials.com), and the 2003 Cedar Fire, and has been invaded by the nonnative, annual grass, purple falsebrome (*Brachypodium distachyon*).

To date, an estimated 15.79 acres of *Brachypodium*-invaded habitat have been mapped on South Crest, and this invasive species also extends offsite to the north, south, and west (Figure 3). Although *Brachypodium* is not the only invasive plant in this area, it poses a particular threat because it forms nearly monotypic stands that inhibit germination and growth of San Diego thornmint, variegated dudleya, and other native, annual forbs. Its effect on perennial bulbs and shrubs is not as clear. While there may be a short-term, beneficial effect on vegetative growth due soil shading and/or water retention, *Brachypodium* may pose long-term, adverse impacts to these species through increased fire frequency and/or intensity, alteration of soil nutrients, and reduced opportunities for regeneration through sexual reproduction.

In an effort to reduce the threat to these species from *Brachypodium*, habitat enhancement/restoration is proposed over an estimated 10 acres of habitat on Skeleton Flats.

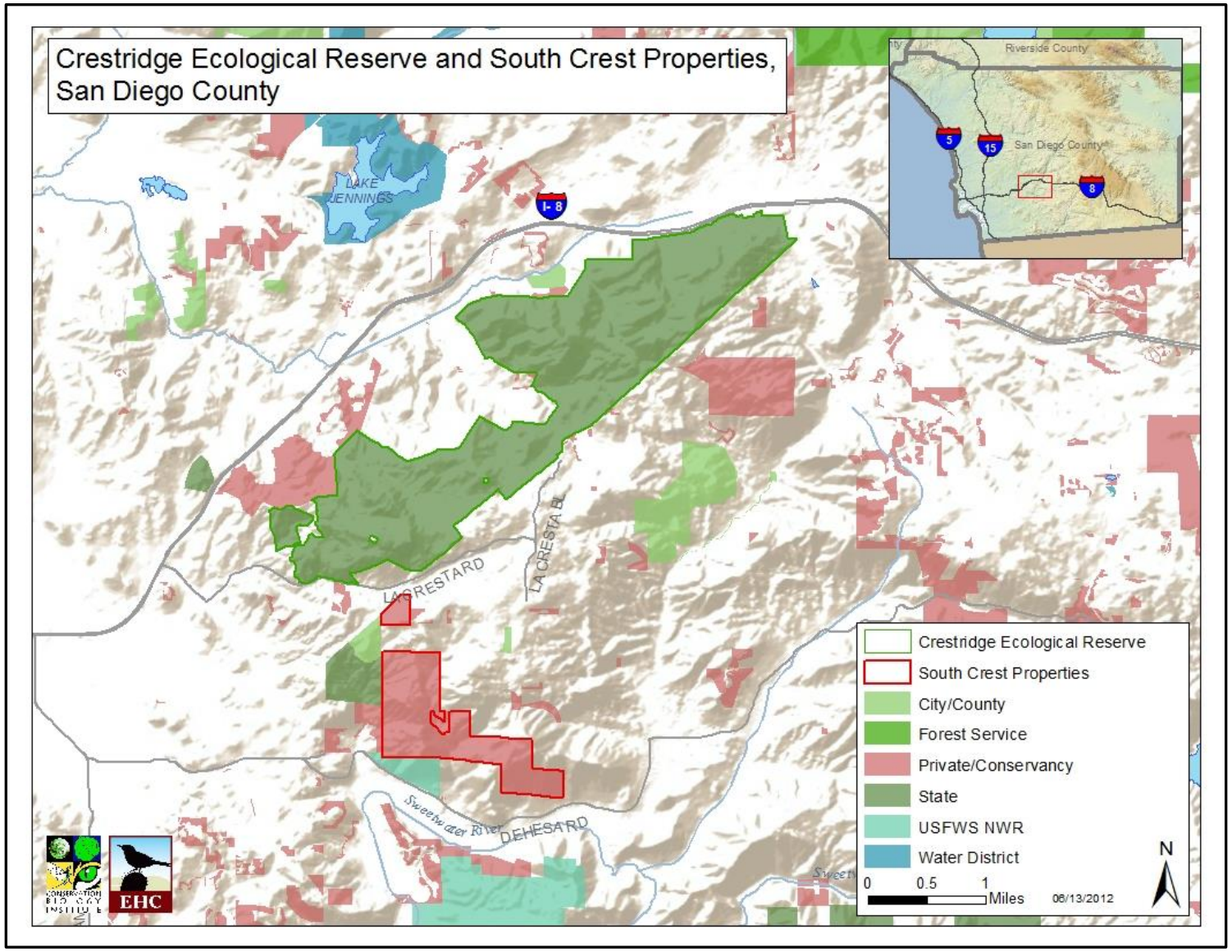


Figure 1. Location of South Crest properties, San Diego County, California.

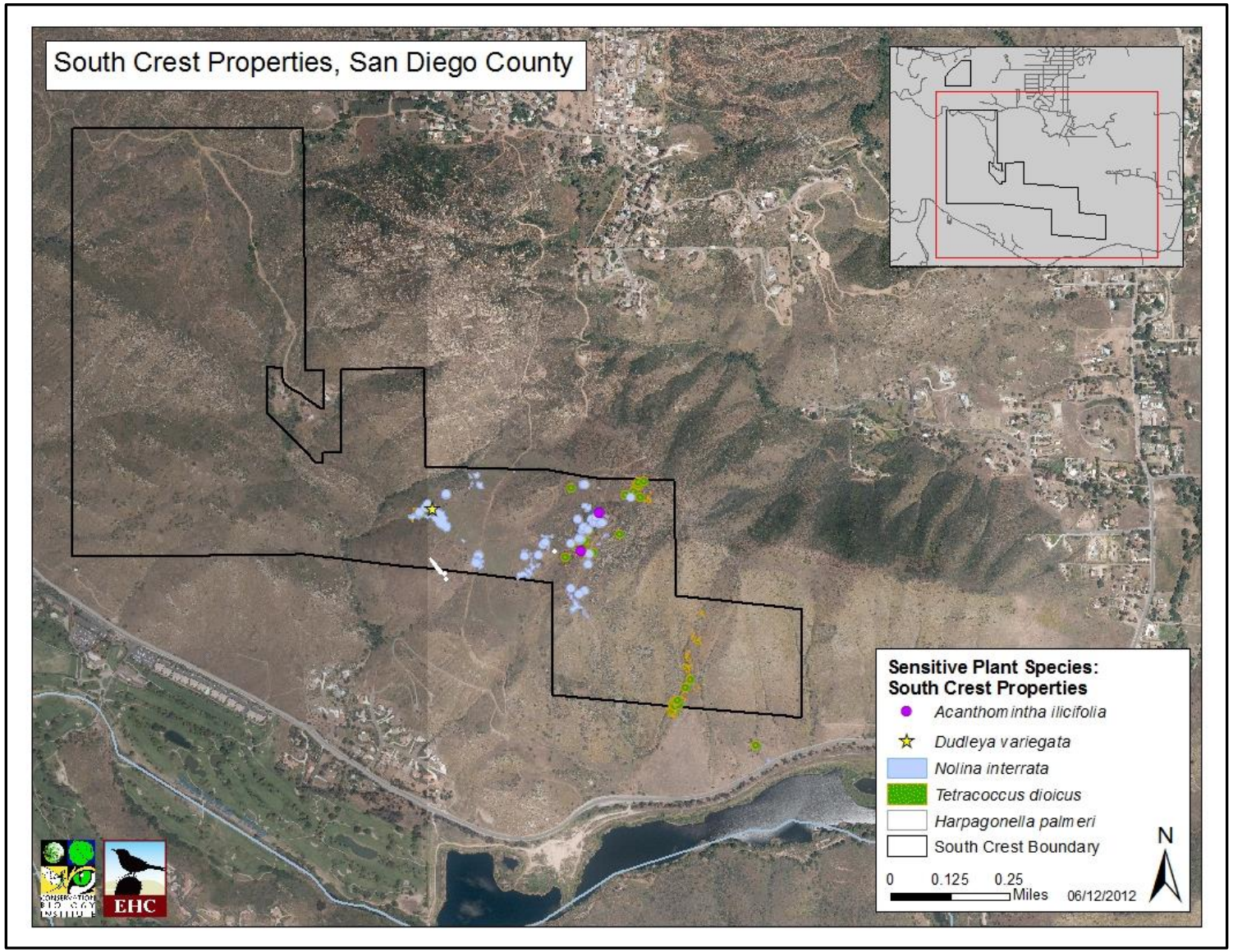


Figure 2. Sensitive plant species, South Crest properties.

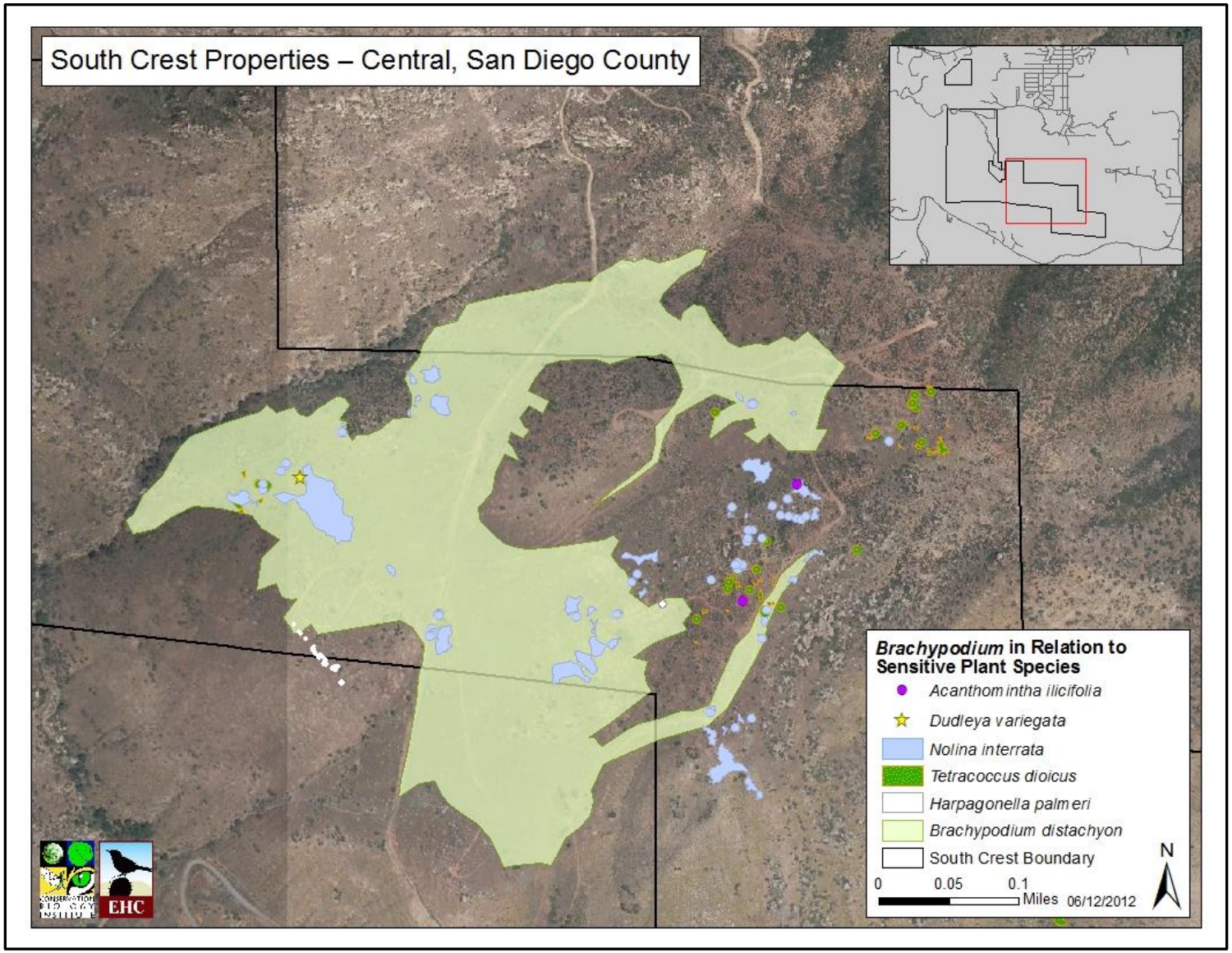


Figure 3. Distribution of *Brachypodium distachyon* on Skeleton Flats in relation to sensitive plant species.

Target restoration areas were selected because (1) they currently or historically supported target species; (2) they are adjacent to target species localities and possess many of the same habitat attributes; and/or (3) they are adjacent or in proximity to existing target species localities and currently function as a source of invasive seed propagules. It should be noted that as these areas are rehabilitated, restoration efforts may expand outward to encompass additional degraded habitat; however, additional restoration is not included in this plan.

The restoration plan will apply control methods tailored to the target sensitive species or to improving habitat adjacent to these targets. The long-term goal of this effort is to develop and maintain vegetative associations that are biologically diverse, support target resources, and are largely invasion-resistant. In addition to weed control and species augmentation, plan implementation will generate (1) costs per acre of alternative invasive control and restoration techniques and (2) success rates of alternative invasive control and restoration techniques. This plan also includes an experimental design component to ensure that any change in conditions can be related to the treatment(s). It should be noted that Skeleton Flats cannot be accessed by vehicles or mechanized equipment (i.e., tractors, hydroseed, imprinting, and drill seed machinery and equipment), nor is water for irrigation available at this site. The restoration approach and strategies described below reflect these impediments and focus on methods deemed suitable for these conditions.

## Approach

*Brachypodium* is a widely distributed species that forms dense stands on clay soils and appears to exact the most detrimental effects on annual species. Although published sources indicate that seed bank longevity is relatively short (one-two years), seed collected and tested from the Crestridge Ecological Reserve exhibits high viability after two years (testing will continue to determine whether or not seed viability drops over time), and it is not yet known whether seed bank management is a viable means of eradication or control. Removal of *Brachypodium* will likely release additional invasive species from the soil seed bank; thus, the treatment approach includes both grass and broadleaf forb control. Grass-specific herbicides have been shown to be effective in controlling *Brachypodium* and will be used except where native grasses occur in relatively high densities. In those cases, mechanical removal will be substituted. Experimental treatments indicate that while herbicides result in the greatest decrease in *Brachypodium* cover, they can also result in a significant increase in exotic forb species. Conversely, mechanical removal is less effective than herbicide treatment but more effective than no treatment, and appears to release fewer exotic forbs from the seed bank (CBI 2012).

Because of the extensive weed seed bank, the overarching goal of this program is to allow plant communities to shift in a favorable direction, with the realization that 100% control of invasive species is unlikely within the two-year timeframe of this project. The following principles will be followed in implementing this shift:

- Remove nonnative, invasive plants (including thatch) to create conditions under which native species can flourish, minimize potential for reinvasion of restored habitat, and increase *potential* habitat for target species.
    - Decrease growth, propagule production, and frequency of dispersal of invasive species
    - Manage seed bank of invasive species
- Establish desirable (native) species that are functionally similar to invader
    - Increase propagule production and frequency of dispersal of native species
    - Alter frequency and timing of native seeding
    - Alter seeding rate of native species

In 2012, we mapped 8 habitat polygons on South Crest (Figure 4), using a qualitative habitat assessment methodology. Data from this mapping effort have been used to develop polygon-specific restoration plans. Table 1 summarizes size and biotic and abiotic conditions of each polygon, Table 2 summarizes restoration treatments for each polygon, and Table 3 provides an implementation schedule. Restoration plans are detailed below for each polygon, and include a synopsis of existing conditions, polygon-specific restoration strategies, management goals and objectives, and restoration specifications.

