Conservation Vision and Management Strategy

Dehesa Nolina (*Nolina interrata*)

San Diego County, California

Prepared for

San Diego Association of Governments
Environmental Mitigation Program Grant 5001763

Prepared by

Conservation Biology Institute

April 2015

CONSERVATION BIOLOGY INSTITUTE

Acknowledgments

- John Ekhoff, Tracie Nelson, California Department of Fish and Wildlife
- John Martin, U.S. Fish and Wildlife Service
- Michael Beck, Jonathan Appelbaum, Endangered Habitats Conservancy
- Trish Smith, Zach Principe, The Nature Conservancy
- Kris Preston, San Diego Management and Monitoring Program
- Emily Perkins, Sharon Coe, U.S. Geological Survey

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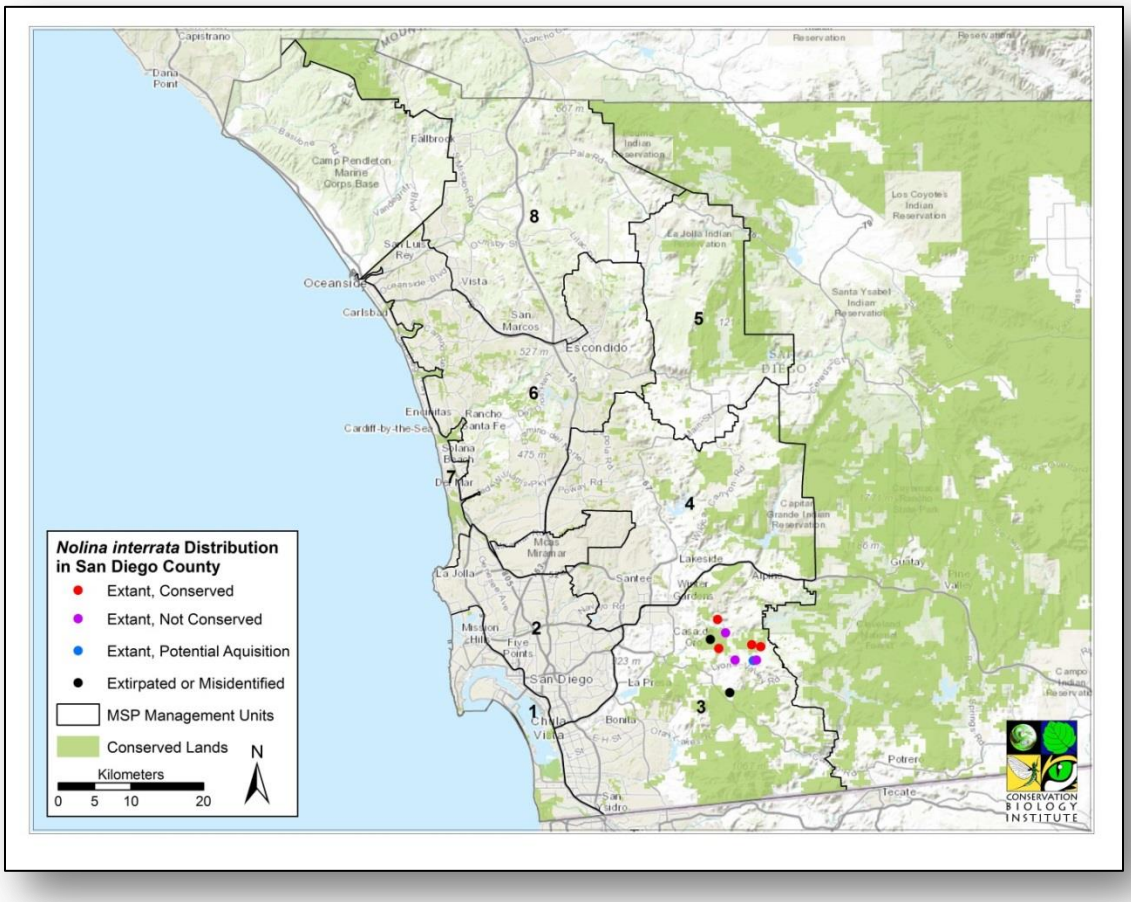
Appendices

1 Introduction

This conservation vision evaluates status and threats for the state-endangered plant species Dehesa nolina (*Nolina interrata*) on conserved lands in San Diego County (Figure 1), prioritizes management actions by population, and identifies survey and research needs. This document supplements information in the Management Strategic Plan (MSP) for Conserved Lands in western San Diego County (SDMMP 2013). The management strategy in Appendix A is consistent with the MSP with respect to threats and stressors, management focus group, and management goals and objectives.

Figure 1

Distribution of Dehesa Nolina in the Management Strategic Planning Area



Dehesa nolina is a narrow endemic species covered by the San Diego Multiple Species Conservation Program (MSCP). Although it was proposed for federal listing as threatened in 1995, the U.S. Fish and Wildlife Service (1998) decided listing was not warranted based on conservation of populations through (1) the MSCP and (2) the County of San Diego's Biological

Mitigation Ordinance, which requires avoidance and minimization of impacts to narrow endemic plants and site-specific management prescriptions. Our review, nearly two decades after adoption of the MSCP, assesses the status of conserved populations and refines management actions to ensure continued persistence of Dehesa nolina.

Data Sources

- Management Strategic Plan for Conserved Lands in Western San Diego County (MSP) (SDMMP 2013)
- California Natural Diversity Database (CNDDB 2014) and Master Occurrence Matrix (MOM) (SDMMP 2014)
- Proposed federal listing and withdrawal of listing proposal (USFWS 1995, 1998)
- Previous surveys and research (e.g., CBI 2012, REC Consultants Inc. 2004, County of San Diego 2002, Rombouts 1996, Dice 1988, Oberbauer 1979, Trelease 1911)
- Dehesa nolina conceptual model and narrative (CBI 2012)
- Invasive Plant Strategic Plan (IPSP) (CBI et al. 2012)
- Study for controlling the impact of *Brachypodium distachyon* on endemic species (CBI 2014)

Approach

Through the following steps, CBI developed a matrix of Dehesa nolina populations on conserved lands with respect to location, ownership, conservation status, and threats to develop site-specific management actions.

- Visited all seven CNDDB populations[1] on conserved lands and lands proposed for conservation between May and July 2014. We did not survey private lands. The CNDDB identifies 2 Dehesa nolina populations on private lands and there may be other populations on private lands, as well.
- Conducted habitat assessments and collected SDMMP rare plant monitoring data at 5 of the seven CNDDB locations on conserved lands (14 sampling points) or all conserved populations where we found Dehesa nolina.
- Interviewed land managers.

[1] We use the term 'population' rather than 'element occurrence' to minimize confusion when discussing regional population structure and principles of population biology. However, we identify Dehesa nolina populations by element occurrence (EO) number and acknowledge that the use of 'population' in this context does not necessarily infer a genetic relationship.

- Identified potential vegetation and soils correlates.
- Identified threats and stressors and reviewed fire history.
- Hypothesized regional population structure.
- Identified data gaps and areas that need to be surveyed.
- Identified priority research questions.

Results

The CNDDB (2014) reports nine Dehesa nolina populations in the U.S., all in and around the Dehesa Valley in Management Unit (MU) 3 (Figure 2). Seven of these populations are reported from conserved lands or lands under consideration for acquisition and conservation (CNDDB 2014). However, we were unable to locate two of the conserved populations in 2014 and suspect they may have been misidentified or are extirpated. At both locations, we identified a gray-blue phase of chaparral yucca (*Hesperoyucca whipplei*) that superficially resembles Dehesa nolina, particularly at a distance (Figure 3). It is possible that previous surveys may have misidentified this species as Dehesa nolina. Based on our field survey results, there appear to be five (rather than seven) extant populations on conserved lands or lands under consideration for acquisition and conservation (Table 1).

The remaining two populations are on private lands: one occurs on land owned primarily by the Sycuan Tribal Development Corporation, and the other occurs across multiple parcels under different ownership. Both populations on private lands appear to be relatively small (based on published reports), but potentially function as steppingstones between larger, conserved populations. We were not granted access to assess Dehesa nolina on Sycuan tribal lands, despite attempts to coordinate with Sycuan staff, including a presentation to the tribal council.

We evaluated all conserved populations. In some cases, we refined previous mapping and identified new stands; however, comprehensive mapping of all populations was beyond the scope of this study. Our primary recommendations are:

- Reduce threats to conserved, extant populations, with a particular focus on large populations (Sycuan Peak Ecological Reserve, McGinty Mountain Ecological Reserve, Dehesa Mountain-South Crest) that are critical for species persistence in the region. Of these three large populations, the Dehesa Mountain-South Crest and McGinty Mountain populations are currently the most at-risk due to threats.

Figure 2

Distribution of Dehesa Nolina in Management Unit 3

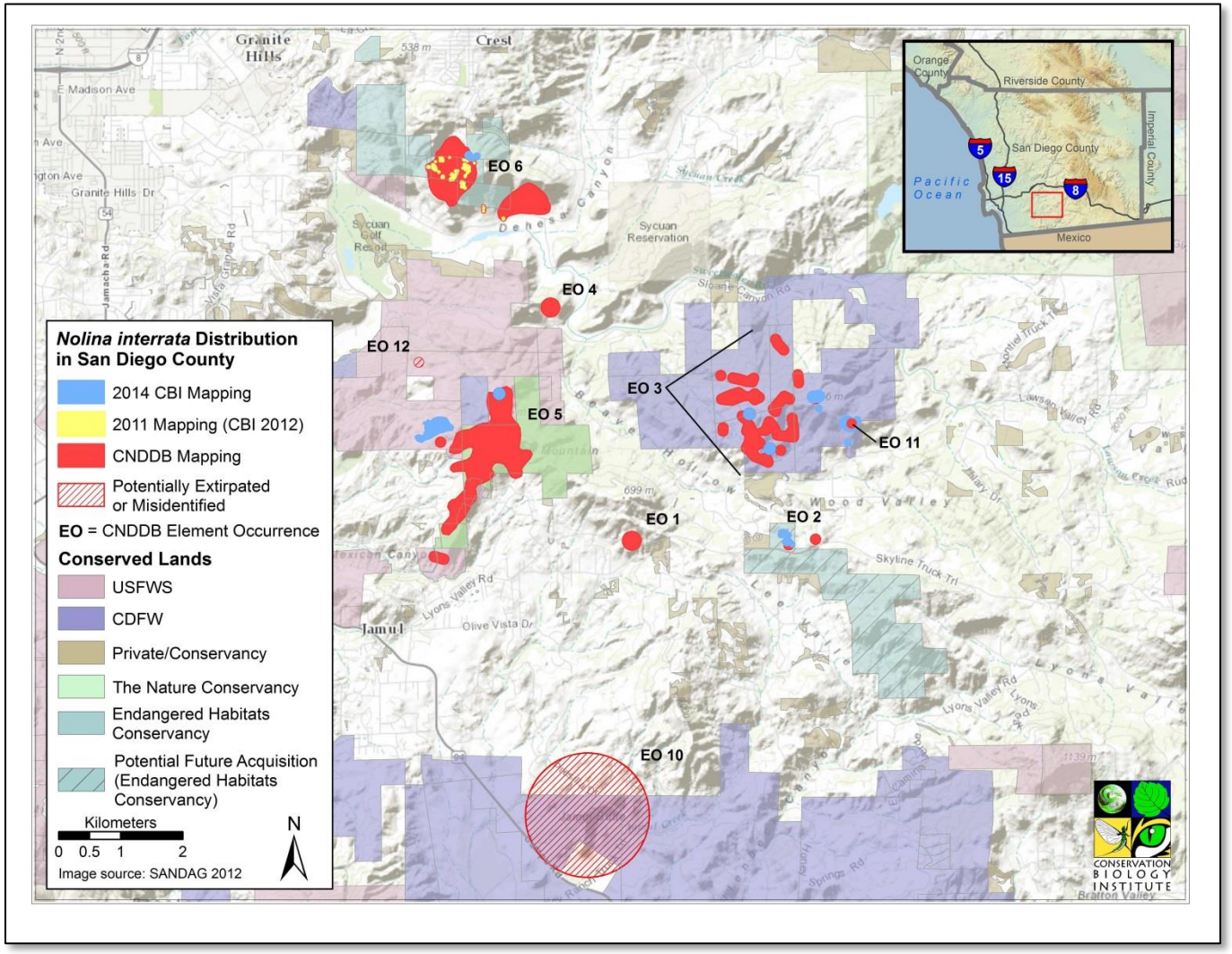


Figure 3

Chaparral Yucca and Dehesa Nolina

a. Color phases of chaparral yucca.

b. Dehesa nolina cluster.

Table 1

Dehesa Nolina on Conserved Lands in Management Unit 3

Population (Element Occurrence)	Status	
	Extant	Misidentified or Extirpated[2]
2[1]	X	---
3	X	---
5	X	---
6	X	---
10	---	X
11	X	---
12	---	X

[1] Occurrence is on private lands currently under assessment for acquisition.

[2] Population may be extirpated or may have been misidentified; however, no Dehesa nolina were identified during 2014 surveys.

- Enhance habitat and augment population size and genetic diversity at extant populations, if determined necessary through surveys and genetic studies.
- Conserve and manage populations not currently protected.
- Survey for additional Dehesa nolina populations in suitable habitat that has not yet been assessed.
- Conserve, manage, and enhance pollinator habitat between Dehesa nolina populations, if determined necessary through surveys and genetic studies.
- Translocate Dehesa nolina into suitable habitat outside the current species' range, if determined necessary to offset adverse impacts from climate change.
- Refine BMPs for Dehesa nolina to facilitate management of this species.

Appendix A. The draft MSP addressed Dehesa nolina in Volume 3, Section 3A (http://sdmmp.com/Libraries/MSP_08_27_2013/Vol3_App3A_Species_Goals_Objectives_01072013_MSP_Draft_08_27_2013.sflb.ashx) (SDMMP 2013). This appendix updates the draft information, provides population descriptions, summarizes threats, stressors, and management opportunities, and identifies goals, objectives, and management actions. Once reviewed and approved by SDMMP, Appendix A serves as the working document for management implementation.

Appendix B. We developed a matrix of extant Dehesa nolina populations on conserved lands in San Diego County that includes the most current information on population location, status, land owner, land manager, management unit, conservation status, census data (if any), and threats. This matrix updates CNDDB (2014) and MOM database (SDMMP 2014) information, based on results of 2014 habitat assessments and rare plant monitoring. The matrix includes information from both habitat assessments and SDMMP rare plant monitoring forms.

Appendix C. This appendix describes natural drivers, threats, and stressors for Dehesa nolina.

Appendix D. These rare plant monitoring data forms were compiled and submitted to SDMMP for inclusion in the MOM database.

2.0 Regional Population Structure

We developed management recommendations using a landscape-level approach that considers the regional population structure of the species. That is, we reviewed the entire species distribution across the landscape, presence of suitable habitat between populations that could allow for expansion or migration in the context of climate change, and apparent gaps in distribution or habitat connectivity that potentially threaten species persistence. Our recommendations focus on reducing threats for existing populations, conserving additional

populations and protecting and enhancing habitat where there are gaps between populations to improve overall resilience and long-term persistence. (Figure 4).

Population Size and Gene Flow

In the absence of genetic studies[2] or historical data regarding past relationships, the assessment of regional population structure is based on a number of assumptions about population size and gene flow (e.g., Menges 1991, Ellstrand and Elam 1993, Kolb 2008):

- Large populations are less susceptible to extirpation than small populations.
- Large populations have higher reproductive success and higher genetic diversity than small populations, particularly those small populations in fragmented landscapes.
- Relatively low levels of gene flow may be sufficient to offset effects of genetic drift in small populations.
- Small populations are more likely to receive gene flow from large populations than from other small ones, even if the latter are closer.
- Large populations can serve as a seed source for restoration; however, we need genetic analyses before determining where seed from these populations can be used.
- Large populations may occur alone and function independently or may occur as part of a population group (*metapopulation*), which consists of noncontiguous populations of various sizes that potentially interact through gene flow or dispersal.

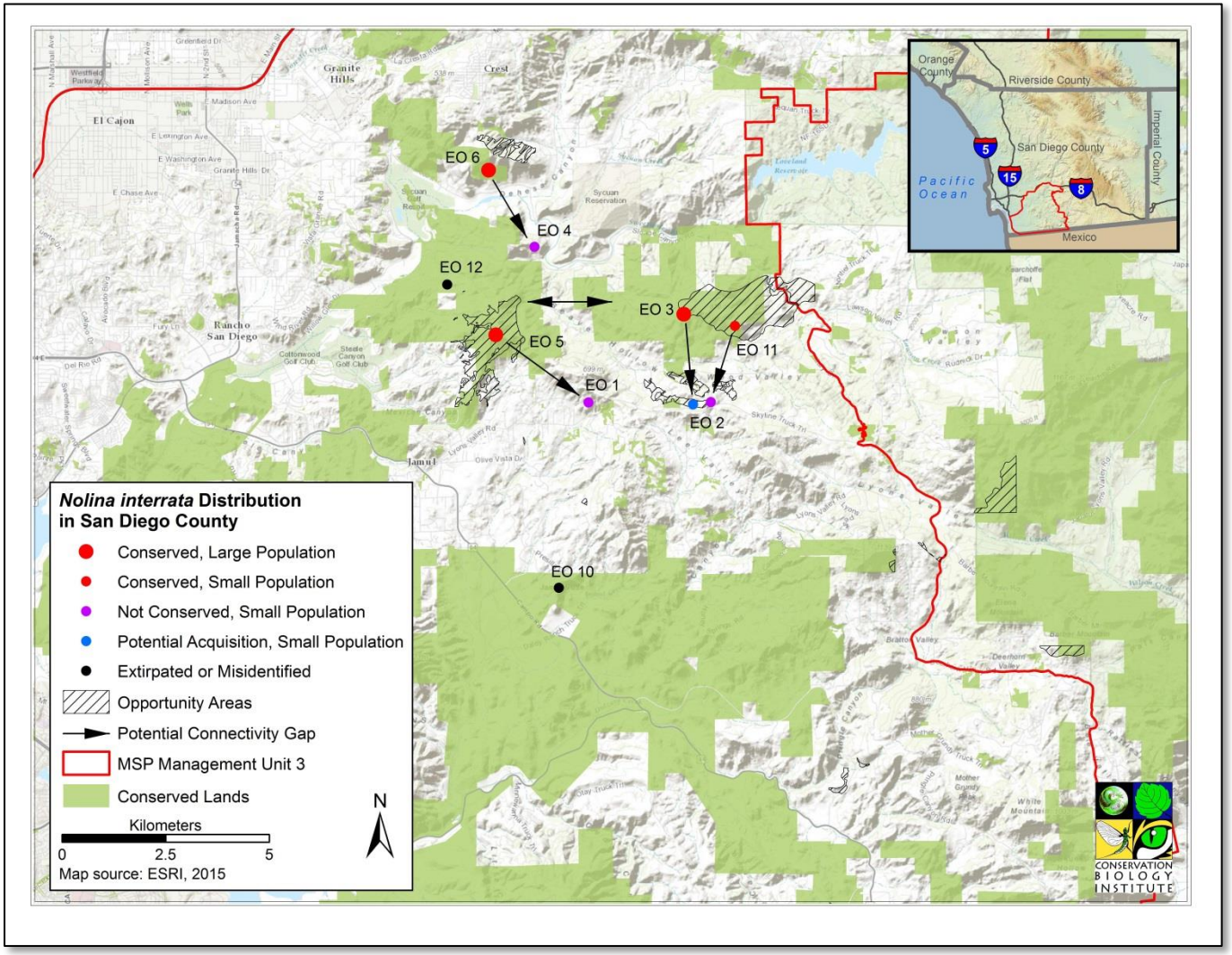
Based on these assumptions, we recommend the following management actions (Figure 4):

1. Maintain large populations (>1,000 individuals) by reducing threats, restoring habitat, and augmenting population size or genetic diversity, as determined necessary through assessments (Appendix A) and genetic studies. Large populations occur on Sycuan Peak Ecological Reserve, McGinty Mountain Ecological Reserve, and Dehesa Mountain-South Crest Preserve (Figure 4). Collect and store seed from these three populations for use in restoration, and use genetic studies to determine appropriate seed transfer locations.
2. Maintain small, conserved populations (<1,000 individuals) by reducing threats. At present, only the Skyline Truck Trail population that is under consideration for acquisition falls into this category (Figure 4). Based on genetic studies, determine

[2] Dehesa nolina reproduces both sexually and asexually; however, the relative importance or contribution of these reproductive strategies in maintaining genetic diversity is not fully known. Refer to Appendix C for a more detailed discussion of reproductive modes and genetic diversity in this species.

Figure 4

Regional Population Structure



whether population augmentation is necessary. Where threats cannot be reasonably controlled or the potential for connectivity with other populations is lacking, small populations are not likely to contribute significantly to regional population structure and, therefore, would be a lower priority for regional management.

3. Conserve extant populations of Dehesa nolina in MU 3 that are currently on private lands (e.g., Element Occurrences [EOs] 1 and 4).

4. Conduct surveys to identify additional Dehesa nolina populations that may occur in suitable habitat that has not yet been assessed. The presence of additional populations could strengthen regional population structure by eliminating gaps in connectivity or gene flow.

5. Conserve, maintain, or restore pollinator habitat between conserved populations to promote genetic flow. All populations would benefit by intact landscape connections.

6. Translocate Dehesa nolina into suitable habitat beyond the current species' range (translocation) if determined necessary to assist dispersal in response to climate change. Translocation sites will likely be situated to the east of the current species' range; thus, the easternmost populations (Sycuan Peak, Skyline Truck Trail) will likely be the best candidates for donor material for translocation.

Habitat Connectivity

Connectivity is the degree to which the landscape facilitates or impedes movement among resource patches (Taylor et al. 2006). Connectivity of natural open space is widely regarded as essential to maintaining functional landscapes and evolutionary processes (e.g., Noss 1987, 1991, Saunders et al. 1991, Beier and Noss 1998). For plants, habitat connectivity allows for movement of pollinators and possibly, dispersal agents between populations, thus, facilitating gene flow. Habitat connectivity may also provide opportunities for species expansion or migration under existing conditions and in response to climate change (Primack 1996, Anacker et al. 2013).

Potential connectivity gaps occur from habitat fragmentation (roads, rural residential development) or represent natural distributions that are regulated by environmental factors (e.g., suitable soils). In the former case, populations that were in proximity historically are now separated by larger distances, and disruption of gene flow between these populations (if any) may affect persistence over time. Where discontinuous populations appear stable and there is suitable intervening habitat, current gaps may approximate historic conditions in terms of gene flow and thus, may not require targeted efforts to improve connectivity.

We identified potential connectivity gaps between populations (Figure 4). Additional surveys and genetic studies are necessary to determine whether these gaps pose a threat to population persistence. Strategies for improving connectivity include:

1. Augment existing populations through assisted migration of pollen, seed, or plants.
2. Conserve extant, currently unconserved populations of Dehesa nolina.
3. Survey for Dehesa nolina in appropriate habitat between existing populations.
4. Conserve, maintain, or enhance habitat for pollinators between existing populations.
5. Translocate the species into suitable habitat outside the current species range to accommodate climate change.

Opportunity Areas

Opportunity areas are lands within MU 3 that have the potential to enhance regional population structure by improving connectivity between Dehesa nolina populations. We identified broad opportunity areas, and refined these based on geographic position, soils, and vegetation (Figure 4). Survey these opportunity areas to:

1. Look for new populations.
2. Assess sites suitable for enhancement of potential pollinator habitat.
3. Assess sites suitable for potential translocation of the species (as informed by genetic analyses).

3.0 Regional and Preserve Level Actions and Research

Management of all Dehesa nolina populations at both regional and preserve-levels is necessary to ensure long-term persistence of the species. This section prioritizes management actions based on population size, threats and stressors, and probable outcome of the management action. Regional management and research should address threats and stressors that affect multiple populations across preserve boundaries, for example, genetic studies and control of widespread invasive species. Some regional threats and stressors,[3] such as altered fire regimes and nitrogen deposition, influence or promote other threats (e.g., post-fire habitat recovery, invasive species). Preserve-level actions apply to a specific preserve or population.

[3] Per the MSP (SDMMP 2013), the terms "threat" and "stressor" are used interchangeably in this document to represent those factors or processes that may impact MSP species and necessitate the need for management to ensure species persistence.

Regional Management Actions

Monitoring and Surveys

1. Establish the following populations as sentinel populations for long-term monitoring (Figure 5):
   a. Skyline Truck Trail Preserve: Sampling point 2-1
   b. Sycuan Peak: Sampling points 3-1, 3-5, 3-8, and 11-1
   c. McGinty Mountain: Sampling points 5-2, 5-4, 5-5, and 5-8
   d. Dehesa Mountain-South Crest: Sampling points 6-1 and 6-2
2. Monitor sentinel populations every 3-5 years, or at an alternate frequency recommended by SDMMP. Monitoring should be conducted often enough to identify change. Individual plants are not expected to increase significantly in size or abundance in <3-5 years, except after fire or other disturbance; however, declines due to specific threats (e.g., invasive species, disease) could occur more frequently. Where threats have been identified, populations should be assessed every 3 years. Where threats are minimal or non-existent, sampling may occur every 5 years. At each monitoring period, monitoring frequency should be re-assessed based on findings.

   Populations that burn during a fire event should be monitored for 3 consecutive years following the fire, regardless of other monitoring intervals or schedules, to assess recovery and threats (particularly, invasive species). Where mass flowering occurs post-fire, populations should be assessed for sex ratios and seed collected for banking.
3. Survey opportunity areas for Dehesa nolina populations or suitable pollinator habitat (Figure 4). Where new populations are detected, baseline data collection should include population status, location, threats, habitat and edaphic covariates, and management needs (SDMMP 2013).

Invasive Plant Control

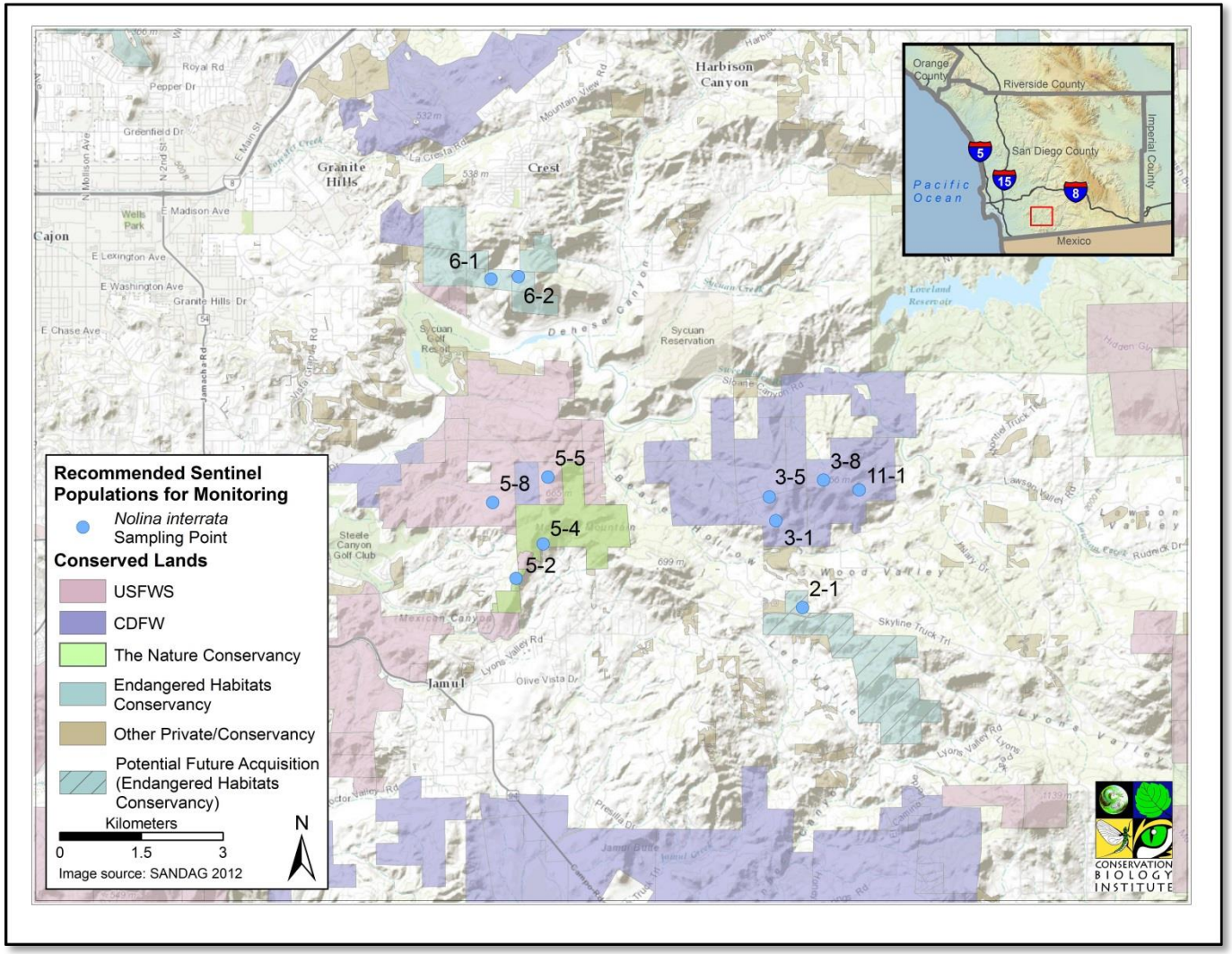
1. Control invasive plants where they are a threat to Dehesa nolina persistence. To date, invasives have been identified as a threat at the Sycuan Peak, McGinty Mountain, and Dehesa-South Crest populations.