# Restoration Plans

## Polygon 001

### Existing Conditions

Polygon 001 lies on a west-facing slope in gabbro-derived soils (Las Posas series), and extends offsite to the north. The entire polygon is 2.32 acres; the onsite acreage is 0.75 acre. Onsite, this polygon occurs on a west-facing slope adjacent to and east of the north-south oriented dirt road that transects Skeleton Flats. Vegetation is classified as *Salvia apiana-Artemisia californica* Association. The shrub stratum comprises nearly 40% of the total cover, while the herb stratum is generally intermittent (≥33% and ≤66% absolute cover) and relatively diverse.

The state-endangered plant, Dehesa beargrass (*Nolina interrata*), is the most common shrub[1] in this polygon; white sage (*Salvia apiana*) is a subdominant shrub. Additional shrubs present in low or trace amounts include California sagebrush (*Artemisia californica*), laurel sumac (*Malosma laurina*), goldenbush (*Isocoma menziesii*), California match-weed (*Gutierrezia* sp.), toyon (*Heteromeles arbutifolia*), deerweed (*Acmispon glaber* [formerly *Lotus scoparius*]), and chamise (*Adenostoma fasciculatum*).

[1] Although Calflora considers this species to be a perennial herb, other sources consider it a shrub or at least a perennial with a woody base or stem (e.g., Baldwin et al. 2012, Sproul et al. 2011, USFWS 1995). For these reasons, and because of its stature onsite, we placed it in the shrub stratum while conducting habitat assessments.

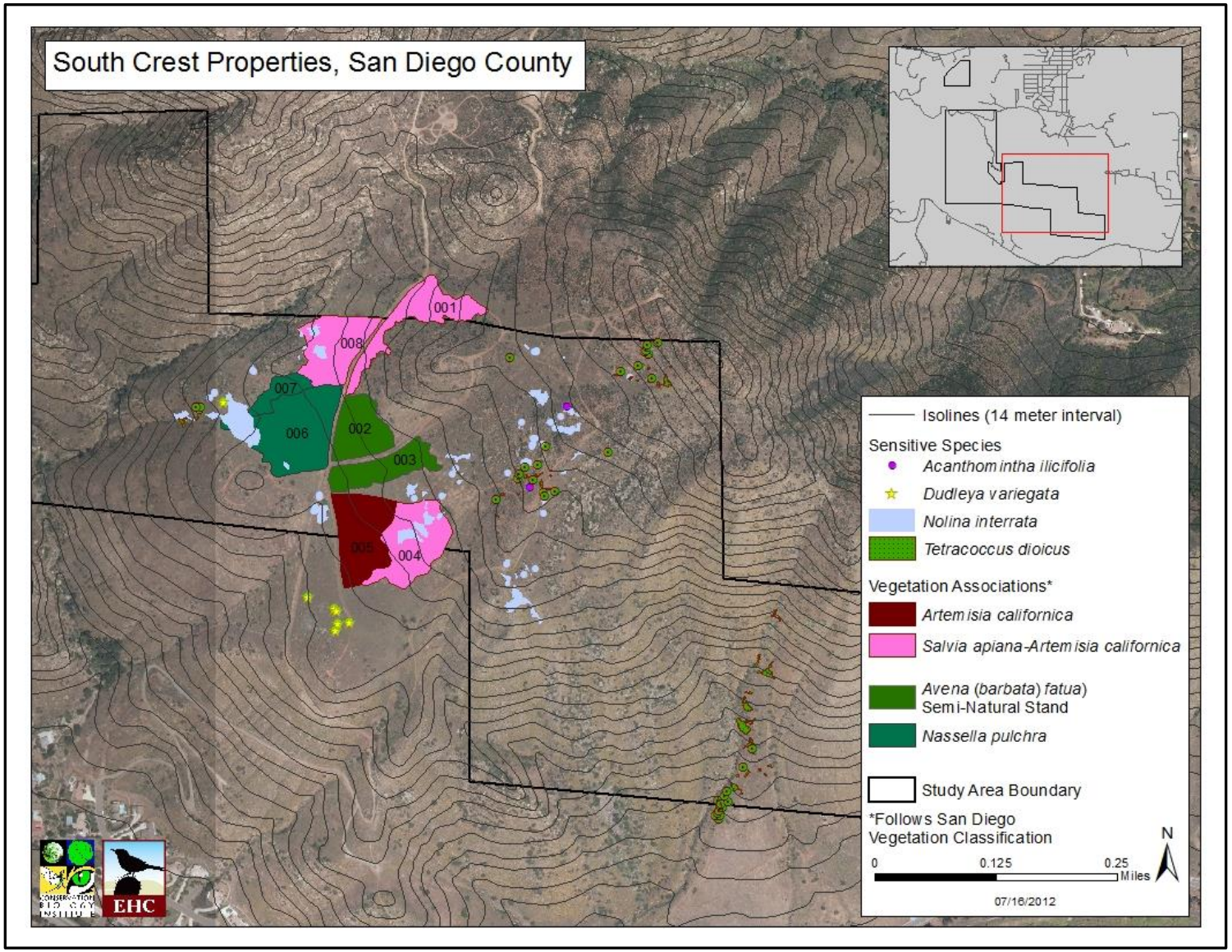


Figure 4. Habitat assessment polygons.

Table 1
Summary of Polygon Attributes

| Polygon | Attribute | | | | |
|---|---|---|---|---|---|
| | Size (acres) | Slope | Soil Type[1] | Vegetation Association[2] | Target Species[3] |
| 1 | 0.75[4] | West | Clay | *Salvia apiana-Artemisia californica* | *Nolina interrata* |
| 2 | 2.00 | West | Clay | *Avena (barbata) fatua)* Semi-Natural Stand | --- |
| 3 | 1.86 | West | Clay; Gabbro | *Avena (barbata) fatua)* Semi-Natural Stand | *Acanthomintha ilicifolia, Dudleya variegata* |
| 4 | 1.74[4] | Southwest, West | Clay; Gabbro | *Salvia apiana-Artemisia californica* Association | *Nolina interrata, Acanthomintha ilicifolia, Dudleya variegata* |
| 5 | 1.63[4] | South, Southwest | Clay | *Artemisia californica* Association | *Dudleya variegata* |
| 6[5] | 4.40 | West, Flat | Clay | *Nassella pulchra* | *Nolina interrata* |
| 7[5] | 0.78 | Southwest | Clay | *Nassella pulchra* | *Nolina interrata* |
| 8 | 2.62 | Northwest, West | Gabbro | *Salvia apiana-Artemisia californica* | *Nolina interrata* |

[1] Clay soils are in the Auld series; gabbro-derived soils are in the Las Posas series (USDA-NRCS 2007).
[2] Vegetation associations follow Sproul et al. 2011.
[3] Target species indicates focus of habitat restoration effort; species may or may not be present in polygon.
[4] Acreage onsite; polygon extends offsite.
[5] Management actions are not planned in these polygons during this project; however, actions are specified in this table and in the text in the event that funding becomes available to extend treatments into these areas in the future.

Table 2
South Crest Properties: Restoration Tasks

| Enhancement/Restoration Tasks | Polygon Number | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6[1] | 7[1] | 8 |
| Seed Collection[2] | X | X | X | X | X | X | X | X |
| Site Preparation | | | | | | | | |
| • Stake polygons (except where delineated by roads)[3] | X | X | X | X | X | | | X |
| • Dethatch; line trim and remove thatch from polygon | | X | X | | | | | |
| • Dethatch; rake and remove thatch from polygon[4] | | | X | | | | | |
| • Treat nonnative grasses with a grass-specific herbicide (i.e., Fusilade II) | X | X | X | X | X | | | X |
| • Treat nonnative forbs with a broad-spectrum herbicide (i.e., glyphosate-based herbicide) | X | X | X | X | X | | | X |
| • Scarify soil, add native seed, and tamp soil | | X | X | | | | | |
| Performance Monitoring[3] | X | X | X | X | X | | | X |

[1] Management actions are not planned in these polygons during this project; however, actions are specified in the text in the event that funding becomes available to extend treatments into these areas in the future.
[2] Task to be conducted by CBI and volunteers.
[3] Task to be conducted by CBI.
[4] One quarter of polygon 3 will be dethatched using rakes instead of line trimmers; the remainder of the polygon will be dethatched using line trimmers.

Table 3
Implementation, Maintenance, and Monitoring Schedule

| Restoration Task | 2012 | | 2013 | | | | 2014 |
|---|---|---|---|---|---|---|---|
| | Fall | Winter | Spring | Summer | Fall | Winter | Spring |
| Seed collection | X | X | X | X | X | | |
| Seed bulking | X | X | X | X | X | X | |
| Dethatching | X | X | | | | | |
| Weed Control[1] | | X | X | X | X | X | X |
| Seeding | | | | | X | X | |
| Performance Monitoring | | | X | X | | | X |

[1] Herbicide and mechanical control.

The herb stratum is dominated by the nonnative grass, purple falsebrome (*Brachypodium distachyon*), which comprised an estimated 50% of the vegetative cover in 2012. Additional nonnative grasses present in trace amounts include wild oats (*Avena barbata*) and foxtail fescue (*Festuca* [formerly *Vulpia*] *myuros*). The native purple needlegrass (*Stipa* [formerly *Nassella*] *pulchra*) and foothill needlegrass (*Stipa* [formerly *Nassella*] lepida) are also present in trace amounts. Exotic forbs include low levels of tocalote (*Centaurea melitensis*) and crete hedypnois (*Hedypnois cretica*), and trace amounts of scarlet pimpernel (*Anagallis arvensis*), prickly wild lettuce (*Lactuca serriola*), short-pod mustard (*Hirschfeldia incana*), red-stem filaree (*Erodium cicutarium*), narrow-leaved filago (*Filago gallica*), and dwarf plantain (*Plantago virginica*). Native forbs present in low or trace amounts include bindweed (*Calystegia macrostegia*), common sand-aster (*Corethrogyne filaginifolia*), blue-eyed grass (*Sisrynchium bellum*), flat-top golden yarrow (*Eriophyllum confertiflorum*), splendid mariposa lily (*Calochortus splendens*), onion (*Allium* sp.), rattlesnake weed (*Daucus pusillus*), narrow-leaved bedstraw (*Galium angustifolium*), clustered tarweed (*Deinandra fasciculata*), slender sunflower (*Helianthus gracilentus*), and California thistle (*Cirsium occidentale* var. *californicum*).

## Restoration Strategy

The restoration strategy for this polygon will focus on reducing the cover of nonnative species, particularly grasses, on slopes above the dirt road. The desired habitat condition is a native shrub matrix with openings that support a native forb component and/or bare ground.

### Management Goals and Objectives

**Goal**: Enhance habitat for native species, including Dehesa beargrass, by decreasing cover of nonnative plants, and reduce the potential for gravity-dispersed nonnative propagules into habitat downslope.

*Objective 1*: Decrease cover of nonnative grasses, particularly *Brachypodium*, to ≤10-25%[2] within 2 years using a grass-specific herbicide (e.g., Fusilade II).

*Objective 2*: Decrease cover of exotic forbs to ≤10-25%[1] cover within 2 years through spot-treatments with herbicide (e.g., glyphosate-based herbicide).

### Restoration Specifications

1. Treat nonnative grass with a grass-specific herbicide (e.g., Fusilade II) once a year for two years; treatments will be initiated in late January or early February 2013. Applications will be made using a backpack sprayer following the label directions (i.e., Fusilade II label directions = 0.4-0.6 ounce per 1000 square feet). Treatment will occur only in the onsite portion of the polygon; native bunchgrasses will be avoided to the degree practicable.
2. Spot-treat nonnative forbs with herbicides twice a year for two years after initial application of the grass-specific herbicide. The first forb treatment will occur in mid-to late March 2013. Herbicide(s) chosen for nonnative forb control will be species-specific, and treatment times will be determined by species phenology, as assessed by CBI and SERG during site visits. Line trimmers may be used to cut nonnative forbs if deemed more appropriate than herbicide application, and should be used prior to seed set. If seed set has occurred, cut vegetation will be placed in the dethatch compost piles (see polygons 2 and 3, below).

## Polygon 002

### Existing Conditions

Polygon 002 (2.0 acres) occurs on terrain that is gently sloping and oriented toward the west. Soils are clays (Auld series), and existing vegetation is classified as *Avena (barbata) fatua)* Semi-Natural Stand, which is a nonnative grassland association. The shrub stratum is poorly-developed, comprising <10% of the total cover. The herb stratum is continuous (≥66% absolute cover) and dominated by nonnative grasses.

Shrubs present in low or trace amounts include goldenbush, laurel sumac, California sagebrush, matchweed, San Diego County viguiera (*Bahiopsis laciniata*), redberry (*Rhamnus crocea*), California buckwheat (*Eriogonum fasciculatum*) and deerweed.

[2] Percentages may be modified based on reference transects.

The herb stratum is dominated by the nonnative grasses, *Brachypodium* and wild oats, which comprised an estimated 35 and 45%, respectively, of the absolute cover in 2012. The native purple needlegrass is present in trace amounts. Exotic forbs include trace amounts of crete hedypnois and prickly wild lettuce. Native forbs include low amounts of common sand-aster and bindweed, and trace amounts blue-eyed grass, splendid mariposa lily, clustered tarweed and California thistle.

## Restoration Strategy

Within this polygon, the restoration strategy will focus on (1) reducing the cover of nonnative species, particularly grasses and (2) augmenting native grass and forb species through the introduction of propagules. Based on the habitat assessment process, this polygon was identified as suitable for native grassland, which is the desired habitat condition.

## Management Goals and Objectives

**Goal**: Enhance habitat for native grassland species by decreasing cover of nonnative plants and introducing native grass and forb propagules.

*Objective 1*: Decrease cover of nonnative grasses, particularly *Brachypodium*, to ≤10-25%[3] within 2 years through a combination of dethatching and grass-specific herbicide (e.g., Fusilade II).

*Objective 2*: Decrease cover of exotic forbs to ≤10-25%[1] cover within 2 years through spot-treatments with herbicide (e.g., glyphosate-based herbicide).

*Objective 3*: Augment native grasses to at least 10%[1] absolute cover by introducing propagules (i.e., seed).

*Objective 4*: Increase native forb percent cover to at least 10% of the absolute cover by introducing early-, mid-, and late-blooming native forb species into the soil seed bank within 2 years of initiating nonnative grass and forb treatments.

## Restoration Specifications

1. Dethatch site in Fall 2012 using line trimmers. Bare soil should be exposed to enhance contact between native seed and soil. All dethatch material should be removed from the polygon and placed in compost piles onsite, as determined by CBI in conjunction with SERG.
2. Treat nonnative grass with a grass-specific herbicide (e.g., Fusilade II) twice a year for one year. The first application will occur in late January or early February 2013, and the second treatment will occur in March or April 2013. Applications will be made using a backpack

[3] Percentages may be modified based on reference transects.

sprayer following the label directions (i.e., Fusilade II label directions = 0.4-0.6 ounce per 1000 square feet). Although the entire polygon will be treated, native bunchgrasses will be avoided to the degree practicable.