Best Management Practices

1. Refine Best Management Practices (BMPs) (e.g., invasives control, seed collection and propagation, out-planting) at regular intervals based on results of management experiments and research studies. CBI is currently working on several aspects of Dehesa nolina BMPs through field and nursery studies.

Figure 5

Sentinel Populations for Long-term Monitoring



Seed Bank

1. Develop a permanent seed source (seed bank) that consists of both conservation and propagation seed collections for research and restoration (see SDMMP 2013 Vol. 1). This is important because flowering, and thus seed production, is sporadic in this species, with profuse flowering occurring only after a fire.
2. Collect and store seeds across multiple years according to established guidelines (RBGK 2001, Wall 2009). Prioritize large populations (e.g., Sycuan Peak, McGinty Mountain, Dehesa-South Crest) and populations that represent the range of genetic variability for seed collection.

Enhancement and Translocation

1. Enhance conserved populations through habitat restoration or population augmentation, as determined necessary through survey and research results. Restoration should include pollinator habitat. Habitat restoration and population augmentation (seed collection, propagation, out-planting of individuals) is currently ongoing at the Dehesa Mountain-South Crest population to offset habitat degradation and loss of plants from fire and other disturbances. Enhancement (restoration) may be necessary in some locations on McGinty Mountain following invasive control efforts.
2. Enhance pollinator habitat between populations, if determined necessary through surveys that assess habitat condition and research that identify gaps that may impede genetic flow. Figure 4 indicates potential connectivity gaps between populations; however, these gaps have not been assessed for habitat condition.
3. Test soils of all or a sample of populations to identify potential soil correlates for use in future translocation efforts.
4. Conduct experimental translocations, if determined necessary to offset adverse impacts to populations from climate change. Incorporate results of soil testing into translocation site selection and results of genetic studies into appropriate propagule source selection for translocation.

Data Storage and Analysis

1. The SDMMP will maintain a regional monitoring and management database.
2. The SDMMP will assess species trends across the region.
3. The SDMMP may refine regional monitoring and management priorities, based on these analyses.

Preserve Actions

Monitoring and Surveys

1. Refine population data through censusing, mapping, and soils testing, using the SDMMP rare plant monitoring protocol and data forms. Submit data to the South Coast Multi-taxa Database and SDMMP for regional analysis.
2. Survey opportunity areas that have not been previously assessed to identify new Dehesa nolina populations.
3. Refer to regional management actions for additional monitoring recommendations (Section 3.1). Preserve land managers may work with SDMMP to monitor sentinel populations at the specified frequencies.

Management

1. Develop or refine a fire management plan that designates access for fire suppression, staging areas (and sensitive biological areas), and post-fire invasive species and erosion control plans.
2. Install fencing and signage and control invasive plants as necessary to protect populations from impacts, establish.

Research

Prioritize research that will inform management at the landscape-level (i.e., *which* populations to manage), followed by management at the preserve-level (i.e., *how* to manage populations).

1. Determine the genetic structure of Dehesa nolina populations on conserved lands to:
    a. Refine the regional population structure hypothesis.
    b. Identify populations that would benefit from enhancement or expansion.
    c. Identify gaps to inform conservation or establishment of additional populations (if present) or pollinator habitat to promote connectivity and genetic diversity.
    d. Identify appropriate source populations of genetic material for use in augmentation.
    e. Identify appropriate seed/plant transfer zones for augmentation.
    f. Inform seed bulking protocols to conserve genetic diversity.
2. Conduct common greenhouse studies in conjunction with results from genetic studies to assess adaptive genetic diversity.
3. Conduct studies on the reproductive biology and population structure of Dehesa nolina (e.g., level and mode of sexual reproduction, sex ratios).
4. Determine seed germination cues and viability rates.

5. Determine effective pollinators and their host plants, maximum pollinator migration/travel distance, and potential effects of climate change on pollinator communities in relation to Dehesa nolina phenology.
6. Determine effects of invasive plant species on Dehesa nolina survival and persistence.

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Appendices

Appendix A: Management Strategic Plan: Dehesa Nolina (*Nolina interrata*)

Appendix B: Nolina Matrix

Appendix C: Natural Drivers and Threats and Stressors

Appendix D: San Diego Management and Monitoring Program (SDMMP) Rare Plant Forms

Appendix A

Management Strategic Plan:

Dehesa Nolina (*Nolina interrata*)

Appendix A

Management Strategic Plan: Dehesa Nolina (*Nolina interrata*)

A.1 Management Units with Known Populations[1]

Dehesa nolina is a perennial herb that occurs in San Diego County and Baja California, Mexico. The California Natural Diversity Database (CNDDB) reports nine occurrences in the U.S., all in or near the Dehesa Valley, and further indicates that six of these occurrences are on conserved lands (CNDDB 2014). Dehesa nolina also occurs in at least three locations in Baja California (CNPS 2015, Oberbauer pers. comm.). This species is a soil endemic that is typically restricted to gabbro-derived or metavolcanic soils (Rombouts 1996, CNPS 2015), although at least one population in San Diego occurs partially on clay soils (CBI 2012). Dehesa nolina is a covered species under the San Diego Multiple Species Conservation Program (MSCP) and is considered a narrow endemic species in the region.

In 2014, CBI assessed populations of Dehesa nolina on conserved lands in Management Unit (MU) 3 of the Management Strategic Planning Area (MSPA) in western San Diego County (Figures A-1 and A-2). Table A-1 summarizes the status of populations on conserved lands, based on this assessment, while Table A-2 summarizes threats for all Dehesa nolina populations in MU 3, based on this assessment and existing data. Of the seven conserved populations reported by CNDDB, five appear to be extant (CNDDB Element Occurrences [EOs] 2, 3, 5, 6, 11), and two appear to be either extirpated or possibly misidentified (EOs 10, 12). Note that a portion of EO (2) is on private lands currently under assessment for acquisition, and was therefore included in this study. Populations range from large to small, and are subject to varying types and levels of threats, as summarized below.

A.2 Population Assessment Results

This section describes assessed populations with respect to location and ownership, status and size, threats and stressors, and management recommendations. Figure A-3 illustrates terminology used in assessing population size and structure (e.g., ramets or rosettes, clusters, patches). Management actions are summarized in Table A-4 of this document. Refer to the Conservation Vision and Management Strategy (strategy, Section 3) for additional regional- and preserve-level management actions.

[1] In keeping with discussions in the Adaptive Management Framework and Appendix C, we generally use the term 'population' rather than 'occurrence' throughout this document to minimize confusion. When referring to specific populations or element occurrences, the term population is synonymous to 'occurrence,' as used in the Management Strategic Plan (SDMMP 2013).

Figure A-1

Distribution of Dehesa Nolina in Management Unit 3

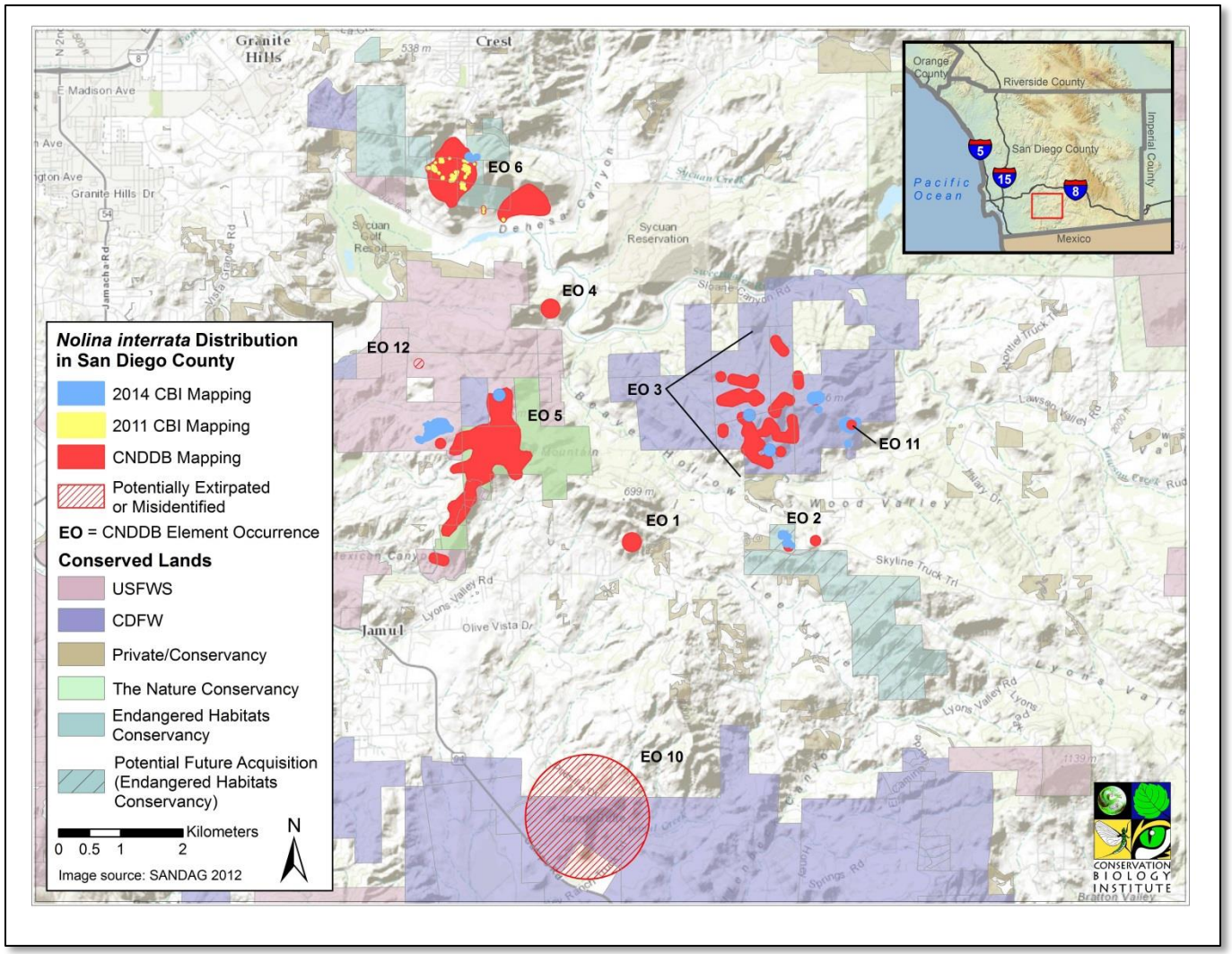


Figure A-2

2014 Dehesa Nolina Sampling Points

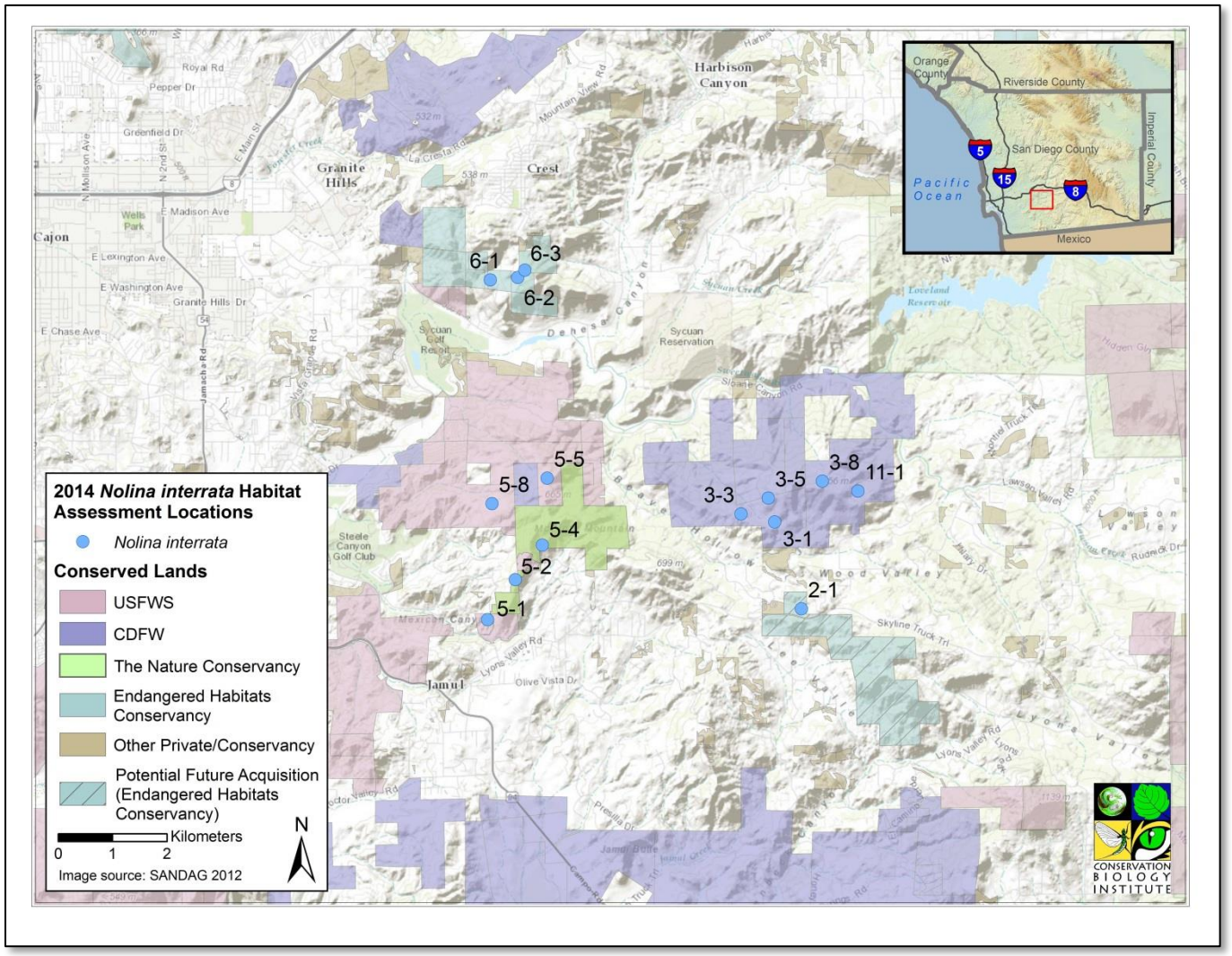


Table A-1

Dehesa Nolina on Conserved Lands in Management Unit 3

Population (Element Occurrence)	Status	
	Extant	Misidentified or Extirpated[2]
2[1]	X	---
3	X	---
5	X	---
6	X	---
10	---	X
11	X	---
12	---	X

[1] Occurrence is on private lands currently under assessment for acquisition.
[2] Population may be extirpated or may have been misidentified; however, no Dehesa nolina were identified during 2014 surveys.