3. Spot-treat nonnative forbs with herbicides twice a year for two years after initial application of the grass-specific herbicide. The first forb treatment will occur in mid-to late March 2013. Herbicide(s) chosen for nonnative forb control will be species-specific, and treatment times will be determined by species phenology, as assessed by CBI and SERG during site visits. Line trimmers may be used to cut nonnative forbs if deemed more appropriate than herbicide application, and should be used prior to seed set. If seed set has already occurred, cut vegetation will be placed in the dethatch compost piles (see above).
4. Introduce native shrub, grass and forb seeds in Fall 2013 and Winter 2014. Prior to seeding, soil will be scarified using garden rakes; scarification will avoid established vegetation to the degree practicable. Seed will be hand broadcast and then tamped into the scarified soil. The forb component of the seed mix should be proportionally skewed towards early-germinating species to compete with early-germinating nonnative grasses (Table 4). No supplemental watering will occur after seeding, unless water can easily be conveyed to the site.

## Polygon 003

### Existing Conditions

Polygon 003 (1.86 acres) is situated on a gentle, west-facing slope and lies directly south of Polygon 002; the two polygons are separated by an east-west trending dirt trail. Clay soils (Auld series) dominate the western half of this polygon, while gabbro-derived soils (Las Posas series) are prevalent in the eastern half. Existing vegetation is classified as *Avena (barbata) fatua)* Semi-Natural Stand Type. The shrub stratum is poorly-developed, comprising <10% of the total cover. The herb stratum is continuous (≥66% absolute cover), and dominated by nonnative grasses.

Shrubs present in low or trace amounts include goldenbush, white sage, California sagebrush, deerweed, laurel sumac, San Diego County viguiera, broom baccharis (*Baccharis sarothroides*), and prickly-pear (*Opuntia* sp.).

The herb stratum is dominated by the nonnative grasses, wild oats and *Brachypodium*, which comprised an estimated 60% and 25%, respectively, of the absolute cover in 2012. There are trace amounts of purple needlegrass in this polygon. Exotic forbs include trace amounts of prickly wild lettuce, tocalote, and short-pod mustard. Native forbs include low amounts of common sand-aster and trace amounts of blue-eyed grass, splendid mariposa lily, narrow-leaved bedstraw, flat-top golden yarrow, and gum plant (*Grindelia camporum*).

Table 4
Proposed Native Seed[1] Mix for Polygon 002

| Scientific Name | Common Name | Flowering Period | Forb Phenology | Source[2] | Pounds/Acre |
|---|---|---|---|---|---|
| *Artemisia californica* | California sagebrush | August - November | --- | Commercial, Collect | 4 |
| *Calochortus splendens* | Splendid mariposa lily | March-July | Mid | Collect | 1 |
| *Corethrogyne filaginifolia* | Sand-aster | July-November | Late | Bulk | 1 |
| *Deinandra fasciculata* | Fascicled tarweed | May-October | Late | Commercial, Collect | 3 |
| *Eriogonum fasciculatum* | California buckwheat | Year-round | --- | Commercial | 8 |
| *Grindelia camporum* | Gumplant | January-November | Early | Commercial; Collect | 4 |
| *Isocoma menziesii* | Goldenbush | June-November | --- | Commercial, Collect | 3 |
| *Lasthenia californica ssp. californica* | California goldfields | March-May | Early | Commercial | 1 |
| *Layia platyglossa* | Tidy tips | February-May | Early | Commercial | 1 |
| *Lupinus bicolor* | Miniature lupine | March-June | Mid | Commercial | 4 |
| *Sisrynchium bellum* | Blue-eyed grass | April-June | Mid | Collect | 3 |
| *Stipa lepida/pulchra* | Foothill/purple needlegrass | March-June | --- | Bulk | 6 |
| **Total Pounds/Acre** | | | | | **39** |

[1] Inclusion of native forbs will be subject to onsite and/or commercial availability.
[2] Source: collect = seed collected by CBI and volunteers; bulk = seed bulked by RECON; commercial = seed purchased through S & S Seeds, RECON, or other native plant nurseries.

## Restoration Strategy

Within this polygon, the restoration strategy will focus on (1) reducing the cover of nonnative species, particularly grasses and (2) augmenting native shrub, grass, and forb species through the introduction of propagules. Based on the habitat assessment process, this polygon was identified as suitable for native grassland. Based on soil types, however, restoration in the western half of this polygon will focus on establishing a native grassland community, while efforts in the eastern half of this polygon will focus on enhancing native shrubs and forbs that are characteristic of scrub habitats.

## Management Goals and Objectives

**Goal**: Enhance habitat for native grassland and scrub species, including variegated dudleya and San Diego thornmint, by decreasing cover of nonnative plants and introducing native shrub, grass, and forb propagules.

*Objective 1*: Decrease cover of nonnative grasses, particularly *Brachypodium*, to ≤10-25%[4] within 2 years through a combination of dethatching and a grass-specific herbicide (e.g., Fusilade II).

*Objective 2*: Decrease cover of exotic forbs to ≤10-25%[1] cover within 2 years through spot-treatments with herbicide (e.g., glyphosate-based herbicide).

*Objective 3*: Augment native grasses in the western half of this polygon to at least 5%[1] absolute cover by introducing propagules (i.e., seed).

*Objective* 4: Augment native shrubs in the eastern half of this polygon to at least 10%[1] absolute cover by introducing propagules (i.e., seed).

*Objective 5*: Increase native forbs throughout this polygon to at least 10% of the absolute cover by introducing early-, mid-, and late-blooming native forb species into the soil seed bank within 2 years of initiating nonnative grass and forb treatments.

## Restoration Specifications

1. Dethatch site in Fall 2012. An estimated one-quarter of this site will be dethatched by raking only, while the remainder of the site will be dethatched by line trimmers and subsequent raking. Bare soil should be exposed through this effort to enhance contact between native seed and soil. All dethatch material should be removed from the polygon and placed in compost piles onsite, as determined by CBI in conjunction with SERG.
2. Treat nonnative grass with a grass-specific herbicide (e.g., Fusilade II) twice a year for one year. The first application will occur in late January or early February 2013, and a second treatment will be applied in March or April 2013. Applications will be made using a backpack sprayer following the label directions (i.e., Fusilade II label directions = 0.4-0.6 ounce per 1000 square feet). Although the entire polygon will be treated, native bunchgrasses will be avoided to the degree practicable.
3. Spot-treat nonnative forbs with herbicides twice a year for two years after initial application of the grass-specific herbicide. The first forb treatment will occur in mid-to late March 2013.

[4] Percentages may be modified based on reference transects.

Herbicide(s) chosen for nonnative forb control will be species-specific, and treatment times will be determined by species phenology, as assessed by CBI and SERG during site visits. Line trimmers may be used to cut nonnative forbs if deemed more appropriate than herbicide application, and should be used prior to seed set. If seed set has already occurred, cut vegetation will be placed in the dethatch compost piles (see above).

4. Introduce native seeds in Fall 2013 and Winter 2014. Prior to seeding, soil will be scarified using garden rakes and avoiding established vegetation to the degree practicable. Seed will be hand broadcast and tamped into the scarified soil. No supplemental watering will occur after seeding, unless water can easily be conveyed to the site. The seed mix will differ between the western and eastern portions of this polygon (Tables 5 and 6).

Table 5
Proposed Native Seed Mix for Polygon 003 – West[1]

| Scientific Name | Common Name | Flowering Period | Forb Phenology | Source[2] | Pounds/Acre |
|---|---|---|---|---|---|
| *Artemisia californica* | California sagebrush | August - November | --- | Commercial, Collect | 4 |
| *Calochortus splendens* | Splendid mariposa lily | March-July | Mid | Collect | 1 |
| *Corethrogyne filaginifolia* | Sand-aster | July-November | Late | Bulk | 1 |
| *Deinandra fasciculata* | Fascicled tarweed | May-October | Late | Commercial, Collect | 3 |
| *Eriogonum fasciculatum* | California buckwheat | Year-round | --- | Commercial | 8 |
| *Grindelia camporum* | Gumplant | January-November | Early | Commercial | 4 |
| *Isocoma menziesii* | Goldenbush | June-November | --- | Commercial | 3 |
| *Lasthenia californica ssp. californica* | California goldfields | March-May | Early | Commercial | 1 |
| *Layia platyglossa* | Tidy tips | February-May | Early | Commercial | 1 |
| *Lupinus bicolor* | Miniature lupine | March-June | Mid | Commercial | 4 |
| *Sisrynchium bellum* | Blue-eyed grass | April-June | Mid | Collect | 3 |
| *Stipa lepida/pulchra* | Foothill/purple needlegrass | March-June | --- | Bulk | 6 |
| **Total Pounds/Acre** | | | | | **39** |

[1] Inclusion of native forbs will be subject to onsite and/or commercial availability.
[2] Source: collect = seed collected by CBI and volunteers; bulk = seed bulked by RECON; commercial = seed purchased through S & S Seeds, RECON, or other native plant nurseries.

Table 6
Proposed Native Seed Mix for Polygon 003 – East[1]

| Scientific Name | Common Name | Flowering Period | Forb Phenology | Source[2] | Pounds/Acre |
|---|---|---|---|---|---|
| *Artemisia californica* | California sagebrush | August-November | --- | Commercial, Collect | 4 |
| *Bahiopsis laciniata* | San Diego viguiera | February - August | --- | Collect | 2 |
| *Cryptantha intermedia* | Cryptantha | March-July | Mid | Bulk | 2 |
| *Deinandra fasciculata* | Fascicled tarweed | May-October | Late | Commercial, Collect | 3 |
| *Eriogonum fasciculatum* | California buckwheat | Year-round | --- | Commercial | 8 |
| *Eriophyllum confertiflorum* | Flat-top golden yarrow | February-August | Early | Commercial | 2 |
| *Isocoma menziesii* | Goldenbush | June-November | --- | Commercial, Collect | 3 |
| *Plantago erecta* | Dotseed plantain | March-April | Early | Bulk | 4 |
| *Salvia apiana* | White sage | April-July | --- | Commercial | 2 |
| **Total Pounds/Acre** | | | | | **30** |

[1] Inclusion of native forbs will be subject to onsite and/or commercial availability.
[2] Source: collect = seed collected by CBI and volunteers; bulk = seed bulked by RECON; commercial = seed purchased through S & S Seeds or RECON.

## Polygon 004

### Existing Conditions

Polygon 004 is situated at the southeast corner of Skeleton Flats, on southwest- and west facing slopes. Although the entire polygon is 3.05 acres, only 1.74 acres occurs onsite. Like polygon 003, the western half of this polygon is underlain by clay soils (Auld series), while the eastern half supports gabbro-derived soils (Las Posas series). Habitat is classified as the *Salvia apiana-Artemisia californica* Association. The shrub stratum is fairly well-developed, comprising about 30% of the total cover. The herb stratum is intermittent (≥33% cover and ≤66% absolute cover); nonnative grasses are the dominant forb species.

Shrubs present in low or trace amounts include California sagebrush, goldenbush, white sage, Dehesa beargrass, lemonadeberry (*Rhus integrifolia*), laurel sumac, deerweed, San Diego County viguiera, redberry, broom baccharis, and prickly-pear (*Opuntia* sp.).

The herb stratum is dominated by the nonnative grasses, *Brachypodium* and wild oats, which comprised an estimated 40% and 20%, respectively, of the absolute cover in 2012. There are trace amounts of purple needlegrass in this polygon. Exotic forbs include trace amounts of crete hedypnois, common sow-thistle, tocalote, and short-pod mustard. Native forbs include low amounts of common sand-aster and bindweed, and trace amounts of blue-eyed grass, splendid mariposa lily, narrow-leaved bedstraw, flat-top golden yarrow, and slender sunflower (*Helianthus gracilentus*).

## Restoration Strategy

Within this polygon, the restoration strategy will focus on (1) reducing the cover of nonnative species, particularly grasses. Dehesa beargrass occurs within this polygon. Variegated dudleya was documented in or near this polygon in 2002 (REC Consultants, Inc. 2004) and San Diegothornmint was documented south of this polygon in 2002 (REC Consultants, Inc. 2004) and north and east of this polygon in 2012 (CBI 2012).

## Management Goals and Objectives

**Goal**: Enhance habitat for native grassland and scrub species, including Dehesa beargrass, San Diego thornmint, and variegated dudleya, by decreasing cover of nonnative plants and introducing native forb propagules.

*Objective 1*: Decrease cover of nonnative grasses, particularly *Brachypodium*, to ≤10-25%[5] within 2 years using a grass-specific herbicide (e.g., Fusilade II).

*Objective 2*: Decrease cover of exotic forbs to ≤10-25%[1] cover within 2 years through spot-treatments with herbicide (e.g., glyphosate-based herbicide).

## Restoration Specifications

1. Treat nonnative grass with a grass-specific herbicide (e.g., Fusilade II) once a year for two years; treatments will be initiated in late January or early February 2013. Applications will be made using a backpack sprayer following the label directions (i.e., Fusilade II label directions = 0.4-0.6 ounce per 1000 square feet). Treatment will occur only in that portion of the polygon that is onsite; native bunchgrasses will be avoided to the degree practicable.
2. Spot-treat nonnative forbs with herbicides twice a year for two years after initial application of the grass-specific herbicide. The first forb treatment will occur in mid-to late March 2013. Herbicide(s) chosen for nonnative forb control will be species-specific, and treatment times will be determined by species phenology, as assessed by CBI and SERG during site visits. Line trimmers may be used to cut nonnative forbs if deemed more appropriate than herbicide

[5] Percentages may be modified based on reference transects.

application, and should be used prior to seed set. If seed set has already occurred, cut vegetation will be placed in the dethatch compost piles (see polygons 2 and 3, above).

## Polygon 005

### Existing Conditions

Polygon 005 is adjacent to and directly west of polygon 004. Almost all of the soils in this polygon are clay (Auld series), the south- to southwest-facing slopes are gentle, and vegetation falls into the *Artemisia californica* Association. The entire polygon is 2.87 acres in size; of this total, 1.63 acres occurs onsite. The shrub stratum is fairly well-developed, comprising about 25% of the total cover. The herb stratum is continuous (≥66% absolute cover) and dominated by nonnative grasses.

California sagebrush is the dominant shrub in this association. Subdominant shrubs present in low or trace amounts include goldenbush, prickly-pear, deerweed, and California buckwheat.

The herb stratum is dominated by the nonnative grasses, *Brachypodium* and wild oats, which comprised an estimated 35% and 30%, respectively, of the absolute cover in 2012. There are good stands of native grassland; purple needlegrass and foothill needlegrass account for about 3 and 2% cover, respectively, in this polygon. Exotic forbs include trace amounts of prickly lettuce and tocalote. Native forbs include trace amounts of common sand-aster, bindweed, blue-eyed grass, splendid mariposa lily, narrow-leaved bedstraw, flat-top golden yarrow, and gum plant.

### Restoration Strategy

Within this polygon, the restoration strategy will focus on reducing the cover of nonnative species, particularly grasses. Variegated dudleya was documented in or near this polygon in 2002 (REC Consultants, Inc. 2004).

### Management Goals and Objectives

**Goal**: Enhance habitat for native species, including variegated dudleya, by decreasing cover of nonnative plants and introducing native forb propagules.

*Objective 1*: Decrease cover of nonnative grasses, particularly *Brachypodium*, to ≤10-25%[6] within 2 years using a grass-specific herbicide (e.g., Fusilade II).

*Objective 2*: Decrease cover of exotic forbs to ≤10-25%[1] cover within 2 years through spot-treatments with herbicide (e.g., glyphosate-based herbicide).

[6] Percentages may be modified based on reference transects.