Skyline Truck Trail (EO 2)

The Skyline Truck Trail population is represented by 2 polygons (CNDDB 2014) (Figure A-4). Because both polygons are currently on private lands, neither is included in the SDMMP Master Occurrence Matrix (MOM) database. The westernmost polygon (Skyline Truck Trail Preserve) was included in this assessment because it is under consideration as a conservation acquisition. Additional, potentially suitable habitat on private lands to the north and east of this potential acquisition was not assessed during this study.

Population Size: An estimated 16 clusters were detected on the Skyline Truck Trail Preserve in 1989 (CNDDB 2014). We refined mapping of the CNDDB polygon and mapped two additional Dehesa nolina polygons (Figure A-4). In addition, we identified 52 clusters within a rare plant sampling plot, and noted additional individuals onsite but outside this sampling area.

Status: This site supports gabbro soils (Las Posas series) and chaparral in the *Adenostoma fasciculatum-Xylococcus bicolor* Alliance and *Adenostoma fasciculatum-Xylococcus bicolor-Ceanothus tomentosus* Association. Additional shrubs include

Dehesa Nolina Counting Units (Rombouts 1996)

Ramet (or rosette) – An individual that has grown vegetatively from another individual as a clone; Dehesa nolina ramets arise from a horizontal underground rootstock.

Cluster – a group of closely spaced ramets. Clusters may contain 2-30 ramets, but generally have between 5-15.

Patch – groups of clusters with a nearest neighbor distance <2 m; may be comprised of as few as 2 to as many as 50 clusters.

Table A-2

Dehesa Nolina Threats Matrix

EO[1]	Status[3]	Preserve	LO[4]	LM[5]	Max. # (year)[6]	Max # Since 2000 (year)[7]	# Last Survey (year)[8]	Threats[9]	Sources[10]
Conserved, Extant									
2	EXT	Skyline Truck Trail	EHC/PVT	EHC/PVT	>200 (1973) Eastern population	52 (2014) western population only	2014	**AFR,** DV (pvt land only), **ND, TR**	CNDDB 2014, Cal Fire 2014, Tonnesen et al. 2007.
3	EXT	Sycuan Peak Ecological Reserve	CDFW	CDFW	>1000 (1979)	1000s (2014) Not counted	2014	**AFR, DM,** FM, **IP, ND, RM,** TR	CNDDB 2014, Cal Fire 2014, Tonnesen et al. 2007, Oberbauer 1979
5	EXT	McGinty Mtn.	USFWS, TNC, PVT	USFWS, TNC	3900-4570 (1979)	1000s (2014) Not counted	2014	**AFR, FM, IP,** HE, **HY, MB, ND,** OHV, RM, SC, **TR**	CNDDB 2014, Cal Fire 2014, Tonnesen et al. 2007, Oberbauer 1979
6	EXT	South Crest	EHC, PVT	EHC, PVT	4647 (2002-2004)	4647 (2002-2004)	1680+ (1665+ In 2011 + 15 in 2014	**AFR,** DM, FP, HA, **HY, IP, ND,** RM, **TR**	CNDDB 2014, CBI 2012, 2014, Cal Fire 2014, Tonnesen et al. 2007, REC Consultants, Inc. 2004
11	EXT	Sycuan Peak Ecological Reserve	CDFW	CDFW	120+ (2014)	120+ (2014)	120+ (2014)	**AFR,** IP, ND, **RM**	CNDDB 2014, Cal Fire 2014, Tonnesen et al. 2007
Conserved, Misidentified or Extirpated									
12	NP	McGinty Mountain	USFWS	USFWS	1% cover (2009)	1% cover (2009)	0 (2014)	**AFR, ND**	CNDDB 2014, Cal Fire 2014, Tonnesen et al. 2007
10	NP	Jamul Butte	CDFW	CDFW	---	---	0	**AFR,** DM,	CNDDB 2014, Cal Fire

Table A-2

Dehesa Nolina Threats Matrix

EO[1]	Status[3]	Preserve	LO[4]	LM[5]	Max. # (year)[6]	Max # Since 2000 (year)[7]	# Last Survey (year)[8]	Threats[9]	Sources[10]
							(2014)	FM, IP, ND, TR	2014, Tonnesen et al. 2007
Not Conserved or Surveyed									
1	PE	Skyline Truck Trail (SE end of McGinty Mtn)	PVT	PVT	1980 (5-10)	---	1980	**AFR,** IP, MB **ND,** TR	CNDDB 2014, Cal Fire 2014, Tonnesen et al. 2007
4	PE	East edge of the Mesa, Singing Hills Ranch	Sycuan/PVT	KLDC	50 (1977)	---	1977	**AFR, ND,** RM, TR	CNDDB 2014, Cal Fire 2014, Tonnesen et al. 2007

[1] EO = element occurrence number from CNDDB (2014).

[2] Occurrence(s) for which there is no element occurrence number.

[3] Status: EXT = Extant occurrence; PE = Presumed extant occurrence; NP = Not present during survey.

[4] LO = Land Owner. CDFW = California Department of Fish and Wildlife; EHC = Endangered Habitat Conservancy; PVT = Private; Sycuan = Sycuan Tribal Land Development Corporation; TNC = The Nature Conservancy; USFWS = U.S. Fish and Wildlife Service.

[5] LM = Land Manager. CDFW = California Department of Fish and Wildlife; EHC = Endangered Habitat Conservancy; KLDC = Kumeyaay Diegueno Land Conservancy; PVT = Private; TNC = The Nature Conservancy; USFWS = U.S. Fish and Wildlife Service.

[6] Max # (year): Maximum census number observed for occurrence; number in parentheses = year of observation.

[7] Max # since 2000 (year): Maximum census number observed for occurrence since 2000; number in parentheses = year of observation.

[8] # Last Survey: Census number at last survey; number in parentheses = year of last survey.

[9] Threats: Reported threats according to land managers, literature, or GIS spatial datasets. AFR = Altered fire regime; DV = Development; DM = Dumping/Trash; FM = Fuel Modification; FP = Feral Pigs; IP = Invasive plants; HA = Historic Agriculture; HE = Herbivory; HY = Hydrology/Erosion; MB = Mountain bikes; ND = Nitrogen deposition; OHV = Off-highway vehicles; RM = Road Maintenance; SC = Soil Compaction; TR = Trails. Threats in bold have been identified as primary threat by land managers. Information on threats may not be comprehensive.

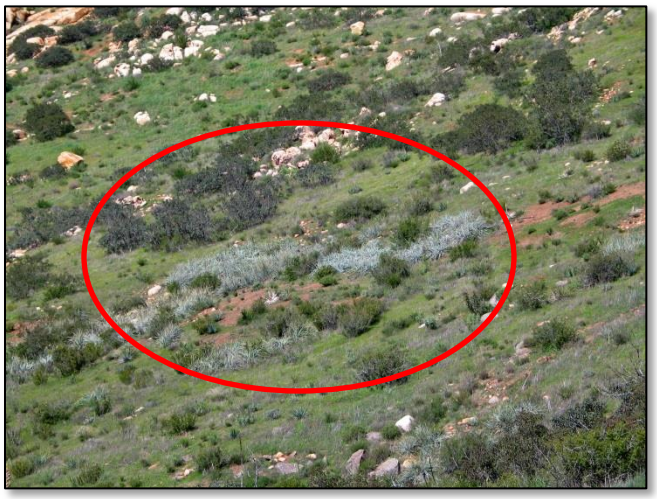
[10] Sources: Refer to reference list for full source citations.

Figure A-3

Dehesa Nolina Counting Units

a. Ramet (rosette)

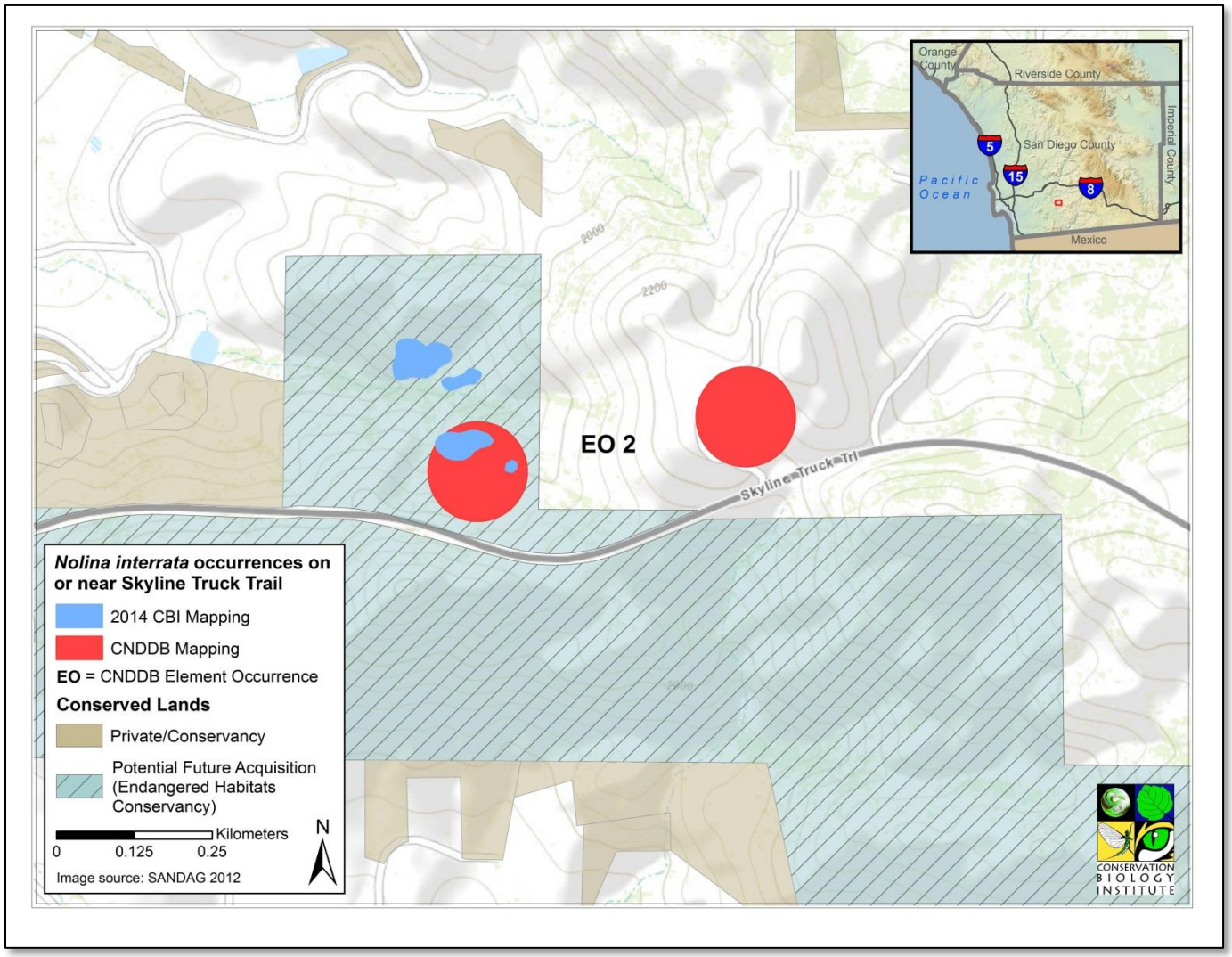
b. Clusters



c. Patches

Figure A-4

Dehesa Nolina on the Skyline Truck Trail Preserve (EO 2)



Parry's tetracoccus (*Tetracoccus dioicus*), Cleveland sage (*Salvia clevelandii*), sugar bush (*Rhus ovata*), chaparral yucca (*Hesperoyucca whipplei*), Veatch silktassle (*Garrya veatchii*), and mountain mahogany (*Cercocarpus betuloides*). No invasive plants were recorded.

Habitat quality is very good to excellent, with minimal disturbance except for the presence of trails. Fire frequency is relatively low at this population, with only 2 recorded fires (1945, 1970) during the period of record (Cal Fire 2014). The property is in a zone of relatively high nitrogen deposition; high nitrogen levels could promote invasive species establishment and spread in the future, particularly if gaps are present for colonization (e.g., post-fire disturbance). Habitat onsite is largely intact except for a main trail and smaller spur trails which are adjacent to or in proximity to Dehesa nolina stands. These trails are used for hiking and are a potential conduit for invasive species, although none were noted in 2014.

Threats: The only threat noted onsite in 2014 was disturbance associated with trails. From a regional perspective, this site is susceptible to impacts from altered fire regimes and nitrogen deposition (Appendix C). Habitat loss from development or fragmentation could impact plants directly or reduce the potential for gene flow within EO 2 or between this population and EO 1 or the larger population on Sycuan Peak Ecological Reserve to the north.

Preserve-specific Recommendations: Refer to the strategy (Sections 3.1, 3.2) and Table A-4 for additional regional and preserve-level recommendations for this site.

- Surveys
  - Refine Dehesa nolina mapping and population size data; map entire population with sub-meter GPS and conduct complete population counts.
  - Conduct Dehesa nolina monitoring at sentinel location every 3-5 years, for 3 consecutive years following fire, or at a frequency determined by SDMMP. Assess populations for threats; implement management actions, as necessary.

Sycuan Peak Ecological Reserve (EOs 3, 11)

Sycuan Peak Ecological Reserve supports one of the largest known populations of Dehesa nolina. The CNDDB (2014) identifies two EOs within this area: EOs 3 and 11, which correspond to MSP occurrences NOIN_3SYCP004 and NOIN_3SYCP005, respectively. Both occurrences are on lands owned and managed by the California Department of Fish and Wildlife (CDFW). The CNDDB identified 10 polygons for EO 3 and 1 polygon for EO 11 (Figure A-1). To be considered part of the same element occurrence, stands are generally within 0.25 mile of each other. EO 11 is approximately 0.3 mile from the nearest polygon in EO 3. Based on proximity, there is the potential that these two EOs function as a single population. Because of the widespread distribution of Dehesa nolina within the Sycuan Peak Ecological Reserve, and the

variable habitat conditions, we assessed the species at 6 sampling points (Figure A-2), including 5 within EO 3 and 1 within EO 11 (Appendix B).

Population Size: CNDDB records indicate that EO 3 included more than 1,000 plants in 1979, while EO 11 consisted of approximately 100 plants in 2005 (CNDDB 2014). CBI reviewed this mapping and found it to be generally accurate in terms of location and extent, although polygon boundaries were revised and expanded in some cases (Figure A-5). We concur that EO 3 is a large population, with more than 1,000 plants on south- and southwest-facing slopes south of Sycuan Peak and nearly 800 plants on north-facing slopes north of the peak. We estimated population size within EO 11 at 120 plants.

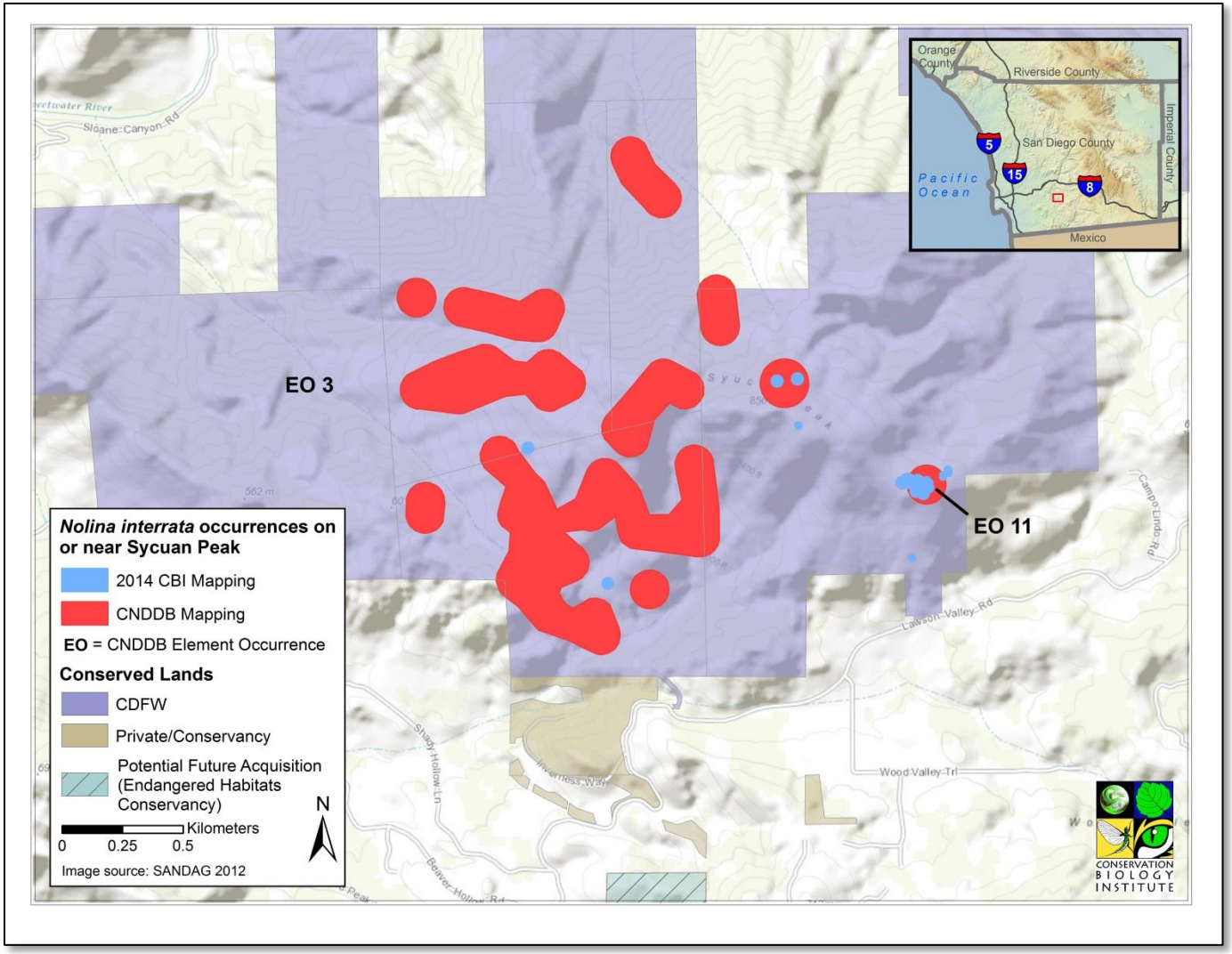
Status: In general, overall site condition on Sycuan Peak is very good to excellent. Habitat in the vicinity of EO 11, for example, includes the most pristine, intact stands of chaparral observed in the study area, as evidenced by shrub species diversity, intact cryptogamic crust, and absence of invasive species. The only area with a lower site condition (fair to good) was on south-facing slopes just north of Skyline Truck Trail, where there is evidence of previous disturbance (e.g., test wells, development pads). Within the ecological reserve, Dehesa nolina occurs primarily on gabbro soils in the Las Posas series, with some occurrences on coarse sandy loams in the Cieneba series (SSURGO). All observed stands were in chaparral in *Adenostoma fasciculatum-Xylococcus bicolor*, *Adenostoma fasciculatum-Xylococcus bicolor-Ceanothus tomentosus*, and *Arctostaphylos glandulosa-Adenostoma fasciculatum* associations. In addition to Dehesa nolina, occupied habitat supports several other sensitive plants, including Gander's ragwort (*Packera ganderi*), Parry's tetracoccus, Fish's milkwort (*Polygala cornuta* var. *fishiae*), felt-leaved monardella (*Monardella hypoleuca* ssp. *lanata*), Ramona horkelia (*Horkelia truncata*), and San Luis Obispo sedge (*Carex obispoensis*). Sycuan Peak has also been identified as suitable for Hermes copper butterfly (*Lycaena hermes*) (Strahm et al. 2012).

Fire frequency is relatively low (2-3 fires within the reported timeframe ([Cal Fire 2014]). The last recorded fire was the 1970 Laguna Fire. The property is in a zone of relatively high nitrogen deposition; high nitrogen levels could promote invasive species establishment and spread in the future, particularly if gaps are present for colonization (e.g., post-fire disturbance).

Threats: Dehesa nolina on Sycuan Peak is threatened by altered fire regimes and nitrogen deposition. Other threats vary by location: road, trails, and vegetation clearing threaten habitat quality and plants, but primarily act as a conduit for introduction and spread of invasive plants. Invasive plants are limited largely to trails adjacent to habitat, and include purple false-brome (*Brachypodium distachyon [Brachypodium])*, tocalote (*Centaurea melitensis*), and red brome (*Bromus madritensis*). Of these invasives, *Brachypodium* is a particular concern because of the potential for widespread invasion following fire or other large-scale disturbance. Other threats to this population include erosion, dumping/trash, and vegetation clearing or road maintenance along trails, and off-road vehicle (ORV)/mountain bike activity.

Figure A-5

Dehesa Nolina on Sycuan Peak Ecological Preserve (EOs 3, 11)



Preserve-specific Recommendations: Refer to the strategy (Sections 3.1, 3.2) and Table A-4 for additional regional and preserve-level recommendations for this site.

- Invasives Control
  - Treat *Brachypodium* along trails/dirt road to prevent incursion into intact habitat following fire or other disturbance.
- Access Control
  - Restrict unauthorized uses within the Sycuan Peak Ecological Reserve through enhanced gating and signage. Authorized uses on CDFW ecological reserves include educational and recreational opportunities (e.g., hiking, wildlife viewing) in areas where these activities have no adverse effects on sensitive biological resources.
    - Improve or replace existing gates along Skyline Truck Trail (e.g., install a solid pipe gate) to restrict unauthorized vehicular access (motorcycles, off-highway vehicles) and reduce the potential for vehicle-ignited fires.
    - Enhance and/or install additional signage to clearly designate restricted activities within the preserve, such as motorcycles, off-highway vehicles, and shooting.
- Surveys
  - Refine Dehesa nolina population estimates.
  - Conduct Dehesa nolina monitoring at sentinel locations every 3-5 years, for 3 consecutive years following fire, or at a frequency determined by the SDMMP. Assess populations for threats and implement appropriate management actions, as necessary.

McGinty Mountain (EO 5)

McGinty Mountain Ecological Reserve also supports one of the largest known populations of Dehesa nolina. The CNDDB identified two EOs within this area: EO 5 and EO 12, which correspond to MSP occurrences NOIN_3MGMO002 and NOIN_3MGM001, respectively. The former occurrence is on land owned and managed by the U.S. Fish and Wildlife Service (USFWS), CDFW, and The Nature Conservancy (TNC), while the latter occurrence is owned and managed by the USFWS. The CNDDB identified 3 polygons for EO 5 and 1 polygon for EO 12 (Figure A-1). We did not observe any plants at EO 12 during this study, as discussed below, but did detect a previously unmapped stand that will likely be considered part of EO 5 based on distance to other plants in that element occurrence. Because of the widespread distribution of Dehesa nolina on McGinty Mountain, and the variable habitat conditions, we assessed the species at 5 sampling points (Figure A-2), within or adjacent to EO 5 (Appendix B).

Population Size: CNDDB records indicate that population size of EO 5 was greater than 4,500 plants in 1979, with smaller estimates in subsequent years; however, it is not clear that these

smaller estimates are from the same location. In 2001, a portion of the population was mapped in detail by John Messina. Population estimates are not available for EO 12; however, Dehesa nolina reportedly comprised <1% cover in a 1.5 acre area during 2009 vegetation surveys (CNDDB 2014). We did not observe Dehesa nolina at EO 12 in 2014, but did detect the species scattered within a 15-20-acre area to the south, in proximity to other stands within EO 5 (Figure A-6). Detailed mapping of Dehesa nolina was not included in the scope of this project; however, we estimated that population size within EO 5 was equal to or larger than the 4,500 plants previously noted.

Status: In general, overall site condition on McGinty Mountain varies from poor to excellent. The majority of the population occurs in habitat that is ranked very good to excellent, as evidenced by shrub species diversity, intact cryptogamic crust, and absence of invasive species within the habitat (although invasives are generally present on adjacent trails). Areas with lower site condition include west-facing slopes west of the peak (good to poor), where the population occurs in disturbed coastal sage scrub (fair to good), where habitat is impacted by illegal trail use, vegetation clearing/fuel modification, and invasive plants.

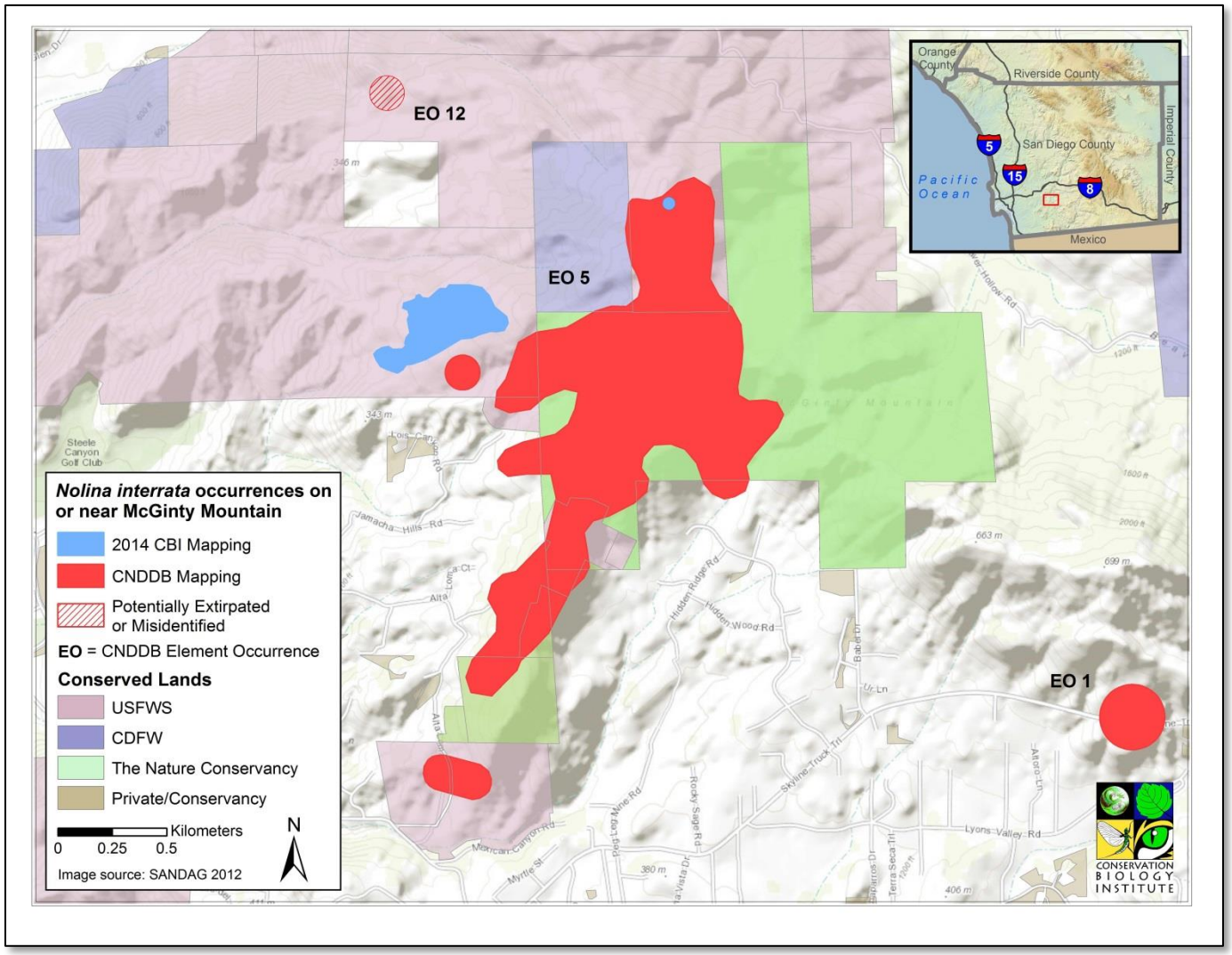
Dehesa nolina within EO 5 occurs on gabbro soils in the Las Posas series. All observed stands were in chaparral in the *Adenostoma fasciculatum-Xylococcus bicolor* and *Arctostaphylos glandulosa* Alliances and the *Adenostoma fasciculatum-Xylococcus bicolor*, *Adenostoma fasciculatum-Xylococcus bicolor-Ceanothus tomentosus*, and *Arctostaphylos glandulosa-Adenostoma fasciculatum* associations, respectively, or in coastal sage scrub in the *Artemisia californica-Eriogonum fasciculatum* Alliance and *Artemisia californica-Eriogonum fasciculatum-Malosma laurina* Association. Other sensitive species observed at EO 5 included Parry's tetracoccus and San Diego thornmint (*Acanthomintha ilicifolia*).