### Restoration Specifications

1 Treat nonnative grass with a grass-specific herbicide (e.g., Fusilade II) once a year for two years; treatments will be initiated in late January or early February 2013. Applications will be made using a backpack sprayer following the label directions (i.e., Fusilade II label directions = 0.4-0.6 ounce per 1000 square feet). Treatment will occur only in that portion of the polygon that is onsite; native bunchgrasses will be avoided to the degree practicable.
2 Spot-treat nonnative forbs with herbicides twice a year for two years after initial application of the grass-specific herbicide. The first forb treatment will occur in mid-to late March 2013. Herbicide(s) chosen for nonnative forb control will be species-specific, and treatment times will be determined by species phenology, as assessed by CBI and SERG during site visits. Line trimmers may be used to cut nonnative forbs if deemed more appropriate than herbicide application, and should be used prior to seed set. If seed set has already occurred, cut vegetation will be placed in the dethatch compost piles (see polygons 2 and 3, above).

## Polygon 006

### Existing Conditions

Polygon 006 is the largest polygon (4.4 acres) on South Crest and occurs west of the north-south oriented road through Skeleton Flats. Soils in the polygon are clays (Auld series), and the aspect ranges from flat to west-facing. Vegetation is classified as *Nassella pulchra* Association, based on the presence of good stands of purple needlegrass. The shrub stratum is poorly-developed, comprising <10% of the total cover. The herb stratum is continuous (≥66% absolute cover); nonnative grasses are the dominant forb species.

Dehesa beargrass is the dominant shrub in this polygon, although it comprises only about 5% of the total vegetative cover. Additional shrubs present in low amounts include California sagebrush, goldenbush, broom baccharis, deerweed, matchweed, and California buckwheat.

The herb stratum is dominated by the nonnative grasses, *Brachypodium* and wild oats, which comprised an estimated 50% and 35%, respectively, of the absolute cover in 2012. Purple needlegrass makes up about 10% of the cover in this polygon. The only exotic forb observed was prickly lettuce, which occurred in trace amounts. Native forbs include low amounts of blue-eyed grass, gum plant and splendid mariposa lily, and trace amounts of bindweed and flat-top golden yarrow.

### Restoration Strategy

Restoration for polygon 006 **will not** be implemented during this program; however, the restoration strategy, and goals and objectives are presented here for future restoration efforts. This polygon supports good stands of purple needlegrass and Dehesa beargrass; therefore, the

restoration strategy will focus on (1) reducing the cover of nonnative species, particularly grasses.

### Management Goals and Objectives

**Goal**: Enhance habitat for native grassland and Dehesa beargrass by decreasing cover of nonnative plants.

*Objective 1*: Decrease cover of nonnative grasses, particularly *Brachypodium*, to ≤10-25%[7] within 2 years using a grass-specific herbicide (e.g., Fusilade II).

*Objective 2*: Decrease cover of exotic forbs to ≤10-25%[1] cover within 2 years through spot-treatments with herbicide (e.g., glyphosate-based herbicide).

### Restoration Specifications

1. Treat nonnative grass with a grass-specific herbicide (e.g., Fusilade II) twice a year for two years, with the first application in late January or early February. Applications will be made using a backpack sprayer following the label directions (i.e., Fusilade II label directions = 0.4-0.6 ounce per 1000 square feet). Although the entire polygon will be treated, native bunchgrasses will be avoided to the degree practicable.
2. Spot-treat nonnative forbs with herbicides twice a year for two years after initial application of the grass-specific herbicide. The first forb treatment will occur in mid-to late March. Herbicide(s) chosen for nonnative forb control will be species-specific, and treatment times will be determined by species phenology, as assessed by CBI and SERG during site visits. Line trimmers may be used to cut nonnative forbs if deemed more appropriate than herbicide application, and should be used prior to seed set. If seed set has already occurred, cut vegetation will be placed in the dethatch compost piles (see polygons 2 and 3, above).

## Polygon 007

### Existing Conditions

Polygon 007 is adjacent to and just north of polygon 006 and is also characterized as *Nassella pulchra* Association. These two polygons differ largely in species composition; polygon 007 has a slightly higher diversity and cover of exotic forbs and a lower cover of native forbs. This polygon is small (0.78 acre), trends to the southwest, and supports clay soils (Auld series). The shrub stratum is poorly-developed, comprising <10% of the total cover. The herb stratum is continuous (≥66% absolute cover); *Brachypodium* and wild oats are the dominant forb species, accounting for most of the herbaceous cover in this polygon.

[7] Percentages may be modified based on reference transects.

Shrub species present in low amounts include California sagebrush, Dehesa beargrass, goldenbush, broom baccharis, deerweed, and California buckwheat. In addition, this polygon supports a stand of the nonnative, invasive species, wild fennel (*Foeniculum vulgare*).

The herb stratum is dominated by the nonnative grasses, *Brachypodium* and wild oats, which comprised an estimated 45% and 35%, respectively, of the absolute cover in 2012. There are good stands of native grassland; purple needlegrass accounts for about 7% cover in this polygon, and there are trace amounts of foothill needlegrass. Exotic forbs include low amounts of the nonnative, invasive species, wild fennel (Foeniculum vulgare), and trace amounts of prickly lettuce, tocalote, and short-pod mustard. Native forbs include low amounts of splendid mariposa lily, and trace amounts of bindweed, gum plant, and blue-eyed grass.

## Restoration Strategy

Restoration for polygon 007 **will not** be implemented during this program; however, the restoration strategy, and goals and objectives are presented here for future restoration efforts. Because this polygon supports good stands of purple needlegrass and Dehesa beargrass, the restoration strategy will focus on (1) reducing the cover of nonnative species, particularly grasses.

## Management Goals and Objectives

**Goal**: Enhance habitat for native grassland and Dehesa beargrass by decreasing cover of nonnative plants.

*Objective 1*: Decrease cover of nonnative grasses, particularly *Brachypodium*, to ≤10-25%[8] within 2 years using a grass-specific herbicide (e.g., Fusilade II).

*Objective 2*: Decrease cover of exotic forbs to ≤10-25%[1] cover within 2 years through spot-treatments with herbicide (e.g., glyphosate-based herbicide).

## Restoration Specifications

1 Treat nonnative grass with a grass-specific herbicide (e.g., Fusilade II) twice a year for two years, with the first application in late January or early February. Applications will be made using a backpack sprayer following the label directions (i.e., Fusilade II label directions = 0.4-0.6 ounce per 1000 square feet). Although the entire polygon will be treated, native bunchgrasses will be avoided to the degree practicable.

2 Spot-treat nonnative forbs with herbicides twice a year for two years after initial application of the grass-specific herbicide. The first forb treatment will occur in mid-to late March. Herbicide(s) chosen for nonnative forb control will be species-specific, and treatment times

[8] Percentages may be modified based on reference transects.

will be determined by species phenology, as assessed by CBI and SERG during site visits. Line trimmers may be used to cut nonnative forbs if deemed more appropriate than herbicide application, and should be used prior to seed set. If seed set has already occurred, cut vegetation will be placed in the dethatch compost piles (see polygons 2 and 3, above).

## Polygon 008

### Existing Conditions

Polygon 008 occurs on a northwest- to west-facing slope and is 2.62 acres in size. It is situated north of and adjacent to polygons 006 and 007, and directly west of the onsite portion of polygon 001. Soils are gabbro-derived (Las Posas series), and vegetation falls into the *Salvia apiana-Artemisia californica* Association. The shrub stratum comprises an estimated 40% of the total cover. The herb stratum is generally intermittent (≥33% and ≤66% absolute cover) and relatively diverse; *Brachypodium* is the most prevalent herbaceous species.

Dehesa beargrass is the most common shrub in this polygon. Additional shrubs present in low or trace amounts include California sagebrush, goldenbush, white sage, redberry, and deerweed.

The herb stratum is dominated by the nonnative grass, *Brachypodium*, which comprised an estimated 35% of the absolute cover in 2012. An additional nonnative grass, wild oats is present in trace amounts. Well-developed stands of both purple needlegrass and foothill needlegrass are present. Exotic forbs present in trace amounts include red-stem filaree, crete hedypnois, tocalote, and wild lettuce. Native forbs present in low or trace amounts include bindweed, splendid mariposa lily, blue-eyed grass, flat-top golden yarrow, Indian paintbrush (*Castilleja* sp.), and common sand-aster.

### Restoration Strategy

Because this polygon supports good stands of purple needlegrass, foothill needlegrass, Dehesa beargrass, and native forbs, the restoration strategy will focus on (1) reducing the cover of nonnative species, particularly grasses.

### Management Goals and Objectives

**Goal**: Enhance habitat for native grassland and Dehesa beargrass by decreasing cover of nonnative plants.

*Objective 1*: Decrease cover of nonnative grasses, particularly *Brachypodium*, to ≤10-25%[9] within 2 years using a grass-specific herbicide (e.g., Fusilade II).

[9] Percentages may be modified based on reference transects.

*Objective 2*: Decrease cover of exotic forbs to ≤10-25%[1] cover within 2 years through spot-treatments with herbicide (e.g., glyphosate-based herbicide).

### Restoration Specifications

1 Treat nonnative grass with a grass-specific herbicide (e.g., Fusilade II) once a year for two years; treatments will be initiated in late January or early February 2013. Applications will be made using a backpack sprayer following the label directions (i.e., Fusilade II label directions = 0.4-0.6 ounce per 1000 square feet). Treatment will occur only in that portion of the polygon that is onsite; native bunchgrasses will be avoided to the degree practicable.

2 Spot-treat nonnative forbs with herbicides twice a year for two years after initial application of the grass-specific herbicide. The first forb treatment will occur in mid-to late March 2013. Herbicide(s) chosen for nonnative forb control will be species-specific, and treatment times will be determined by species phenology, as assessed by CBI and SERG during site visits. Line trimmers may be used to cut nonnative forbs if deemed more appropriate than herbicide application, and should be used prior to seed set. If seed set has already occurred, cut vegetation will be placed in the dethatch compost piles (see polygons 2 and 3, above).

## Summary

Table 7 presents a summary of all treatments to be implemented under this plan (polygons 1,2,3,4,5,8).

Table 7
*Brachypodium* Control/Habitat Restoration Treatments

| Polygon | 2012 | 2013 | | | 2014 | | |
|---|---|---|---|---|---|---|---|
| | Dethatch | Fusillade | Glyphosate | Seed | Fusillade | Glyphosate | Seed |
| 001 | --- | 1x | 2x | --- | 1x | 2x | --- |
| 002 | X | 2x | 2x | X | --- | 2x | X |
| 003 | X | 2x | 2x | X | --- | 2x | X |
| 004 | --- | 1x | 2x | --- | 1x | 2x | --- |
| 005 | --- | 1x | 2x | | 1x | 2x | --- |
| 008 | --- | 1x | 2x | --- | 1x | 2x | --- |

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# APPENDIX D

# PHOTODOCUMENTATION

# (DETHATCHING)

# Appendix D

## *Brachypodium Removal: Crestridge Ecological Reserve and South Crest Properties*

Task 5: Site Preparation (Dethatching) Photodocumentation

SANDAG Contract No. 5001965

CONSERVATION BIOLOGY INSTITUTE

# *Site Preparation: Dethatching*


Photograph 1: South Crest, Polygon 2 (Pre-dethatch)

Photograph 2: South Crest, Polygon 2 (Post-dethatch)

# *Site Preparation: Dethatching*


Photograph 3: South Crest, Polygon 2 (Pre-dethatch)

Photograph 4: South Crest, Polygon 2 (Post-dethatch)

# *Site Preparation: Dethatching*


Photograph 5: South Crest, Polygon 2 (Pre-dethatch)

Photograph 6: South Crest, Polygon 2 (Post-dethatch)

# *Site Preparation: Dethatching*


Photograph 7: South Crest, Polygon 3 (Pre-dethatch)

Photograph 8: South Crest, Polygon 3 (Post-dethatch)

# *Site Preparation: Dethatching*


Photograph 9: South Crest, Polygon 3 (Pre-dethatch)

Photograph 10: South Crest, Polygon 3 (Post-dethatch)

# *Site Preparation: Dethatching*

Photograph 11: South Crest, Close-up of Thatch (Pre-dethatch)

Photograph 12: South Crest, Close-up of Thatch (Post-dethatch)

# *Site Preparation: Dethatching*

Photograph 13: South Crest, Polygon 2 (Dethatched [left]; Not Dethatched [right])

Photograph 14: South Crest, Polygon 3 (Not Dethatched [left]; Dethatched [right])

# *Site Preparation: Dethatching*

Photograph 15: South Crest, Polygon 3 (Raking Thatch)

Photograph 16: South Crest, Polygon 3 (Raked Thatch)

# *Site Preparation: Dethatching*

Photograph 17: South Crest (Thatch Piles)

Photograph 18: South Crest (Thatch Piles)

# *Site Preparation: Dethatching*


Photograph 19: Crestridge Ecological Reserve, Polygon 1 (Pre-dethatch)

Photograph 20: Crestridge Ecological Reserve, Polygon 1 (Post-dethatch)

# *Site Preparation: Dethatching*


Photograph 21: Crestridge Ecological Reserve, Polygon 1 (Pre-dethatch)

Photograph 22: Crestridge Ecological Reserve, Polygon 1 (Post-dethatch)

# *Site Preparation: Dethatching*

Photograph 23: Crestridge Ecological Reserve, Polygon 1 (Pre-dethatch)

Photograph 24: Crestridge Ecological Reserve, Polygon 1 (Post-dethatch)

# *Site Preparation: Dethatching*

Photograph 25: Crestridge Ecological Reserve, Close-up of Thatch (Pre-dethatch)

Photograph 26: Crestridge Ecological Reserve, Close-up of Thatch (Post-dethatch)