Fire frequency is relatively low, ranging from 1-3 fires within the reported timeframe (Cal Fire 2014). The last recorded fire on McGinty Mountain was the 1970 Laguna Fire. The site is in a zone of relatively high nitrogen deposition; high nitrogen levels could promote invasive species establishment and spread in the future, particularly if gaps are present for colonization (e.g., post-fire disturbance).

Threats: Dehesa nolina on McGinty Mountain is threatened by altered fire regimes and nitrogen deposition. Other threats vary by location: vegetation clearing/fuel modification, trails (and illegal vehicle use) threaten habitat quality and individual plants, and act as a conduit for introduction and spread of invasive plants. Currently, invasive plants (e.g., *Brachypodium*) occur along trails and within habitat in some locations. A major concern is the potential for the spread of *Brachypodium* from trail edges into currently intact habitat after a fire. Other localized threats include erosion, soil compaction, and herbivory.

Figure A-6

Dehesa Nolina on McGinty Mountain Ecological Preserve (EO 5)



Preserve-specific Recommendations: Refer to the strategy (Sections 3.1 and 3.2) and Table A-4 for additional regional and preserve-level recommendations for this site.

- Invasives Control
  - Control *Brachypodium* and other potentially problematic invasive species along roads or trails to prevent their spread into high quality habitat after fire or other disturbance.
  - Manage *Brachypodium* around Dehesa nolina patches in the vicinity of sampling point 5-8 (Figure A-2). Dethatch and/or treat with a grass-specific herbicide (e.g., Fusilade II). Both Dehesa nolina and *Brachypodium* populations in this area are extensive (>15-20 acres), so treatment may need to be phased.
- Access Control
  - Close illegal/unauthorized trails and install signage to direct users onto authorized trails, particularly in the vicinity of sampling point 5-4 (Figure A-2).
  - Install signage that indicates restricted or prohibited vehicular access (e.g., motorcycles, off-highway vehicles) within the preserve, particularly in the vicinity of sampling point 5-5 (Figure A-2).
- Erosion Control
  - Monitor erosion in the vicinity of sampling site 5-1 and 5-4 (Figure A-2) and install erosion control devices (e.g., gravel bags, straw wattles, check dams) or re-route erosive trails to protect Dehesa nolina plants below the trail from undercutting due to erosion.
- Vegetation Management
  - Monitor vegetation recovery in the vicinity of sampling site 5-2 (Figure A-2) where vegetation was disturbed in 2012 by unauthorized clearing associated with fuel modification.
  - Continue outreach efforts to homeowners to ensure that fuel modification zones do not extend beyond 100 feet from structures into the preserve.
- Surveys
  - Refine Dehesa nolina mapping and population estimates.
  - Conduct Dehesa nolina monitoring at sentinel locations every 3-5 years, for 3 consecutive years following fire, or at a frequency determined by the SDMMP. Assess populations for threats and implement appropriate management actions, as necessary.

Dehesa Mountain - South Crest (EO 6)

Dehesa Mountain is the type locality for Dehesa nolina. The majority of plants within this population occur on South Crest and adjacent properties (e.g., Michelson) that are owned and

managed by the Endangered Habitats Conservancy (EHC). Dehesa nolina also occurs adjacent to Dehesa Road, on property owned by the Sycuan Tribal Development Corp. or private entities; however, these plants do not currently occur on conserved lands.

The Dehesa Mountain – South Crest population is one of the three largest Dehesa nolina populations in the U.S. (along with Sycuan Peak and McGinty Mountain). The CNDDB has identified this population as EO 6, which corresponds to MSP occurrence NOIN_3SOCR003. Because the majority of plants in this population occur on conserved lands in the South Crest complex, it is referred to as the South Crest population in the MOM database. For this study, our assessment focused on that portion of the population on or in the vicinity of Skeleton Flats, where the majority of plants occur (Figure A-1). We assessed the population at 2 sampling points (Figure A-2) that represent the variation in habitat conditions at this site. The entire South Crest population was mapped and assessed in detail in 2012 under a Transnet EMP grant (CBI 2012).

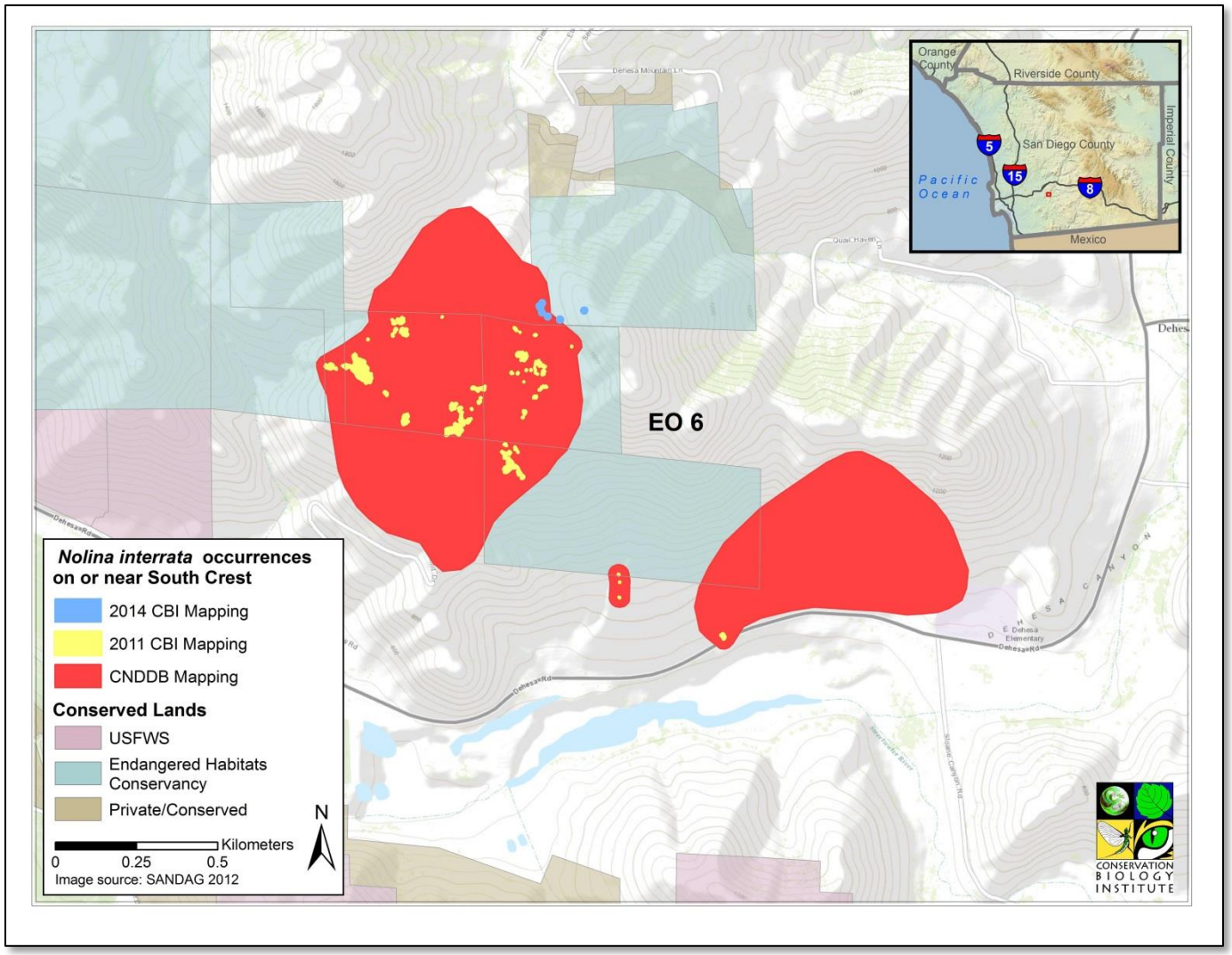
Population Size: Prior to the 2003 Cedar Fire, an estimated 4,647 clusters were mapped on and adjacent to South Crest. Of this total, an estimated 1,733 clusters occurred on South Crest (REC Consultants, Inc. 2004). The South Crest population was re-assessed in 2011 and 1,665 clusters were mapped in 97 patches. This represented a loss of over 100 clusters, presumably as a result of the Cedar Fire (CBI 2012). The majority of the South Crest population (94 patches; 1,656 clusters) occurs on or around Skeleton Flats, while the remaining patches are on slopes above Dehesa Road. Most plants (86 patches; 89% of all patches) occur on gabbro soils (Las Posas series), including all patches on slopes above Dehesa Road. The remaining patches, including some of the largest patches mapped in 2011, occur on clay soils (Auld series) on Skeleton Flats. The majority of the population on South Crest (88 patches; 99% of all patches) burned in 2003 in either the Cedar (85 patches) or Dehesa fires (3 patches).

During the 2014 assessment, we mapped an additional 15 Dehesa nolina clusters on the EHC-owned Michelson property, which is adjacent to South Crest (Figure A-7). Additional EHC acquisitions in this area that support additional Dehesa nolina have not yet been assessed since they were acquired in 2015, after survey completion.

Status: The South Crest population is variable with respect to site condition, ranging from highly disturbed (poor condition) on Skeleton Flats to very good to excellent on slopes above Skeleton Flats. Dehesa nolina at sampling point 6-1 (Figure A-2) occurs on clay soils (Auld series) in the *Nassella pulchra* (*Stipa pulchra*) alliance/association, and habitat is dominated by the invasive grass, *Brachypodium*, which comprised 35% of the vegetative cover in 2014. Other nonnative species include wild oats (*Avena barbata*), ripgut grass (*Bromus diandrus*), red brome, tocalote, and crete weed (*Hedypnois cretica*). However, this area also has a native component (in addition to *S. pulchra*), including sand-aster (*Corethrogyne filaginifolia*), blue-eyed grass (*Sisyrinchium bellum*), goldenbush (*Isocoma menziesii*), small-flowered morning glory (*Convolvulus simulans*),

Figure A-7

Dehesa Nolina on Dehesa Mountain - South Crest (EO 6)



splendid Mariposa lily (*Calochortus splendens*), gumplant (Grindelia camporum), chocolate lily (Fritillaria biflora), (*Fritillaria biflora*), and fascicled tarweed (*Deinandra fasciculata*). The sensitive plant, variegated dudleya (*Dudleya variegata*), occurs in proximity to this sampling point, and a coastal California gnatcatcher (*Polioptila californica californica*) (the first sighting on the South Crest property since the 2003 Cedar Fire) was observed in 2014.

Despite the lower habitat quality on Skeleton Flats, this is an important site due to the density of Dehesa nolina and the presence of variegated dudleya, coastal California gnatcatcher, and native grassland habitat. The site also supports high densities of redberry (*Rhamnus crocea*), which is a host plant for the sensitive Hermes copper butterfly. Restoration efforts are ongoing on a portion of Skeleton Flats. The focus of these efforts is to reduce the cover of *Brachypodium* and other nonnative species and improve native species diversity. After 2 years of treatment, *Brachypodium* in experimental test plots was reduced from over 50% cover to <10% cover. Qualitative monitoring in February 2015 identified a number of native species (both seeded and naturally-recruiting species) in treated areas (Table A-3); many of the naturally-recruiting species were not observed onsite prior to treatment While further invasives control is needed, these results indicate that efforts to-date have greatly improved habitat quality and increased native species diversity. An additional component of the restoration process will be the out-planting of both Dehesa nolina and variegated dudleya in 2016 from individuals currently in production at RECON Native Plant Nurseries from seed collected on or near the site.

Habitat at sampling point 6-2 (Figure A-2) occurs on gabbro soils (Las Posas series) within the *Rhamnus crocea Provisional* alliance/association, although other chaparral associations also occur on this slope. Shrub diversity is high and includes laurel sumac (*Malosma laurina*), redberry, California buckwheat (*Eriogonum fasciculatum*), California sagebrush (*Artemisia californica*), white sage (*Salvia apiana*), deerweed (*Acmispon glaber*, formerly *Lotus scoparius*), and others. Native forb diversity is also high and includes slender sunflower (*Helianthus gracilentus*), blue dicks (*Dichelostemma capitatum*), flat-top golden yarrow (*Eriophyllum confertiflorum*), blue-eyed grass, dotseed plantain (*Plantago erecta*), and ladies' tobacco (*Pseudognaphalium californicum*). The federally and state-endangered San Diego thornmint occurs in proximity to this sampling point. Nonnative annual grasses and forbs are present, but are not abundant.

The Dehesa Mountain - South Crest population has been subjected to repeated fires, and habitat has been invaded by nonnative plants, particularly the invasive grass *Brachypodium* in coastal sage scrub and native grasslands. Slopes above Dehesa Road do not appear to have the same level of *Brachypodium* invasion, but are exhibiting habitat type conversion from repeated burning of coastal sage scrub. The number of recorded fires in the Dehesa Mountain - South Crest population is the highest for any Dehesa nolina population, ranging from 2 to 7 between 1952 and 2013 (Cal Fire 2014). The areas of highest *Brachypodium* invasion have experienced 5 fires since 1970. The site is in a zone of relatively high nitrogen deposition; high

Table A-3

Native Plant Species in South Crest Restoration Sites

Scientific Name	Seeded	Natural Recruitment
Acmispon glaber		X
Acmispon sp. (another annual Lotus)		X
Acmispon strigosus		X
Allium haematochiton		X
Amsinckia sp.		X
Antirrhinum nuttallianum		X
Artemisia californica	X	X
Astragalus sp. (annual)		X
Calochortus splendens		X
Calystegia macrostegia		X
Chlorogalum parviflorum		X
Cirsium occidentale		X
Convolvulus simulans		X
Corethrogyne filaginifolia	X	X
Crassula connata		X
Cryptantha intermedia	X	
Deinandra fasciculata	X	X
Dichelostemma capitatum		X
Eriogonum fasciculatum	X	X
Eriophyllum confertiflorum	X	X
Gutierrezia sp.		X
Isocoma menziesii	X	X
Lasthenia californica	X	
Layia platyglossa	X	
Lepidium nitidum		X
Lupinus bicolor	X	
Mirabilis laevis		X
Plantago erecta	X	
Salvia apiana	X	
Salvia mellifera	X	
Sisyrinchium bellum	X	X
Stephanomeria sp.		X
Uropappus lindleyi		X

nitrogen levels could promote invasive species establishment and spread in the future, particularly if gaps are present for colonization (e.g., post-fire disturbance).

Threats: This population is subject to a number of threats in addition to fire and nitrogen deposition. Nonnative grasses (particularly, *Brachypodium*) and forbs are considered the primary threat to Dehesa nolina on Skeleton Flats. Other threats include altered hydrology and subsequent erosion which is undercutting individual plants; roads and trails; and recreational activity (particularly, unauthorized uses such as off-road vehicles). Management is ongoing to repair erosion that is undercutting Dehesa nolina plants and habitat (CBI in progress) or close key roads and trails (EHC in progress). Feral pig activity has been observed onsite, but appears to have been transient. Herbivory may impact Dehesa nolina reproduction, although we do not yet know the magnitude of this threat. We have observed that flowering stalks are eaten by deer and small mammals (possibly, woodrats), and flowers and capsules are eaten by insects (e.g., beetles and ants).

Preserve-specific Recommendations: Refer to the strategy (Sections 3.1 and 3.2) and Table A-4 for additional regional and preserve-level recommendations for this site.

- Invasives Control
  - Continue invasives control efforts on Skeleton Flats, with a focus on reducing cover and density of *Brachypodium* and nonnative forbs, and increasing native plant diversity. Refine *Brachypodium* Best Management Practices (BMPs).
  - Investigate alternative *Brachypodium* control methods (subject to funding) that can be used at the landscape-scale, including a combination of prescribed fire and herbicide.
  - Treat additional invasive species, as necessary, where they threaten Dehesa nolina directly or have the potential to impact nolina habitat. (e.g., *Foeniculum vulgare, Cynara cardunculus, Brassica tournefortii, Emex spinosa, Oxalis pes-caprae*).
  - Monitor site annually (or at a frequency determined adequate) for feral pig activity to determine the need for management actions. Where actions are determined necessary, coordinate with SDMMP, wildlife agencies, and other regional entities regarding appropriate control protocols and permits.
- Access Control
  - Install additional signage and/or maintain existing signage that clearly indicates authorized uses on the Preserve.
  - Install additional signage and/or maintain existing signage that clearly indicates trail closures.
  - Install additional fencing, as necessary, to protect sensitive habitat and ongoing restoration efforts.

  - Install pipe gate or other barrier across road to the north of Skeleton Flats to prevent OHV use.

- Erosion Control
  - Erosion control devices were installed in gullies on Skeleton Flats in 2014 to reduce erosion that was undercutting Dehesa nolina plants. Monitor and maintain these structures on a yearly basis to ensure they continue to control erosion, and replace them as they become ineffective (e.g., gravel bag disintegration).
  - Continue invasive control efforts around gullies to reduce competition from nonnative grasses and forbs and promote establishment of native shrubs and grasses that will bind the soil.
  - Develop a long-term erosion control plan that involves rerouting the current, concentrated water flow away native grasslands. This plan will likely involve input from an engineer or hydrologist and major road grading.
- Habitat Restoration and Species Augmentation
  - Continue invasives control efforts (herbicide treatments) in the Skeleton Flats region.
  - Continue monitoring invasives control and seed augmentation efforts for 1-3 years to assess success and refine Best Management Practices (BMPs). Efforts are currently underway as part of this grant to propagate Dehesa nolina from seed and out-plant nursery-grown individuals onto the South Crest preserve (Skeleton Flats) to replace losses suffered in the 2003 Cedar Fire. In addition to plant production (and subject to availability), this study will also:
    - assess the feasibility of seed collection for this species in the absence of fire or disturbance
    - determine seed viability
    - refine BMPs for seed germination and plant propagation
    - monitor short-term planting success rates
- Surveys
  - Conduct Dehesa nolina monitoring at sentinel locations every 3-5 years, for 3 consecutive years following fire, or at a frequency determined by the SDMMP. Assess populations for threats and implement appropriate management actions, as necessary.

Jamul Butte (EO 10)

The CNDDB (2014) shows this occurrence on or near Jamul Butte, although the mapping is imprecise and there are no additional details for this population. The locality information was based solely on a note in the *Rare Plants of San Diego County* (Reiser 1994) that indicated Dehesa nolina had been reported from Jamul Butte; however, the source of that information is

unknown. During surveys of Jamul Butte and surrounding lands, we did not find Dehesa nolina but did identify a number of blue-green chaparral yuccas on the north slope of Jamul Butte which at a distance, could conceivably be mistaken for Dehesa nolina (Figure A-8). Alternatively, development around Jamul Butte since 1986 or habitat degradation may have impacted this population. In any case, Dehesa nolina was not detected on conserved lands at EO 10 during this assessment.

Figure A-8. Chaparral yucca and Dehesa nolina on Sycuan Peak.

a. Color phases of chaparral yucca. b. Dehesa nolina cluster.

Habitat on Jamul Butte consists of coastal sage scrub on south-facing slopes and chaparral on north-facing slopes. South-facing slopes have a relatively high percentage of nonnative grasses and forbs. This area last burned in 1970, and fire interval within the period of record is about 30 years (Cal Fire 2014). Up until the late 1990s, lands adjacent to Jamul Butte were actively farmed which may have contributed to habitat disturbance on slopes (e.g., invasive species). Nitrogen deposition in this area is relatively high, which may also contribute to the success of invasive species and poorer recovery of coastal sage scrub following fire (Cox et al. 2014). Additional threats on Jamul Butte include trails and dumping, recreational activities, and fire management activities.

McGinty Mountain (EO 12)

The CNDDB (2014) shows this occurrence approximately 1 mile northwest of McGinty Mountain summit on USFWS lands within the San Diego National Wildlife Refuge. The occurrence was identified during 2009 regional vegetation mapping, and the Dehesa nolina population was estimated as <1% cover within a 1-5 acre area. CBI biologists surveyed this location and adjacent lands in 2014, but found no Dehesa nolina. However, we did find a number of blue-green phase yuccas; thus, it is possible that Dehesa nolina was misidentified at

this site. Site disturbance is low at this site and consists of a series of dirt trails with some invasive plants along the trail edges.

Habitat at this location consists of coastal sage scrub (*Artemisia californica-Eriogonum fasciculatum* and *Bahiopsis laciniata* alliances). Two fires have been recorded at this (1950 and 1970; Cal Fire 2014). This occurrence is in a zone of relatively high nitrogen deposition, which may influence future nonnative species invasions and post-fire scrub recovery (Cox et al. 2014).

A.3 Management Categorization Rationale

Dehesa nolina has been designated a Management Focus Category SO species by the SDMMP, because '*persistence of one or more significant occurrences in the MSPA is at high risk of loss without immediate management action above and beyond that of daily maintenance activities*' (SDMMP 2013). Factors contributing to this status include a highly limited range in MU 3 and Baja California, vulnerability to catastrophic disturbance, and soil endemism. Prior to this study, the SDMMP identified six populations on conserved lands in MU 3, based on existing CNDDB data. Our results suggest that only four of these populations are extant, with a fifth population occurring partially on lands that may be conserved in the future.

A primary threat to Dehesa nolina at both the regional- and preserve-levels appears to be the nonnative grass, *Brachypodium*, which poses a particular threat in grassland and disturbed coastal sage scrub habitats (CBI 2012, CBI et al. 2012). At the regional level, additional threats include potentially low genetic diversity, habitat fragmentation, altered fire regime, nitrogen deposition, and climate change. At the preserve-level, direct and indirect threats include development, dumping, vegetation clearing for fuel modification, feral pigs, historic agriculture, herbivory, altered hydrology and erosion, roads and trails, and soil compaction, among others.

A.4 Management Approach

Management for Dehesa nolina will be directed at both the regional- and preserve- (local) levels. At the regional-level, the management approach will consider regional population structure and connectivity to maintain or enhance gene flow between populations, thus, enhancing long-term persistence. This should be prioritized as follows: (1) maintain and enhance large populations on conserved lands, (2) maintain and enhance all other populations on conserved lands, (3) augment existing populations through assisted migration of pollen, seed, or plants, if determined necessary by genetic studies (4) identify new Dehesa nolina populations or pollinator habitat between existing populations, (5) establish new populations in unoccupied but suitable habitat between existing populations, and (6) translocate the species into suitable habitat outside the current species range, if determined necessary to accommodate climate change.

Genetic studies that elucidate levels of genetic diversity or relationships within and between populations, as well as adaptive genetic diversity, will be important in refining the regional

management approach. Establishing a regional seed bank will preserve genetic diversity and ensure a source of genetically appropriate material for both research and augmentation efforts. Finally, management of some regional-level threats may be most effective if addressed at the regional or management-unit level, i.e., across multiple preserves.

At the preserve-level, the management approach will focus on controlling or managing threats to Dehesa nolina populations within individual preserves.

Management recommendations are grouped by type of objective, as defined in the MSP (SDMMP 2013) and described below. Table A-4 presents goals, objectives, and management actions. Management objectives are categorized as regional or local, per the MSP (SDMMP 2013).

Baseline surveys (ISV): Baseline surveys are recommended at both the regional and preserve- (local) levels. Regional surveys would survey opportunity areas for new populations of Dehesa nolina in potentially suitable habitat, while local surveys are recommended to fill data gaps for presumed extant populations in private ownership. Data collection should include information on population status, location, threats, habitat and edaphic covariates, and management needs (SDMMP 2013).

Inspect and manage populations (IMG): This objective includes routine, preserve-level monitoring and maintenance to ensure species persistence and identify emerging management issues; the latter should be addressed immediately, if possible. Routine management may include fencing, signage or other barriers to prevent trampling from authorized or unauthorized, and invasive species control. Preserve-level monitoring and maintenance should be conducted for all conserved, extant Dehesa nolina populations every 3-5 years, as discussed in the strategy (Section 3.2), for 3 consecutive years following a burn, or at an alternate frequency recommended by SDMMP.

Invasive plant control (IPC). Invasive plant control was not identified as a specific management objective type in the MSP (SDMMP 2013); however, because of the potentially severe detrimental effects of some invasive plants (e.g., *Brachypodium distachyon;* CBI 2012) on Dehesa nolina persistence, this management action is elevated to a regional objective in the following cases: (1) invasive plant cover is so dense that it inhibits germination and growth of Dehesa nolina; (2) affected populations are in proximity and would benefit from treatment across multiple preserves or management units; and/or (3) affected populations have been determined to be regionally important to Dehesa nolina persistence. The highest priority for IPC management will be large populations. Not all invasive infestations will require regional-level management. For many invasives, routine, periodic management will be sufficient for control.

Genetic studies (GN): Genetic studies are recommended to (1) refine regional population structure hypotheses, (2) identify existing populations that would benefit from enhancement or expansion, (3) identify gaps in 'genetic' connectivity that may require creation of new populations or pollinator habitat, (4) identify appropriate source populations for seed banking and restoration, and (5) identify appropriate seed transfer zones. A combination of neutral genetic and quantitative genetic studies is recommended to identify recent gene flow and genetic diversity within and among populations, as well as potentially adaptive genetic diversity. Note that some genetic research has been done on Dehesa nolina (e.g., Rombouts 1996, Heaney pers. comm.).

Research studies (RS): Targeted research on reproductive biology and population structure, germination and propagation studies, effective pollinators and host plants, and invasive species interactions is recommended to improve management of this species. While genetic studies also fall under research, they are discussed in a separate objective.

Best management practices (BMP): A number of experimental management studies are in progress that may result in development or refinement of BMPs for Dehesa nolina; recommended research studies may result in additional BMPs. Therefore, periodic updating of Dehesa nolina BMPs is included as a management objective.

Establish and maintain a seed bank and/or bulk seed (SB): A regional seed bank would benefit conservation, restoration, and research for this species. Refer to SDMMP (2013) (Vol. 1) for a discussion of potential seed bank facilities. Rancho Santa Ana Botanic Garden (RSABG) has established a seed bank for this species, but it would benefit from additional collections. Seed collections should follow established guidelines (RBGK 2001, Wall 2009) for collection and storage. Multiple year collections are recommended for populations selected for management, subject to seed availability. Large populations (Table A-2) will be priority targets for seed banking, as will additional populations determined to have a unique genetic structure. Because of sporadic flowering in this species, which is related to fire events, we recommend developing and funding a seed collection program in advance of fire events to maximize seed collection opportunities.

Enhance/expand existing populations (IEX): This objective is specific to populations that have suffered losses due to catastrophic events (e.g., fire, disease) or where genetic studies indicate enhancement/expansion would contribute to long-term persistence. The need for population enhancement or expansion will be based on results from baseline (ISV), monitoring (IMG), and/or genetic (GN) studies. Enhancement may also refer to enhancing pollinator habitat within or between populations.