# APPENDIX E

# HERBICIDE LOGS

Appendix E.1 2013 Herbicide Logs

Appendix E.2 2014 Herbicide Logs

| Date | Herbicide | Herbicide use (oz) | Diluted Amount Sprayed (gal) | % Solution | Adjuvent use (oz) | Site | Polygon | Area sprayed (acres, approx) | Target Species |
|---|---|---|---|---|---|---|---|---|---|
| 2/11/2013 | Fusilade II | 12 | 16 | 0.59% | 8 | South Crest | 2 | 0.5 | *Bracypodium distachyon* |
| 2/11/2013 | Fusilade II | 26 | 52 | 0.39% | 26 | South Crest | 2 | 1 | *Bracypodium distachyon* |
| 2/12/2013 | Fusilade II | 28 | 56 | 0.39% | 28 | South Crest | 2, 3 | 1.5 | *Bracypodium distachyon* |
| 2/13/2013 | Fusilade II | 46 | 92 | 0.39% | 46 | South Crest | 3, 4, 5 | 2.5 | *Bracypodium distachyon* |
| 2/21/2013 | Fusilade II | 62 | 124 | 0.39% | 62 | South Crest | 4, 5, 8 | 3 | *Bracypodium distachyon* |
| 2/22/2013 | Fusilade II | 28.5 | 57 | 0.39% | 28.5 | South Crest | 8 | 0.8 | *Bracypodium distachyon* |
| 2/25/2013 | Fusilade II | 40 | 80 | 0.39% | 40 | Crestridge Ecological Reserve (Thornmint Hill) | 3, 5 | 2 | *Bracypodium distachyon* |
| 2/26/2013 | Fusilade II | 47 | 94 | 0.39% | 47 | Crestridge Ecological Reserve (Thornmint Hill) | 3, 5 | 3 | *Bracypodium distachyon* |
| 2/28/2013 | Fusilade II | 34 | 68 | 0.39% | 34 | Crestridge Ecological Reserve (Thornmint Hill) | 3, 5 | 2 | *Bracypodium distachyon* |
| 3/11/2013 | Fusilade II | 39.6 | 72 | 0.43% | 36 | South Crest | 1, 2 | 1.75 | *Brachypodium distachyon* |
| 3/12/2013 | Fusilade II | 50.05 | 91 | 0.43% | 45.5 | South Crest | 2, 3 | 3 | *Brachypodium distachyon* |
| 3/13/2013 | Fusilade II | 35.2 | 64 | 0.43% | 32 | Crestridge Ecological Reserve (Thornmint Hill) | 5 | 2 | *Brachypodium distachyon* |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 3/15/2013 | Fusilade II | 19.8 | 36 | 0.43% | 18 | Crestridge Ecological Reserve (Thornmint Hill) | 5 | 1 | *Brachypodium distachyon* |
| 3/18/2013 | Glyphosate Pro 4 | 52.0 | 20 | 2% | 0 | South Crest | 2, 3 | 2.1 | Broad-leaf non-natives |
| 3/19/2013 | Glyphosate Pro 4 | 52.0 | 20 | 2% | 0 | South Crest | 3, 4, 5 | 3.5 | Broad-leaf non-natives |
| 3/21/2013 | Fusilade II | 3.85 | 7 | 0.43% | 3.5 | South Crest | 4, 5 | 0.2 | *Brachypodium distachyon* |
| 3/21/2013 | Glyphosate Pro 4 | 36.4 | 14 | 2% | 0 | South Crest | 4, 5, 8 | 3 | Broad-leaf non-natives |
| 3/25/2013 | Glyphosate Pro 4 | 20.8 | 8 | 2% | 0 | South Crest | 1 | 0.75 | Broad-leaf non-natives |
| 3/25/2013 | Glyphosate Pro 4 | 16.9 | 6.5 | 2% | 0 | Crestridge Ecological Reserve (Thornmint Hill) | 3 | 4.2 | Broad-leaf non-natives |
| 3/26/2013 | Glyphosate Pro 4 | 15.6 | 6 | 2% | 0 | Crestridge Ecological Reserve (Thornmint Hill) | 5, 1 | 3.1 | Broad-leaf non-natives |

| Date | Herbicide | Herbicide use (oz) | Diluted Amount Sprayed (gal) | % Solution | Adjuvent use (oz) | Site | Polygon | Area sprayed (acres, approx) | Target Species |
|---|---|---|---|---|---|---|---|---|---|
| 2/19/2014 | Fusilade II | 32 | 25 | 1% | 10 | Crestridge Ecological Reserve (Thornmint Hill) | 3, 5 | 7.29 | *Brachypodium distachyon* |
| 2/20/2014 | Fusilade II | 20 | 15 | 1% | 6 | Crestridge Ecological Reserve (Thornmint Hill) | 3, 5 | see above | *Brachypodium distachyon* |
| 2/21/2014 | Fusilade II | 58 | 45 | 1% | 17 | Crestridge Ecological Reserve (Thornmint Hill) | 3, 5 | see above | *Brachypodium distachyon* |
| 2/21/2014 | Glyphosate | 4 | 1.5 | 2% | 1 | Crestridge Ecological Reserve (Thornmint Hill) | 3, 5 | see above | *Broad-leaf non-natives* |
| 2/14/2014 | Fusilade DX | 82 | 30 | 2% | 15 | South Crest | 4 ,5, 8 | 3.4 | *Brachypodium distachyon* |
| 3/4/2014 | Glyphosate | 18 | 7 | 2% | 6 | South Crest | 2, 3, 4, 5, 8 | 10.74 | Broad-leaf non-natives |
| 3/10/2014 | Glyphosate | 32 | 12.5 | 2% | 8 | South Crest | 2, 3, 4, 5, 8 | see above | Broad-leaf non-natives |
| 3/11/2014 | Glyphosate | 32 | 12.5 | 2% | 8 | South Crest | 2, 3, 4, 5, 8 | see above | Broad-leaf non-natives |
| 3/19/2014 | Glyphosate | 16 | 6.25 | 2% | 4 | Crestridge Ecological Reserve (Thornmint Hill) | 1, 3, 5 | 9 | Broad-leaf non-natives |

# APPENDIX F

# SEED

Appendix F.1 Seed Palettes

Appendix F.2 Volunteer-collected Seed

# Appendix F.1
## Final Seed Palettes

| Site (Polygon #)[1] | Species | Target (lbs) | Actual Amount (lbs)[2] | | | Total Applied (lbs) | Average (lbs/row) | Average (lbs/acre) |
|---|---|---|---|---|---|---|---|---|
| | | | S & S | RNP | Volunteer | | | |
| CER (Polygon 1) | *Acmispon glaber* | 3.12 | 3.12 | --- | --- | 3.12 | 0.20 | 2.00 |
| | *Aristida adscensionis* | 3.12 | --- | 0.08 | --- | 0.08 | 0.01 | 0.05 |
| | *Artemisia californica* | 6.24 | 6.24 | 7.25 | 2.80 | 16.29 | 1.02 | 10.44 |
| | *Bahiopsis laciniata* | 3.12 | 3.12 | 1.56 | 0.63 | 5.31 | 0.33 | 3.40 |
| | *Cryptantha intermedia* | 3.12 | --- | 0.70 | --- | 0.70 | 0.04 | 0.45 |
| | *Deinandra fasciculata* | 4.68 | --- | 4.68 | --- | 4.68 | 0.29 | 3.00 |
| | *Eriogonum fasciculatum* | 12.48 | 12.48 | | 3.85 | 16.33 | 1.02 | 10.47 |
| | *Plantago erecta* | 6.24 | --- | 5.00 | --- | 5.00 | 0.31 | 3.21 |
| | *Salvia apiana* | 3.12 | 3.12 | --- | --- | 3.12 | 0.20 | 2.00 |
| | *Salvia columbariae* | 1.56 | --- | 1.68 | --- | 1.68 | 0.11 | 1.08 |
| | **Total** | **46.80** | **28.08** | **20.95** | **7.28** | **56.31** | **3.52** | **36.09** |
| South Crest (Polygon 2) | *Artemisia californica* | 8.00 | 8.00 | 8.00 | 0.56 | 16.56 | 0.75 | 8.28 |
| | *Calochortus splendens* | 2.00 | --- | --- | --- | 0.00 | 0.00 | 0.00 |
| | *Corethrogyne filaginifolia* | 2.00 | --- | 1.90 | --- | 1.90 | 0.09 | 0.95 |
| | *Deinandra fasciculata* | 6.00 | --- | 6.25 | 0.94 | 7.19 | 0.33 | 3.59 |
| | *Dodecatheon clevelandii* | --- | --- | --- | 0.13 | 0.13 | 0.01 | 0.06 |

# Appendix F.1
## Final Seed Palettes

| Site (Polygon #)[1] | Species | Target (lbs) | Actual Amount (lbs)[2] | | | Total Applied (lbs) | Average (lbs/row) | Average (lbs/acre) |
|---|---|---|---|---|---|---|---|---|
| | | | S & S | RNP | Volunteer | | | |
| | *Eriogonum fasciculatum* | 16.00 | 16.00 | --- | 2.31 | 18.31 | 0.83 | 9.16 |
| | *Grindelia camporum* | 8.00 | --- | --- | --- | 0.00 | 0.00 | 0.00 |
| | *Isocoma menziesii* | 6.00 | 14.00 | --- | 0.63 | 14.63 | 0.66 | 7.31 |
| | *Lasthenia californica ssp. californica* | 2.00 | 2.00 | -- | --- | 2.00 | 0.09 | 1.00 |
| | *Layia platyglossa* | 2.00 | 2.00 | --- | --- | 2.00 | 0.09 | 1.00 |
| | *Lupinus bicolor* | 8.00 | 8.00 | --- | --- | 8.00 | 0.36 | 4.00 |
| | *Sisyrinchium bellum* | 6.00 | 8.00 | --- | 0.30 | 8.30 | 0.38 | 4.15 |
| | *Stipa pulchra* | 12.00 | --- | 11.10 | --- | 11.10 | 0.50 | 5.55 |
| | **Total** | **78.00** | **58.00** | **27.25** | **4.86** | **90.11** | **4.10** | **45.06** |
| South Crest (Polygon 3, western half) | *Allium haematochiton* | --- | --- | --- | 0.09 | 0.09 | 0.01 | 0.07 |
| | *Artemisia californica* | 5.00 | 5.00 | 4.00 | 2.00 | 11.00 | 1.10 | 8.80 |
| | *Calochortus splendens* | 1.25 | --- | --- | --- | 0.00 | 0.00 | 0.00 |
| | *Corethrogyne filaginifolia* | 1.25 | --- | 1.00 | --- | 1.00 | 0.10 | 0.80 |
| | *Deinandra fasciculata* | 3.75 | --- | 6.00 | --- | 6.00 | 0.60 | 4.80 |
| | *Eriogonum fasciculatum* | 10.00 | 10.00 | --- | 1.00 | 11.00 | 1.10 | 8.80 |
| | *Fritillaria biflora* | --- | --- | --- | 0.13 | 0.13 | 0.01 | 0.10 |

# Appendix F.1
## Final Seed Palettes

| Site (Polygon #)[1] | Species | Target (lbs) | Actual Amount (lbs)[2] | | | Total Applied (lbs) | Average (lbs/row) | Average (lbs/acre) |
|---|---|---|---|---|---|---|---|---|
| | | | S & S | RNP | Volunteer | | | |
| | *Grindelia camporum* | 5.00 | --- | --- | 0.31 | 0.31 | 0.03 | 0.25 |
| | *Isocoma menziesii* | 3.75 | 8.75 | --- | 0.75 | 9.50 | 0.95 | 7.60 |
| | *Lasthenia californica ssp. californicum* | 1.25 | 1.25 | --- | --- | 1.25 | 0.13 | 1.00 |
| | *Layia platyglossa* | 1.25 | 1.25 | --- | --- | 1.25 | 0.13 | 1.00 |
| | *Lupinus bicolor* | 5.00 | 5.00 | --- | --- | 5.00 | 0.50 | 4.00 |
| | *Sysirinchium bellum* | 3.75 | 5.00 | --- | 0.13 | 5.13 | 0.51 | 4.10 |
| | *Stipa pulchra* | 7.50 | --- | 5.00 | --- | 5.00 | 0.50 | 4.00 |
| | *Stipa lepida* | 0.00 | --- | 1.45 | --- | 1.45 | 0.15 | 1.16 |
| | **Total** | **48.75** | **36.25** | **17.45** | **4.41** | **58.11** | **5.81** | **46.48** |
| South Crest (Polygon 3, eastern half) | *Artemisia californica* | 5.00 | 5.00 | 5.00 | 2.00 | 12.00 | 1.20 | 9.60 |
| | *Bahiopsis laciniata* | 2.50 | 2.50 | 1.56 | --- | 4.06 | 0.41 | 3.25 |
| | *Cryptantha intermedia* | 2.50 | --- | 1.00 | --- | 1.00 | 0.10 | 0.80 |
| | *Deinandra fasciculata* | 3.75 | --- | 6.00 | --- | 6.00 | 0.60 | 4.80 |
| | *Eriogonum fasciculatum* | 10.00 | 10.00 | --- | 3.40 | 13.40 | 1.34 | 10.72 |
| | *Eriophyllum confertiflorum* | 2.50 | 2.50 | --- | --- | 2.50 | 0.25 | 2.00 |
| | *Isocoma menziesii* | 3.75 | 3.75 | --- | 0.69 | 4.44 | 0.44 | 3.55 |

# Appendix F.1
## Final Seed Palettes

| Site (Polygon #)[1] | Species | Target (lbs) | Actual Amount (lbs)[2] | | | Total Applied (lbs) | Average (lbs/row) | Average (lbs/acre) |
|---|---|---|---|---|---|---|---|---|
| | | | S & S | RNP | Volunteer | | | |
| | *Plantago erecta* | 5.00 | --- | 5.00 | --- | 5.00 | 0.50 | 4.00 |
| | *Salvia apiana* | 2.50 | 2.50 | --- | --- | 2.50 | 0.25 | 2.00 |
| | **Total** | **37.50** | **26.25** | **18.56** | **6.09** | **50.90** | **5.09** | **40.72** |

1 CER = Crestridge Ecological Reserve.
2 S & S = S & S Seeds, Inc.; RNP = RECON Native Plant Nursery; Volunteer = Volunteer-collected seed under the direction of Earth Discovery Institute (EDI).

# Appendix F.2 - Volunteer-collected Seed

| Collection # | Species | Common Name | Collection Date | GPS Location | Location Description | Site Description | | | | | Plant Population | | Fruiting Stage | Team Members | Amount |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Aspect | Slope (º) | Elevation | Sun/Shade (%'s) | Soil type | Total # of Plants | # of Plants Sampled | | | |
| CER_MUME_01_2012 | Muhlenbergia microsperma | | 10/16/2012 | | Thornmint Hill | W | steep | | 100%/0% | clay | 1000's | 100's | Over ripe | Vinje | Several ounces |
| SC_NAPU_01_2012 | Nassella pulchra | Purple needlegrass | 5/15/2012 | 32º47'25.75" 116º52'01.96" | South Crest | | gentle | | 100%/0% | | | | | Vinje | 1 pound |
| | Fritillaria biflora | chocolate lily | 5/15/2012 | | South Crest | N | gentle | | 100%/0% | clay | 100+ | 40-50 | | Vinje, Battle | 1 ounce |
| | Sisyrinchium bellum | Blue-eyed grass | 5/15/2012 | | South Crest | N | gentle | | 100%/0% | clay | 1000's | 100's | Ripe | Vinje, Battle | 1 ounce |
| | Dichelostemma capitatum | Blue dicks | 5/17/2013 | | South Crest | N | gentle | | 100%/0% | clay | 1000's | 100's | Ripe | Vinje, Battle | < 1 ounce |
| CER_SIBE_01_2012 | Sisyrinchium bellum | Blue-eyed grass | 5/30/2012 | | CER, east side of trail that departs next to Hubbell building, at open knoll just north of 1st set of switchbacks | W | 5º | | 95%/5% | | 140 fruiting | 10% each plant | Ripe | Andrea Johnson, Mickey Johnston, Cathy Chadwick | Several ounces |
| RJER_SAAP_01_2012 | Salvia apiana | White sage | 6/18/2012 | | Same as 6/11/2012 | W, E, flat | 0-5º | | 100%/0% | | 50+ | 6 | Early | Debbie Ekhaml, Mary Jane Quinn, Louise Thomas, Cathy Chadwick | |
| RJER_CASP_02_2012 | Calacortus splendens | Splendid mariposa lily | 6/18/2012 | | Same as 6/11/2012 | W, E, flat | 5-20º | | 100%/0% | | 50+ | 20 | Early | Debbie Ekhaml, Mary Jane Quinn, Louise Thomas, Cathy Chadwick | Several ounces |
| RJER_SIBE_01_2012 | Sisyrinchium bellum | Blue-eyed grass | 6/18/2012 | | Same as 6/11/2012 | E | 5-20º | | 100%/0% | | 2 | 2 | Late | Debbie Ekhaml, Mary Jane Quinn, Louise Thomas, Cathy Chadwick | |
| RJER_DICA_02_2012 | Dichelostemma capitatum | Blue dicks | 6/18/2012 | | Same as 6/11/2012 | E | 5-20º | | 100%/0% | | 5 | 5 | Late | Debbie Ekhaml, Mary Jane Quinn, Louise Thomas, Cathy Chadwick | |

# Appendix F.2 - Volunteer-collected Seed

| Collection # | Species | Common Name | Collection Date | GPS Location | Location Description | Site Description | | | | | Plant Population | | Fruiting Stage | Team Members | Amount |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Aspect | Slope (º) | Elevation | Sun/Shade (%'s) | Soil type | Total # of Plants | # of Plants Sampled | | | |
| RJER_CASP_03_2012 | Calacortus splendens | Splendid mariposa lily | 7/2/2012 | | Same as 6/11/2012 | W, E, flat | 5-20º | | 100%/0% | | ≈200 | ≈5-10% each plant | Ripe | Rick Craven, Mary Duffy, Debbie Ekhaml, Cathy Chadwick, Vicky Bonnett | 1 ounce |
| CER_CEVE_01_2012 | Centarium venustum | charming centaury, canchalagua | 7/27/2012 | | Horsemill area grasslands | flat | | | 100%/0% | | ≈300 | 30-40 | Ripe | Cathy Chadwick, Andrea Johnson, Mickey Johnston | |
| CER_CASP_01_2012 | Calacortus splendens | Splendid mariposa lily | 8/3/2012 | | Trail west from CER La Cresta Heights entrance | flat | | | 100%/0% | | 1 | 1 | late | Cathy Chadwick, Mickey Johnston | 1 ounce |
| CER_HESC_01_2012 | Helianthemum scoparium | Sunrose | 8/3/2012 | | Trail west from CER La Cresta Heights entrance | flat | | | 100%/0% | | ≈50 | ≈50 | late | Cathy Chadwick, Mickey Johnston | |
| CER_MIAU_01_2012 | Mimulus Aurantiacus | Monkeyflower | 8/3/2012 | | Trail west from CER La Cresta Heights entrance | flat | | | 95%/5% | | 5 | 5 | ripe | Cathy Chadwick, Mickey Johnston | |
| CER_RHOV_01_2012 | Rhus ovata | Sugar bush | 8/3/2012 | | Trail west from CER La Cresta Heights entrance | flat | | | 100%/0% | | 10 | 4 | late | Cathy Chadwick, Mickey Johnston | |
| CER_ERFA_01_2012 | Eriogonum fasciculaturm | California buckwheat | 8/3/2012 | | Trail west from CER La Cresta Heights entrance | flat | | | 100%/0% | | >100 | 14 | early | Cathy Chadwick, Mickey Johnston | |
| CER_SAAP_01_2012 | Salvia apiana | White sage | 8/3/2012 | | Trail west from CER La Cresta Heights entrance | flat | | | 100%/0% | | ≈50 | 19 | ripe | Cathy Chadwick, Mickey Johnston | |
| RJER_SAAP_02_2012 | Salvia apiana | White sage | 8/6/2012 | | Slope west of RJER parking lot | E | 15-20º | | 100%/0% | | >500 | ≈210 (10%) | Ripe | Debbie Ekhaml, Mary Jane Quinn, Mary Duffy, Rick Craven, Cathy Chadwick | |
| RJER_ERFA_01_2012 | Eriogonum fasciculaturm | California buckwheat | 8/6/2012 | | Slope west of RJER parking lot | E | 5-10º | | 100%/0% | | >500 | ≈200 (10%) | Early | Debbie Ekhaml, Mary Jane Quinn, Mary Duffy, Rick Craven, Cathy Chadwick | |

# Appendix F.2 - Volunteer-collected Seed

| Collection # | Species | Common Name | Collection Date | GPS Location | Location Description | Site Description | | | | | Plant Population | | Fruiting Stage | Team Members | Amount |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Aspect | Slope (º) | Elevation | Sun/Shade (%'s) | Soil type | Total # of Plants | # of Plants Sampled | | | |
| RJER_ERFFO_01_2012 | Eriogonum fasciculaturm var. foliolosum | California buckwheat | 8/6/2012 | | Slope southwest of RJER parking lot | NE | 5-10º | | 100%/0% | | 1 | 1(10%) | Ripe | FWS Youth Conservation Corp member, Matt | |
| RJER_ERFA_02_2012 | Eriogonum fasciculaturm | California buckwheat | 8/9/2012 | | Slope southwest of RJER parking lot | NE | 5-10º | | 100%/0% | | >500 | ≈232(10%) | Early | FWS Youth Conservation Corp | |
| CER_ERFA_02_2012 | Eriogonum fasciculaturm | California buckwheat | 8/10/2012 | | Hill north of Horsemill entrance | SW | 5-10º | | 100%/0% | | >100 | 20 | early | Cathy Chadwick, Andrea Johnson, Mickey Johnston | |
| CER_MIAU_02_2012 | Mimulus Aurantiacus | Monkeyflower | 9/12/2012 | 32º49'07.96" 116º52'00.36" | Johnson residence yard, 405 La Cresta Heights Road, El Cajon, 92021; adjacent to CER | NNW | 10-15º | 1,692 | 75%/25% | | | | ripe | Andrea Johnson | |
| SC_GRCA_01_2012 | Grindelia camporum | Gumplant | 10/9/2012 | | South Crest | | | | | | | | | Santare | |
| SC_ISME_01_2012 | Isocoma menziesii | | 10/13/2012 | | South Crest | | | | | | | | | Santare | |
| CER_COFI_01_2012 | Corethrogyne filaginafolia | Sand aster | 10/10/2012 | 32º49'07.96" 116º52'00.36" | Johnson residence yard, 405 La Cresta Heights Road, El Cajon, 92021; adjacent to CER | NNW | 10-15º | 1,692 | 75%/25% | | | | ripe | Andrea Johnson | |
| CER_COFI_02_2012 | Corethrogyne filaginafolia | Sand aster | 10/12/2012 | | CER Horsemill area | flat | flat | | 90%10% | | 2 | 2 | ripe | Chadwick, Johnson, Johnston | |
| CER_COFI_03_2012 | Corethrogyne filaginafolia | Sand aster | 10/19/2012 | 32º49'38.58" 116º50'03.23" | CER Intersection of Red Tail Trail and Valley View Truck Trail | NW | 5º | | 95%5% | | 100+ | 50 | ripe | Chadwick, Johnson, Johnston | |
| CER_ISME_01_2012 | Isocoma menziesii | Menzie's goldenbush | 10/19/2012 | | CER Horsemill area | W | 5º | 1,300 | 100%/0% | | | | early | Johnson, Johnston | |
| SC_ISME_02_20124 | Isocoma menziesii | | 10/25/2012 | | South Crest | | | | | | | | | Vinje, Santare | |
| SC_ERFA_01_2012 | Eriogonum fascilatum | California buckwheat | 10/25/2012 | | South Crest | | | | | | | | | Vinje, Santare | |
| | Salvia columbariae | Chia | 10/16/2013 | | CER | W, S | gentle to steep | | 100%/0% | | 1000's | 100's | Ripe, but late in season. | Vinje | 1/2 pound |
| | Cryptantha intermedia | Popcorn flower | 10/16/2012 | | CER | W, S | gentle to steep | | 100%/0% | | 1000's | 100's | Ripe, but late in season. | Vinje | Several ounces |

# Appendix F.2 - Volunteer-collected Seed

| Collection # | Species | Common Name | Collection Date | GPS Location | Location Description | Site Description | | | | | Plant Population | | Fruiting Stage | Team Members | Amount |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Aspect | Slope (º) | Elevation | Sun/Shade (%'s) | Soil type | Total # of Plants | # of Plants Sampled | | | |
| SC_CRIN_01_2012 | Cryptantha intermedia | | 10/25/2012 | | South Crest | | | | | | | | | Vinje | Several ounces |
| SC_BALA_01_2012 | Bahiopsis lacinata | San Diego sunflower | 10/26/2012 | | South Crest | | | | | | | | | Santare | |
| SC_ISME_03_20124 | Isocoma menziesii | | 11/2/2012 | | South Crest | | | | | | | | | Chadwick, Johnson, Johnston | |
| SC_GRCA_02_2012 | Grindelia camporum | Gumplant | 11/2/2012 | | South Crest | | | | | | | | | Chadwick, Johnson, Johnston | |
| CER_ARCA_01_2013 | Artemesia Californica | California sagebrush | 1/18/2013 | | CER, Horsemill grassland | W, SW | 5º | 1,400 | 100% | | | | | Chadwick, Johnson, Johnston | |
| CER_ARCA_02_2013 | Artemesia Californica | California sagebrush | 1/25/2013 | | CER, Horsemill CSS and grassland | W, SW | 5º | 1,400 | 100% | | | | | Johnson, Johnston | |
| RJER_ARCA_01_2013 | Artemesia Californica | California sagebrush | 2/25/2013 | | slope above tecate cypress, west of RJER paking lot | E, NE | 10-25º | | 100% | | | | | | |
| CER_ARCA_03_2013 | Artemesia Californica | California sagebrush | 3/8/2013 | | Rios Canyon, base of Thornmint Hill | W, SW | 5º | | 100% | | | | | | |

# APPENDIX G

# MONITORING DATA AND ANALYSIS

Appendix G.1 Crestridge Ecological Reserve

Appendix G.2 South Crest

Appendix G.3 Statistical Analysis Report

# APPENDIX G.1

# MONITORING DATA,

# CRESTRIDGE ECOLOGICAL RESERVE

## 2013-2014 COVER DATA

Note: Appendix includes *Brachypodium* cover data summary tables only; complete data tables are available on CBI's Data Basin website (databasin.org); raw data may be available on request from CBI.

# Crestridge Ecological Reserve - 2013 *Brachypodium* Cover Data

| Pre-treatment | Cover (%) | | Post-treatment | Cover (%) | |
|---|---|---|---|---|---|
| | Treatment | Control | | Treatment | Control |
| | | | | | |
| **Polygon 001** | | | **Polygon 001** | | |
| **Block 1** | 58 | 72 | **Block 1** | 3 | 56 |
| **Block 2** | 72 | 56 | **Block 2** | 0 | 69 |
| **Block 3** | 67 | 33 | **Block 3** | 0 | 78 |
| **Polygon 003** | | | **Polygon 003** | | |
| **Block 1** | 47 | 39 | **Block 1** | 0 | 44 |
| **Block 2** | 53 | 64 | **Block 2** | 0 | 72 |
| **Block 3** | 61 | 25 | **Block 3** | 3 | 81 |
| **Polygon 005** | | | **Polygon 005** | | |
| **Block 1** | 50 | 61 | **Block 1** | 0 | 36 |
| **Block 2** | 50 | 44 | **Block 2** | 0 | 47 |
| **Block 3** | 58 | 67 | **Block 3** | 0 | 31 |

| Polygon | 2012 | 2013 | | | | 2014 | | |
|---|---|---|---|---|---|---|---|---|
| | Dethatch | Mow | Fusilade | Glyphosate | Seed | Mow | Fusilade | Glyphosate |
| 1 | X | 2x | --- | 2x | 1x | 1x | --- | 2x |
| 3 | --- | --- | 1x | 2x | --- | --- | 1x | 2x |
| 5 | --- | --- | 2x | 2x | --- | --- | 1x | 2x |

| Pre-treatment | Cover (%) | | Post-treatment | Cover (%) | |
|---|---|---|---|---|---|
| | Treatment | Control | | Treatment | Control |
| | | | | | |
| **Polygon 001** | | | **Polygon 001** | | |
| **Block 1** | 0 | 3 | **Block 1** | 6 | 36 |
| **Block 2** | 0 | 0 | **Block 2** | 8 | 22 |
| **Block 3** | 3 | 3 | **Block 3** | 11 | 31 |
| **Polygon 003** | | | **Polygon 003** | | |
| **Block 1** | | | **Block 1** | 0 | 44 |
| **Block 2** | | | **Block 2** | 6 | 39 |
| **Block 3** | | | **Block 3** | 3 | 36 |
| **Polygon 005** | | | **Polygon 005** | | |
| **Block 1** | | | **Block 1** | 8 | 14 |
| **Block 2** | | | **Block 2** | 0 | 31 |
| **Block 3** | | | **Block 3** | 0 | 22 |

| Polygon | 2012 | 2013 | | | | 2014 | | |
|---|---|---|---|---|---|---|---|---|
| | Dethatch | Mow | Fusilade | Glyphosate | Seed | Mow | Fusilade | Glyphosate |
| 001 | X | 2x | --- | 2x | 1x | 1x | --- | 2x |
| 003 | --- | --- | 1x | 2x | --- | --- | 1x | 2x |
| 005 | --- | --- | 2x | 2x | --- | --- | 1x | 2x |

# APPENDIX G.2

# MONITORING DATA,

# SOUTH CREST

## 2013-2014 COVER DATA

Note: Appendix includes *Brachypodium* cover data summary tables only; complete data tables are available on CBI's Data Basin website (databasin.org); raw data may be available on request from CBI.

# South Crest - 2013 *Brachypodium* Cover Data

| Pre-treatment | Cover (%) | | Post-treatment | Cover (%) | |
|---|---|---|---|---|---|
| | Treatment | Control | | Treatment | Control |
| | | | | | |
| Polygon 002 | | | Polygon 002 | | |
| Block 1 | 28 | 42 | Block 1 | 0 | 31 |
| Block 2 | 39 | 14 | Block 2 | 0 | 17 |
| Block 3 | 25 | 8 | Block 3 | 0 | 33 |
| Polygon 003 | | | Polygon 003 | | |
| Block 1 | 50 | 69 | Block 1 | 0 | 47 |
| Block 2 | 84 | 14 | Block 2 | 6 | 50 |
| Block 3 | 64 | 47 | Block 3 | 3 | 53 |
| Polygon 004 | | | Polygon 004 | | |
| Block 1 | 42 | 17 | Block 1 | 3 | 53 |
| Block 2 | 33 | 39 | Block 2 | 3 | 53 |
| Block 3 | 39 | 39 | Block 3 | 6 | 8 |
| Polygon 005 | | | Polygon 005 | | |
| Block 1 | 53 | 8 | Block 1 | 6 | 42 |
| Block 2 | 11 | 6 | Block 2 | 17 | 64 |
| Block 3 | 11 | 8 | Block 3 | 0 | 28 |
| Polygon 008 | | | Polygon 008 | | |
| Block 1 | 28 | 42 | Block 1 | 22 | 47 |
| Block 2 | 25 | 36 | Block 2 | 14 | 53 |
| Block 3 | 42 | 36 | Block 3 | 28 | 58 |

| Polygon | 2012 | 2013 | | | 2014 | | |
|---|---|---|---|---|---|---|---|
| | Dethatch | Fusilade | Glyphosate | Seed | Fusilade | Glyphosate | Seed |
| 2 | X | 2x | 2x | X | --- | 2x | X |
| 3 | X | 2x | 2x | X | --- | 2x | X |
| 4 | --- | 1x | 2x | --- | 1x | 2x | --- |
| 5 | --- | 1x | 2x | | 1x | 2x | --- |
| 8 | --- | 1x | 2x | --- | 1x | 2x | --- |

# South Crest - 2014 *Brachypodium* Cover Data

| Pre-treatment | Cover (%) | | Post-treatment | Cover (%) | |
|---|---|---|---|---|---|
| | Treatment | Control | | Treatment | Control |
| | | | | | |
| **Polygon 002** | | | **Polygon 002** | | |
| **Block 1** | 0 | 6 | **Block 1** | 0 | 17 |
| **Block 2** | 3 | 6 | **Block 2** | 14 | 36 |
| **Block 3** | 0 | 0 | **Block 3** | 6 | 22 |
| **Polygon 003** | | | **Polygon 003** | | |
| **Block 1** | 0 | 3 | **Block 1** | 0 | 36 |
| **Block 2** | 3 | 3 | **Block 2** | 3 | 47 |
| **Block 3** | 8 | 3 | **Block 3** | 14 | 28 |
| **Polygon 004** | | | **Polygon 004** | | |
| **Block 1** | | | **Block 1** | 3 | 25 |
| **Block 2** | | | **Block 2** | 0 | 19 |
| **Block 3** | | | **Block 3** | 6 | 19 |
| **Polygon 005** | | | **Polygon 005** | | |
| **Block 1** | | | **Block 1** | 0 | 28 |
| **Block 2** | | | **Block 2** | 6 | 33 |
| **Block 3** | | | **Block 3** | 3 | 36 |
| **Polygon 008** | | | **Polygon 008** | | |
| **Block 1** | | | **Block 1** | 0 | 31 |
| **Block 2** | | | **Block 2** | 14 | 28 |
| **Block 3** | | | **Block 3** | 8 | 50 |

| Polygon | 2012 | 2013 | | | 2014 | | |
|---|---|---|---|---|---|---|---|
| | Dethatch | Fusilade | Glyphosate | Seed | Fusilade | Glyphosate | Seed |
| 2 | X | 2x | 2x | X | --- | 2x | X |
| 3 | X | 2x | 2x | X | --- | 2x | X |
| 4 | --- | 1x | 2x | --- | 1x | 2x | --- |
| 5 | --- | 1x | 2x | | 1x | 2x | --- |
| 8 | --- | 1x | 2x | --- | 1x | 2x | --- |

# APPENDIX G.3

# STATISTICAL ANALYSIS REPORT

# Statistical analysis of a replicated adaptive management experiment: Control of *Brachypodium Distachyon* at Crestridge and South Crest.

*Photo: Wikipedia.org*

Prepared by:
Dr. Douglas Deutschman, Professor of Biology
June 15, 2014

## Organization of this Report:

The report is organization in three sections. In the first section, I summarize the effectiveness of the different treatments on cover of *Brachypodium distachyon* (hereafter BrDi), the primary endpoint of the experiment. In the second section, I present a wider array of graphics, summary statistics, and analyses that describe inter-annual variability, differences between the two sites, and impact of the experiment on BrDi as well as the cover of other functional groups. In the third section, I discuss the results and make some recommendations about future adaptive management.

# I. Experimental Control of Brachypodium Distachyon

Design of the Experiment:

The experiment used elements of both blocked and split-plot designs (Figure 1) at two sites Crestridge Ecological Reserve (CER) and South Crest (SC). These types of designs are common in agriculture and ecology/conservation because they allow managers to measure the impact of the treatment despite significant spatial heterogeneity. In addition, the design used a pre- and post- treatment survey (related to BACI designs: Before, After, Control, Intervention).

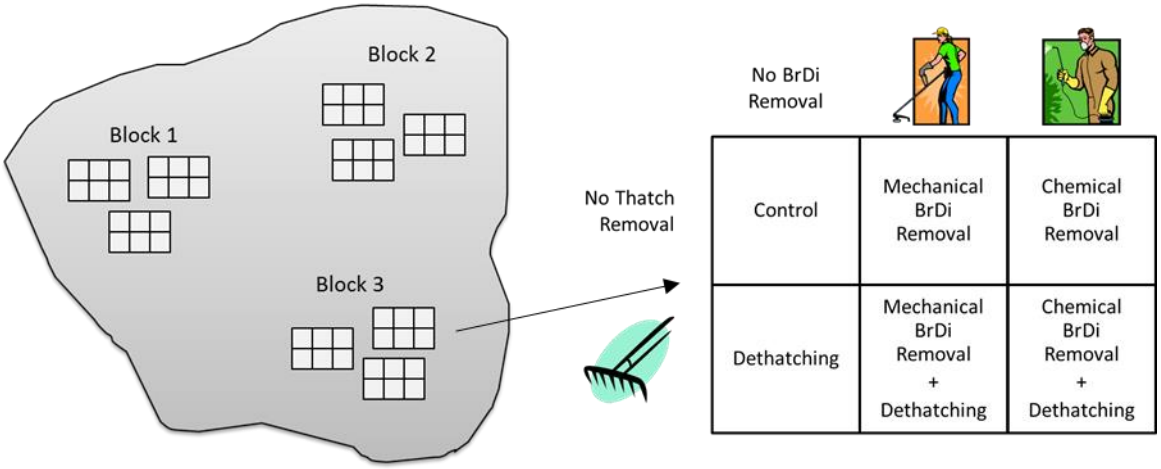



**Figure 1:** Schematic of experimental design.

The statistical analysis of pre-post and split-plot designs can be complex because the model most include terms for the spatial structure as well as the paired values (pre and post) measured from the same plot. A repeated-measures ANOVA was used for all initial analyses. In many cases, analyses could be simplified to more common ANOVA and paired t-tests. When possible, the simpler analysis is presented to make interpretation easier.

Major Results: Control of *Brachypodium distachyon*

In general, all treatments were effective at reducing the cover of *Brachypodium distachyon* (BrDi; See Table 1). In most cases, BrDi cover was reduced to zero or nearly zero for all treated plots (Figure 2). There was some evidence of polygon to polygon variability but no consistent difference between CER and SC. The treatment effect was the dominant statistical signal in both years.

| 2013 | SSQ | df | MSQ | F-ratio | P-value |
|---|---|---|---|---|---|
| **Between Blocks** | | | | | |
| Site | 3.90 | 1 | 3.90 | 0.11 | 0.742 |
| Polygons within Sites | 643.9 | 6 | 107.3 | 3.09 | 0.033 |
| Error | 555.7 | 16 | 34.7 | | |
| | | | | | |
| **Within Blocks** | | | | | |
| Treatment | 7847.4 | 1 | 7847.4 | 177.9 | <.001 |
| Treatment * Site | 3.07 | 1 | 3.07 | 0.07 | 0.795 |
| Treatment * Polygons | 413.2 | 6 | 68.9 | 1.56 | 0.222 |
| Error | 705.7 | 16 | 44.1 | | |

| 2014 | SSQ | df | MSQ | F-ratio | P-value |
|---|---|---|---|---|---|
| **Between Blocks** | | | | | |
| Site | 185.0 | 1 | 185.0 | 1.41 | 0.252 |
| Polygons within Sites | 2657.4 | 6 | 442.9 | 3.38 | 0.024 |
| Error | 2095.0 | 16 | 130.9 | | |
| | | | | | |
| **Within Blocks** | | | | | |
| Treatment | 23655.7 | 1 | 23655.7 | 244.0 | <.001 |
| Treatment * Site | 1261.4 | 1 | 1261.4 | 13.0 | 0.002 |
| Treatment * Polygons | 1107.6 | 6 | 184.6 | 1.90 | 0.142 |
| Error | 1551.0 | 16 | 96.9 | | |

**Table 1:** GLM of BrDi cover in 2013 and 2014. The treatment effect is much larger than any differences among polygons or between years.

In 2013, several plots at SC were not completely treated by the contractor leading to some residual BrDi (PGR, pers. comm.). In 2014, modest amounts of BrDi cover reflected new growth after an unseasonably late spring rain (PGR, pers. comm.).

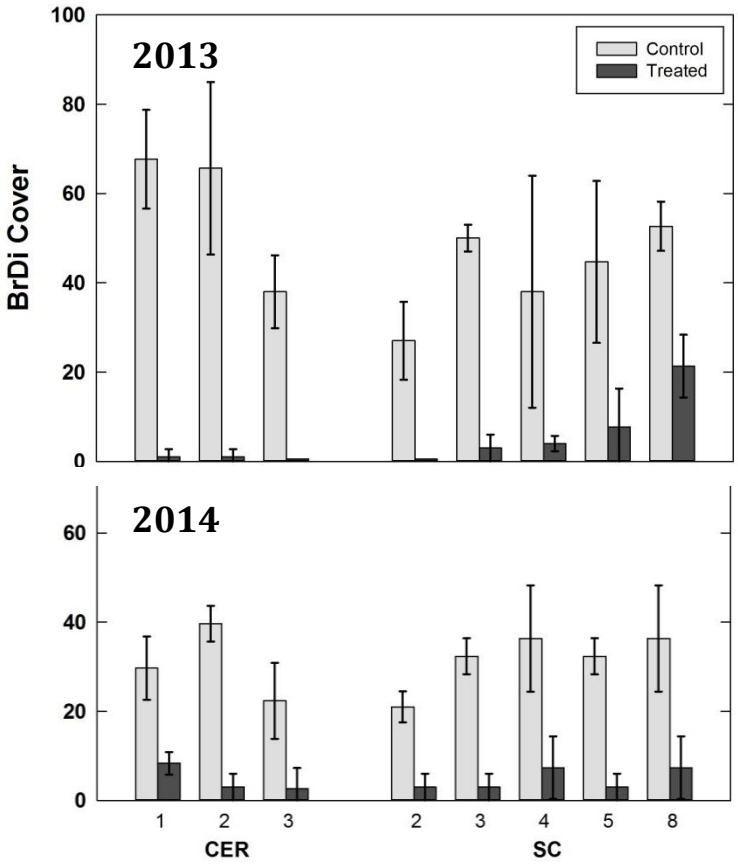



**Figure 2:** Cover of BrDi in 2013 and 2014. Each polygon is a complete block of the experiment (three at CER and five at SC).

There was little difference among the different control methods used (Figure 3). Although there was some evidence that Glypohosate + Fusilade was more effective than Glyphosate + mechanical removal at CER, the addition of Fusilade at SC did not appear to improve control. The differences observed among the treatments were small compared to the difference between all the treated plots compared to the untreated controls.

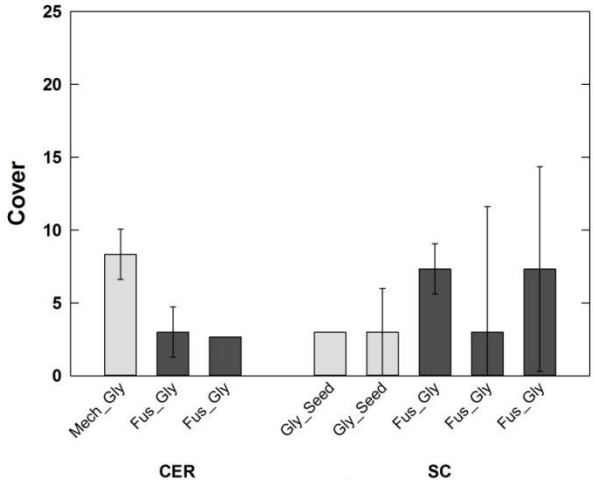
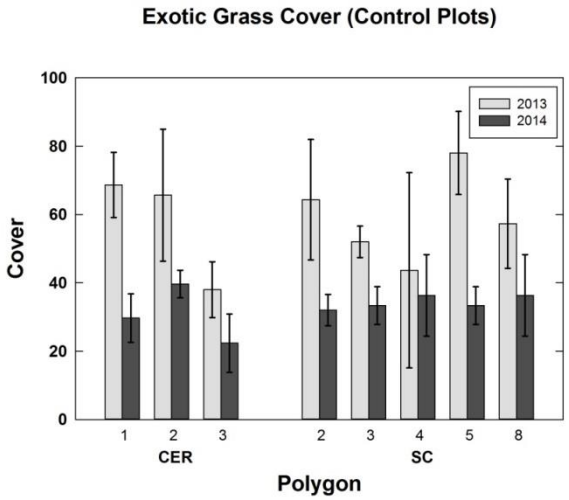



**Figure 3:** Cover of BrDi as a function of treatment (2014 data shown).

## II. Analysis of Functional Group and Richness Data

Cover of exotic grass was significantly higher on untreated plots in 2013 compared to 2014 (Figure 4). Inter-annual variation in grass is highly variable and often driven by the amount and timing of rainfall. It is important to note that control of BrDi was achieved in both years.




| Source | SS | df | MS | F-Ratio | P-Value |
|---|---|---|---|---|---|
| ***Between Subjects*** | | | | | |
| Site | 80.0 | 1 | 80.0 | 0.371 | 0.549 |
| Error | 4,746 | 22 | 215.7 | | |
| ***Within Subjects*** | | | | | |
| Year | 7,514.3 | 1 | 7,514.3 | 36.73 | 0.000 |
| Year * Site | 12.27 | 1 | 12.27 | 0.060 | 0.809 |
| Error | 4,501 | 22 | 204.58 | | |

**Figure 4:** Cover of exotic grasses from control plots in 2013 and 2014.

Cover of native forbs and grasses was low and variable (Figure 5, left). Average cover of native plants was never greater than 10%. A similar pattern was observed on treated plots (Figure 5, right). There is no evidence that treatment altered native cover. It is important to remember that native cover was low and patchy.

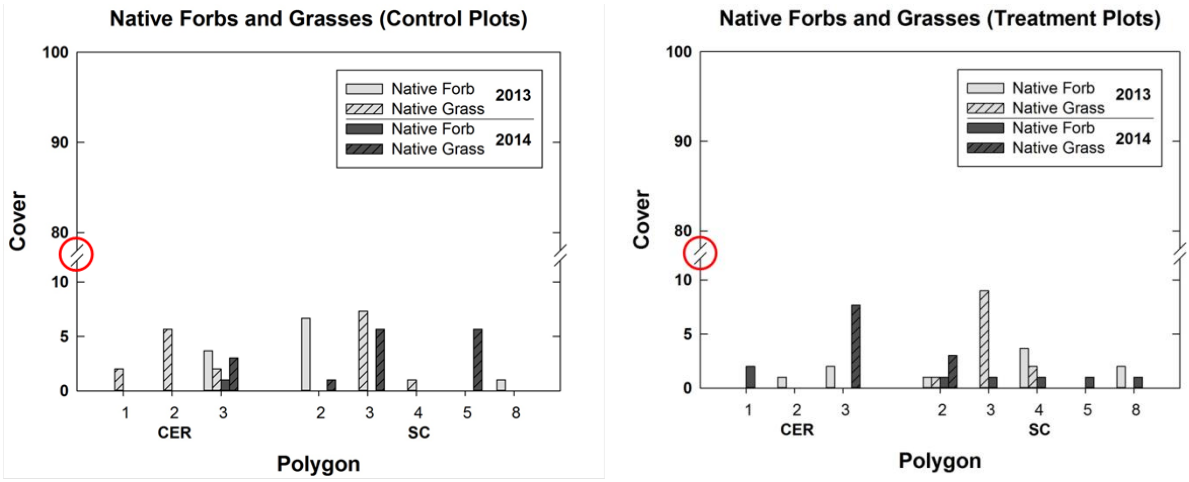
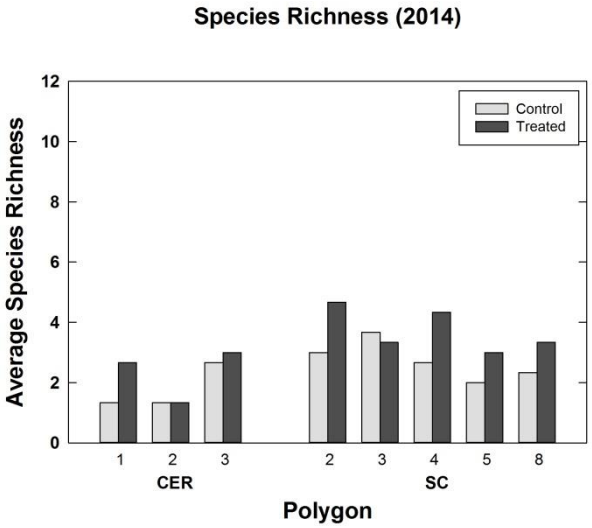



**Figure 5:** Cover of native grasses and forbs from control and treatment plots in 2013 and 2014.

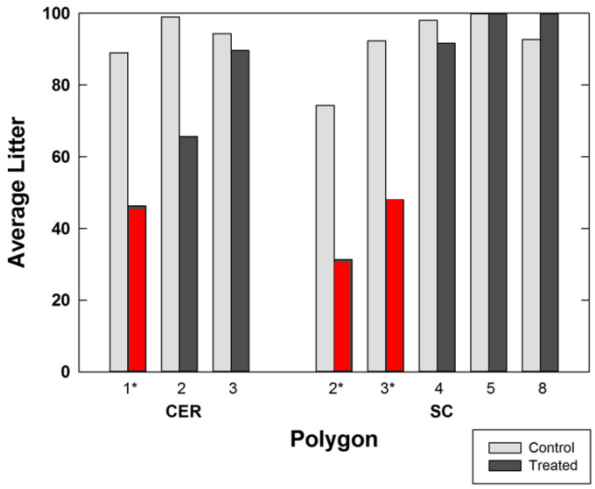
There is some evidence that total species richness is higher in treated plots relative to controls (Figure 6). There is also some evidence that SC has higher species richness than CER. Species richness is low and these effects are fairly small. Detecting meaningful change in species richness probably requires scaling the experiment up to larger plots.




| Source | SS | df | MS | F-Ratio | P-Value |
|---|---|---|---|---|---|
| ***Between Subjects*** | | | | | |
| Site | 5.20 | 1 | 5.20 | 6.699 | 0.041 |
| Error | 4.66 | 6 | 0.77 | | |
| ***Within Subjects*** | | | | | |
| Treatment | 2.27 | 1 | 2.27 | 7.500 | 0.034 |
| Trt * Site | 0.19 | 1 | 0.19 | 0.612 | 0.464 |
| Error | 1.82 | 6 | 0.30 | | |

**Figure 6:** Total species richness. Values are averages of blocks within each polygon. Treated plots have slightly higher richness and SC is more species rich than CER.

There is strong evidence that the dethatching treatment reduces litter (Figure 7, red bars). Control of BrDi without dethatching did not reduce litter on this time scale.




| Source | SS | df | MS | F-Ratio | P-Value |
|---|---|---|---|---|---|
| ***Between Subjects*** | | | | | |
| Site | 64.44 | 1 | 64.44 | 0.50 | 0.511 |
| Dethatch | 3320.1 | 1 | 3320.1 | 25.81 | 0.004 |
| Error | 643.1 | 5 | 128.6 | | |
| ***Within Subjects*** | | | | | |
| Treatment | 180.4 | 1 | 180.4 | 2.64 | 0.165 |
| Trt * Site | 136.0 | 1 | 136.0 | 1.99 | 0.217 |
| Trt * Dethatch | 1259.7 | 1 | 1259.7 | 18.46 | 0.008 |
| Error | 341.3 | 5 | 68.2 | | |

**Figure 7:** Litter in control and treated plots. Values are averages of blocks within each polygon. The three dethatched plots (red bars) have substantially lower litter than all others.

## III. Discussion and Recommendations

The results from this adaptive management experiment are encouraging. Control of BrDi can be achieved with one of several chemical (herbicide) regimes. Further, dethatching reduces litter substantially. Despite these successes, the long-term success of the experiment is uncertain. The control of BrDi did not lead to substantial increases in the cover of native species. It is possible that controlling BrDi increased species richness, but the signal was small due to the scale of the plots.

Recommendations:

- BrDi was reduced to low levels across the plots and in both years. As a result, measuring pre-treatment (before) cover values does not improve the analysis. The pre-treatment cover estimates can be eliminated without losing information or power.

- The cover estimates were very precise, but estimates of species richness were low and idiosyncratic. Species richness and composition should be estimated from larger belts or areas. This will provide more precise information about changes in community composition.

- There is significant inter-annual variability in the cover of BrDi and other species. Understanding the success of any control program requires measurement over a fairly long time period (perhaps 5 to 7 years?) in order to separate trend from inter-annual fluctuations.

- This experiment provides an important baseline of data and adding further years of treatment and/or monitoring will only increase their value.

- The utility of these methods for management depend on how they can be scaled up. If the experiment is continued, larger-scale plots should be pilot tested.

# APPENDIX H

# BEST MANAGEMENT PRACTICES

# Appendix H
# Best Management Practices

Appendix H outlines Best Management Practices (BMPs) for controlling *Brachypodium* distachyon (*Brachypodium*), based on information from both experimental studies and literature (primarily, DiTomaso et al. 2013). Figure H-1 presents a decision tree for implementing *Brachypodium* control measures.[1] We expect that BMPs for this species (including the decision tree) will be refined based on results of additional research or experimental management programs. *Brachypodium* BMPs included in this appendix fall into the following categories:

- Dethatching
- Mechanical Control
- Chemical Control
- Other Potential Control Methods

## Dethatching

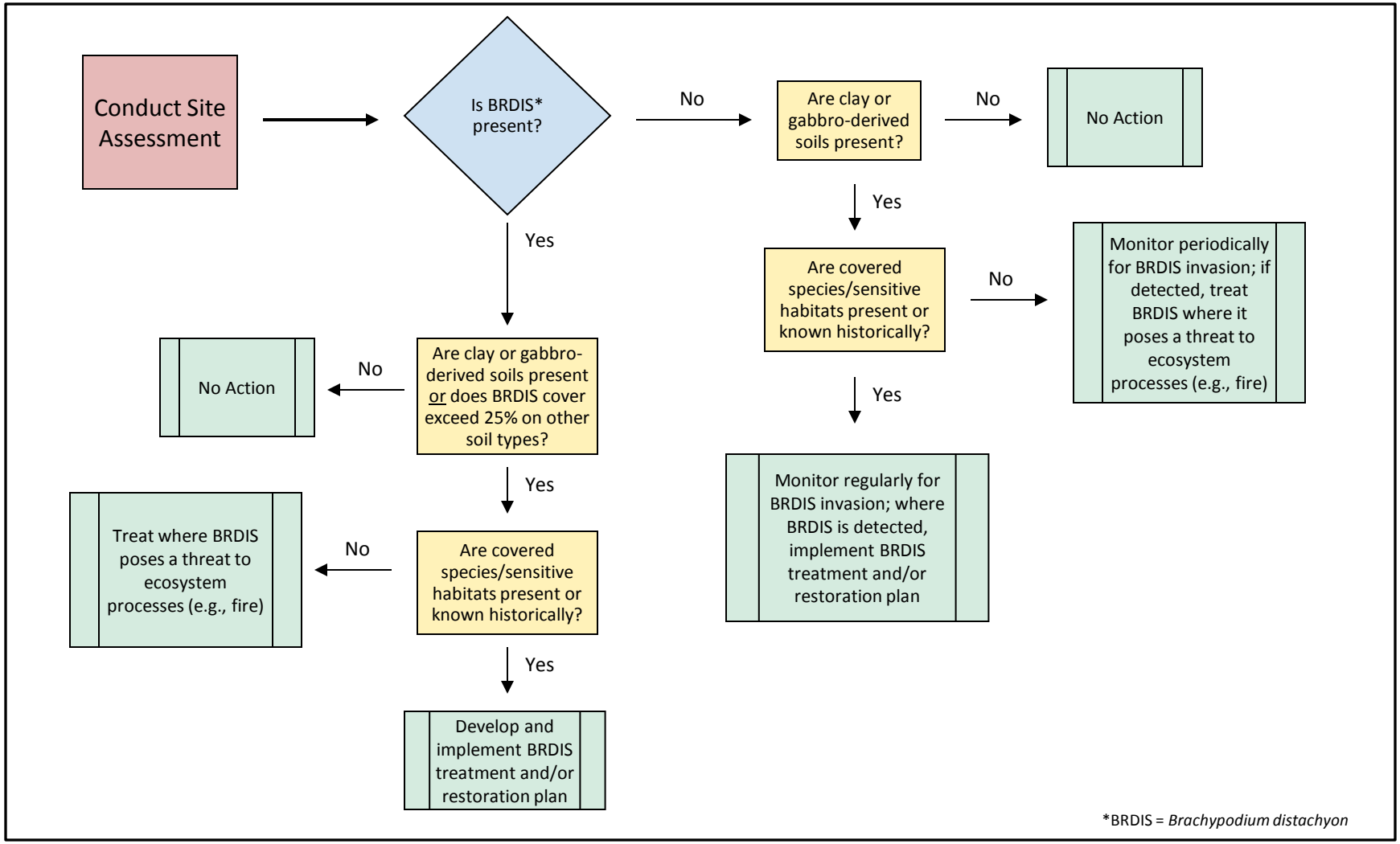
Dethatching significantly reduces *Brachypodium* litter and may result in a number of benefits, which include promoting native species germination and growth, facilitating herbicide application, and reducing fine fuels. Dethatching is particularly important if the control strategy includes a restoration component, such as seeding or planting.

Dethatching should be conducted when *Brachypodium* litter is dry and native annual forbs have dropped their seed (e.g., mid- to late summer or fall). Removing litter too early in the season could promote germination and growth of early fall-germinating nonnative forbs, such as *Erodium* spp. Dethatched material should be removed from the site or placed downslope of the restoration area to minimize reintroducing *Brachypodium* seed into the treatment area.

Where site assessments indicate a highly reduced or absent native species component in the treatment area, dethatching can be done using line trimmers, tractor-mounted mowers (mechanical), or dethatch rakes (hand). A combination of line trimming and raking up cut biomass can also be used depending on desired levels of bare ground. Where native species are present in sufficient numbers, dethatching should be conducted by hand

[1] Land managers may choose to implement *Brachypodium* control measures outside the framework of the decision tree (e.g., regardless of soil type). The decision tree prioritizes treatment where *Brachypodium* is suspected to exact the most detrimental effects on target species and habitats, based on information to date.

Figure H-1
*Brachypodium* Treatment Decision Tree



raking (using dethatch rakes) to avoid impacting native shrubs and grasses, to the degree feasible.

Comprehensive dethatching may be a one-time effort, particularly if followed by an intensive or regular *Brachypodium* control program and/or introduction of native propagules.

### Mechanical Control

DiTomaso et al. (2013) indicates that pulling, disking, and cutting are options for *Brachypodium control*. Hand pulling plants is recommended only in small areas or where the infestation is sparse (e.g., small stands of *Acanthomintha ilicifolia*). Disking is not recommended where *Brachypodium* occurs on clay or other restricted soils, because of disturbance to the soil crust and/or soil profile. Mechanical control (mowing) was shown to be effective in this study, particularly if timed appropriately. Mowing should occur prior to seed production but after most soil moisture has been depleted to prevent regrowth (DiTomaso et al. 2013). In San Diego, the timeframe for mechanical control is typically late February to early April (depending on temperature and rainfall) and when *Brachypodium* is still flowering, but before fruit formation. Mowing too early in the season will likely necessitate a second mowing event. Mowing too late will have limited effectiveness because of inputs to the soil seed bank. Because of the unpredictability of rainfall in our region, we recommend contingency funding to allow for additional mowing in the event of late rainfall that stimulates *Brachypodium* germination.

Mowing can be achieved with line trimmers or larger mowing equipment if the blades can be set low enough to effectively remove *Brachypodium* flower heads. Mowed material can be left in place or removed. Where mowed material is left in place, it will likely suppress germination of other species in the soil seed bank until it breaks down. At this time, we do not know the effects of this litter on soil ecology, or whether there are any lasting effects in the soil subsequent to breakdown.

Mechanical control should be implemented for at least three consecutive years to control the *Brachypodium* seed bank, particularly if the infestation is dense. Thereafter, frequency of control will depend on *Brachypodium* density. At this time, we suggest implementing additional control when *Brachypodium* reaches 10% cover in a previously treated area. This will prevent seed bank buildup and minimize detrimental effects on other (native) species.

## Chemical Control

This study investigated the use of chemical control on *Brachypodium* and other nonnative grasses and forbs. We used Fusilade (Fluazifop) to treat *Brachypodium*, which resulted

in high control (>90%) when applied uniformly and at the correct time. Fusilade is grass-selective and does not appear to damage most broadleaf species or have any soil activity (DiTomaso et al. 2013). It may impact native grasses, particularly when they are small, so care should be taken to avoid spraying these species.[2] A glyphosate-based herbicide was used to spot-treat nonnative forbs that germinated once *Brachypodium* levels were reduced. The following guidelines should be implemented for chemical control:

1. Apply herbicide prior to invasive plant fruit formation, to the extent possible. For *Brachypodium* control using Fusilade, this will likely occur in February, although application may be appropriate earlier (e.g., late January) or later (e.g., early March), depending on the year. Timing of application is critical; Fusilade applied once seed heads have formed will be ineffective. Fusilade applied while soil moisture is still high or prior to significant rainfall events will kill existing plants but not individuals that germinate subsequent to herbicide application. As a rule of thumb, treatment when plants are 2-6 inches high (and prior to flowering) will result in the most effective control.
2. Sites should be monitored for herbicide effectiveness and additional germination events. Depending on findings, an additional herbicide application may be necessary.
3. Chemical treatment of nonnative forbs will likely occur after nonnative grass treatment. Nonnative forb phenology varies by species, geographic location, and weather conditions. Some nonnative forbs will be flowering or fruiting while others are just beginning to germinate. Thus, multiple visits may be necessary for effective herbicide control of nonnative forbs. In addition, nonnative forb density may be inversely related to nonnative grass density. Thus, as nonnative grasses are reduced on a site, nonnative forb control efforts may increase, at least temporarily.

<u>Other Considerations and Requirements</u>

- Apply only herbicides approved for use in wildland environments.
- Herbicide applicators should possess a Qualified Applicator's License (QAL) or be trained by someone that possesses a QAL.
- Obtain land owner permission prior to application of herbicides, if necessary.

[2] Fusilade is not effective in treating the nonnative grass, *Festuca myuros*. Although this species was not common within our study area, it has been reported to colonize some sites once other nonnative grasses are removed (Bell pers. comm). *Festuca myuros* can be effectively treated with glyphosate-based herbicide, although spot-treating nonnative grasses results in collateral damage to other native species.

# Other Potential Control Methods

Grazing

Grazing has not yet been tested as a control method for *Brachypodium* in San Diego County. One concern is the effect of livestock on soil structure (including cryptogamic crust, if present). DiTomaso et al. (2013) indicates that *Brachypodium* produces forage of poor quality and low palatability (DiTomaso et al. 2013), and a grazing strategy that targets this species would likely require short duration, high intensity grazing just before seed heads were produced. Grazing as a control method for *Brachypodium* should be tested prior to large-scale implementation.

Fire

Available evidence suggests that *Brachypodium* seed is killed by fire (Brown and Bettink 2010); thus, fire may be a potential management tool for this species in some areas. *Brachypodium* also appears to colonize burned areas relatively quickly (presumably, from buried seed or from sources outside the burn), and a combination of treatments (e.g., fire to kill surface seed and remove thatch followed by mechanical or chemical control) may be the most effective treatment.

In other regions, prescribed burning in early summer when plants were capable of carrying a fire was shown to significantly reduce the population of annual false-brome (DiTomaso et al. 2013). This timing would also minimize impacts to most native forbs and grasses. Use of prescribed burning for *Brachypodium* control would require coordination with the California Department of Forestry and Fire Protection (CalFire) to develop a burn plan and implement a controlled burn.

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