Translocate or establish new populations (ITR): Dehesa nolina management will focus on maintaining or enhancing existing populations. However, experimental translocation efforts may be implemented where monitoring indicates that natural movement of this species is outpaced by changing habitat conditions (e.g., due to climate change) or where natural barriers to dispersal to existing suitable or potentially suitable future habitat are identified.

Prepare an implementation plan (PIP): Many objectives will require development of an implementation plan, to be prepared in collaboration with stakeholders (SDMMP 2013). The IP plan will identify the Implementation Entity/Organization and include a detailed description of management actions, timeline, and funding source(s).

Implement actions in implementation plan (IIP): This objective is included as a placeholder at this time, as it is contingent on the previous objective (PIP), which will contain details necessary for implementation (SDMMP 2013).

Regional and MU goals for Dehesa nolina are as follows:

Regional Management Goal: Maintain populations of Dehesa nolina to increase resilience to environmental stochasticity, maintain genetic diversity and ensure persistence over the long term (>100 years) in native plant communities.

MU 3 Management Goal: Same as regional management goal.

Table A-4

Management Objectives and Actions

Type[1]	Objectives	MUs	Management Actions
ISV; Regional, Local	In 2016-2020, conduct surveys of selected extant populations to fill data gaps with respect to population size and mapping extent. Submit data to the SC-MTX website portal. Populations include Sycuan Peak (EO 3), McGinty Mountain (EO 5), and Skyline Truck Trail (EO 2) (if conserved).	3	• Refine perimeter population mapping where spatial data are lacking. • Refine population size estimates. • Use covariate data to develop a habitat suitability model for Dehesa nolina.
ISV; Regional	In 2016-2020, conduct surveys of *opportunity areas* to identify new populations. Submit all data to the SC-MTX website portal. New populations can potentially enhance regional population structure by filling gaps in connectivity.	3	• Conduct surveys within *opportunity areas* to identify new Dehesa nolina populations. • For all new populations, collect covariate data on status, vegetation composition and cover (association-level mapping), soils, invasive nonnative plants and other threats, and management entity. • Map perimeter of new populations. • Based on survey results, identify management actions necessary to maintain or enhance new populations. • Use covariate data to develop/refine habitat suitability model for Dehesa nolina.
ISV; Regional	In 2016-2020, conduct soil testing of extant populations to establish baseline parameters (reference library) of soils that support Dehesa nolina. Soil sampling may occur in conjunction with other survey efforts. Submit data to the SC-MTX website portal for use in refining habitat suitability models and identifying appropriate sites for expansion or translocation, if determined necessary.	3	• Conduct range-wide soil testing at all extant populations (or a representative sample of populations). • Use data to develop or refine Dehesa nolina habitat suitability model. • Use data to establish baseline parameters for appropriate Dehesa nolina soils.
IMG; Regional, Local	Beginning in 2016, inspect extant, conserved sentinel populations at the monitoring frequency identified in this	3	• Conduct regional monitoring surveys using standardized data collection and data management protocols to assess abundance status and quantify potential

Table A-4

Management Objectives and Actions

Type[1]	Objectives	MUs	Management Actions
	document or an alternate frequency recommended by SDMMP. Use a regional monitoring protocol (SDMMP rare plant monitoring form) to record abundance and collect covariate data to determine management needs. Conduct routine management actions as necessary. Submit monitoring and management data to SC-MTX website portal.		threats. • Based on monitoring results, determine if routine or intensive management is warranted. • Perform routine management activities (e.g., fencing, signage, invasive plant control) to protect populations from impacts. • Where intensive management is warranted and cannot be conducted within existing monitoring budget, prepare a detailed plan for implementation and secure funding.
IPC; Regional	Beginning in 2018, implement invasive plant control at large populations on Conserved Lands where invasives have been identified as a threat to Dehesa nolina persistence (e.g., *Sycuan Peak, McGinty Mountain*). Conduct treatment for a minimum of 3 years using BMPs developed at the Dehesa Mountain-South Crest population, and monitor Dehesa nolina response. Submit monitoring and management data to SC-MTX website portal. Where funding is available, treatments may be initiated prior to 2018.	3	• Implement site-specific invasive control management actions to maintain Dehesa nolina habitat based on BMPs and results from experimental projects (e.g., *Brachypodium* removal project). Actions may include thatch removal and invasives control using herbicide or mechanical methods. • Determine response of Dehesa nolina and/or nolina habitat to management actions and the need for further actions. • Based on results of initial management actions, determine need for (1) further invasives control and (2) additional habitat enhancement such as seeding of additional native plant species that support pollinator communities or facilitate sustainable Dehesa nolina populations by inhibiting germination and growth of invasive species.
GN; Regional	Conduct studies to determine the genetic structure of Dehesa nolina populations on Conserved Lands, and submit data to the SC-MTX website portal. Genetic studies will be used to (1) refine the regional population structure hypotheses, (2) identify existing populations that would benefit	3	• Use BMPs to collect plant material for genetic samples at all conserved Dehesa nolina populations in MU 3. • Analyze genetic structure (e.g., neutral genetic studies) to determine recent gene flow and genetic diversity within and among Dehesa nolina populations

Table A-4

Management Objectives and Actions

Type[1]	Objectives	MUs	Management Actions
	from enhancement or expansion, (3) identify 'gaps' that may require establishment of new populations or pollinator habitat to promote connectivity and genetic diversity, and (4) identify appropriate source populations of genetic material (seeds, seed transfer zones) for augmentation.		on Conserved Lands. • Conduct quantitative genetic studies (e.g., common garden, reciprocal transplant studies), as necessary, to identify potentially adaptive genetic diversity. • Use results of genetic studies to prioritize management by identifying (1) populations with lowered diversity that should be enhanced through augmentation, (2) gaps in functional connectivity that may require establishment of new populations or enhancement/creation of pollinator habitat, (3) high diversity populations that may function as seed sources for augmentation, and (4) appropriate seed transfer zones to maximize short- and long-term restoration success by using genetic material that is locally adapted to site conditions or possesses phenotypes that may promote survival and adaptation to changing conditions (Kramer and Havens 2009).
RS; Regional	Initiate management-oriented research studies for Dehesa nolina (refer to ISV, above, for soil studies and GN, above, for genetic studies).	3	• Develop protocols for seed bulking to conserve genetic diversity and enhance resilience to the local environment. • Conduct seed studies to determine seed germination cues and viability rates. • Identify *effective* Dehesa nolina pollinators and their host plants, as well as maximum pollinator migration/travel distance; assess whether shifts in phenology and pollinator communities may affect nolina persistence. • Conduct additional studies, if necessary, to determine the effects of invasive plant species on Dehesa nolina persistence.
BMP;	In 2015-2017, refine BMPs based on results of experimental management	3	• Refine BMPs by incorporating results of management experiments to control

Table A-4

Management Objectives and Actions

Type[1]	Objectives	MUs	Management Actions
Regional	studies currently in progress, as well as research studies.		invasive species that threaten Dehesa nolina populations in San Diego County (e.g., *Brachypodium* removal project). • Develop BMPs based on research studies (e.g., seed bulking guidelines, seed transfer zones).
SB; Regional	Establish a permanent seed source (seed bank) that consists of both conservation and propagation collections. The conservation collection should be held in long-term storage to preserve genetic diversity and provide a seed source in the event of catastrophic disturbance, thus providing a 'hedge' against extinction or extirpation. This collection may also function as source material for management-oriented research. The propagation collection will provide genetically appropriate source material for seed bulking or out-planting to augment extant populations or create new populations.	3	• Develop and implement a seed collection and storage strategy that follows existing BMPs (RBGK 2001, Wall 2009) and maximizes genetic variability by collecting over multiple years and across populations and (2) sampling from multiple habitats and ecological niches. The program should be developed and funded in advance of fire events which stimulate flowering in this species. • Collect seed from all conserved populations of sufficient size to accommodate harvest or that possess a unique genetic structure. • Maintain detailed records for all collected seed to document donor and receptor sites, collection dates, and amounts collected; submit data to the SC-MTX website portal and regional seed bank database. • Store seeds at a qualified seed bank by population, date, and for small populations (<1,000 plants), along maternal lines. Test seed for viability upon accession and regularly thereafter to assess seed viability over time. • Structure seed testing program to obtain additional information through the testing process, such as dormancy factors and germination rates. • Bulk seed or grow plants at a qualified facility for enhancement, expansion, or transplantation projects using seed from genetically appropriate donor

Table A-4

Management Objectives and Actions

Type[1]	Objectives	MUs	Management Actions
			accessions in the propagation seed bank collection. • If sufficient seed exists, seed from genetically appropriate donor accessions in the propagation seed collection may be out-planted directly to enhance existing populations or establish new populations outside the current species' range.
IEX; Regional and/or Local	Enhance/augment genetically depauperate populations determined to be regionally important for long-term persistence. Enhance pollinator habitat within or between populations, as determined necessary to reduce gaps in genetic connectivity.	3	• Prioritize populations for management based on an assessment of population size, status (including genetic structure), and threats; the potential for management to significantly reduce identified threats; and the availability of adjacent, suitable habitat for population expansion. • Incorporate BMPs into restoration design; in addition, include an experimental design to test effectiveness of any new methods used (e.g., seed bank augmentation).
ITR; Regional and/or Local	Translocate Dehesa nolina into suitable sites beyond the current species' distribution, if determined necessary to offset impacts from climate change. Suitable sites will be determined through baseline surveys, soil testing, habitat suitability modeling, and possibly, other research studies.	3	• Use results of genetic studies and land use patterns to elucidate historic genetic flow patterns. • Use opportunity areas map (and refinements, based on additional surveys or habitat suitability modeling) to identify suitable sites for enhancement of pollinator habitat to fill gaps in connectivity. • Use edaphic and vegetation correlates, as well as results from other pertinent research (e.g., pollinator studies) to refine site selection. • Test soils at potential translocation sites and compare to reference sites to determine site suitability based on soils. • Use seed for augmentation from genetically appropriate seed collection

Table A-4

Management Objectives and Actions

Type[1]	Objectives	MUs	Management Actions
			zones. Collect and bulk seed according to approved BMPs.
PIP; Regional	Prepare implementation plan(s) including delineation of suitable habitat for enhancing existing populations or establishing new populations outside the current species range, as determined necessary from results of surveys, modeling, and research. Implementation plan(s) should follow the implementation template in the MSP, Vol. 3 (SDMMP 2013).	3	• Using the strategy as a guideline, develop an implementation plan(s) to reduce threats and promote population resilience. • Develop habitat suitability or climate change models to prioritize sites for translocation. • Use results of genetic studies to identify populations that need augmentation to bolster genetic diversity, as well as appropriate source populations for augmentation. • Use BMPs to control threats (including invasive plant species) and bulk seed for augmentation.
IIP; Regional and/or Local	Implement high priority management actions identified in approved implementation plans(s) for populations on Conserved Lands.	3	• Management actions will be determined by the Implementation Plan.

[1] BMP = Develop and test BMPs (Best Management Practices); GN = Genetic studies; IEX = Enhance/expand existing populations; IIP = Implement actions identified in implementation plan. IMG = Inspect and manage populations as necessary; IPC = Invasive plant control; ISV = Conduct surveys to collect baseline data on population locations, status, and habitat/threat covariates; PIP = Prepare an implementation plan; RS = Conduct research studies; SB = Establish and maintain a seed bank and/or bulk seed.

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Appendix B

Nolina Matrix

B.1 Data Definitions

B.2 Nolina Matrix

Appendix B-1: Data Definitions

Attribute	Description/Definition
ID #	Assessment Identification Number
EO #	Element Occurrence Number (assigned by the California Natural Diversity Database [CNDDB])
Sampling Point	Sampling site for Habitat Assessment and/or SDMMP rare plant monitoring form
Species	NOIN = *Nolina interrata* (Dehesa nolina)
Site Name:	
Skyline Truck Trail	Skyline Truck Trail Property (EO 2)
South Crest	South Crest Preserve (Dehesa Mountain - South Crest) (EO 6)
Sycuan Peak	Sycuan Peak Ecological Reserve (EOs 3, 11)
McGinty Mountain	McGinty Mountain Preserve (EOs 5, 12)
Jamul Butte	California Department of Fish and Wildlife property adjacent to Hollenbeck Canyon (EO 10)
Michelson	Endangered Habitats Conservancy Acquisition adjacent to South Crest Preserve (EO 6)
Investigators:	
PGR	Patricia Gordon-Reedy
CB	Curtis Battle
JV	Jessie Vinje
TS	Trish Smith
MSP Occurrence ID	Unique number assigned by the San Diego Monitoring and Management Program (SDMMP) for covered species within the Management Strategic Plan (MSP) area.
Land Owner/Land Manager	
USFWS	U.S. Fish and Wildlife Service (San Diego National Wildlife Refuge)
CDFW	California Department of Fish and Wildlife
TNC	The Nature Conservancy
EHC	Endangered Habitats Conservancy
Sampling Point Coordinates	Provided in NAD 83
Site Access	Provides information on how site can be accessed for management
4WD	Access by 4-wheel drive
2WD	Access by 2-wheel drive
None	No vehicular access; site must be accessed on foot
Photo #	Unique photo identification number
Photo Reference	Compass direction photo was taken
Photo Height	Distance from ground to camera level (feet)
Photo Angle	Angle of photograph (provided in degrees)
Photo Location	Location where photograph is stored; CBI = Conservation Biology Institute
Aspect	Slope direction
Soil Texture	From field test or SCS
Soil Series	From Soils mapping

Appendix B-1: Data Definitions

Attribute	Description/Definition
Vegetation Alliance (2012 Map)	Based on 2012 San Diego Vegetation map
Vegetation Association (2012 Map)	Based on 2012 San Diego Vegetation map
Vegetation Alliance	Based on field mapping
Vegetation Association	Based on field mapping
Holland	Holland Vegetation Classification
SDVC	San Diego Vegetation Classification
Plant Functional Groups:	
EF	Exotic Forb
EG	Exotic Grass
NF	Native Forb
NG	Native Grass
Shrub	Shrub
Cover Class	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 Cover Class	Based on estimated percent cover of all species in functional group; individual species cover classes are not necessarily additive to this total
Bare Ground/Rock Cover	Estimated percent cover (expressed as a cover class) of bare ground and rocks within assessment area
Thatch Cover	Estimated percent cover (expressed as a cover class)of thatch within assessment area
Thatch Depth	Measured vertically from soil surface
Cryptobiotic crust	surface crust of various cyanobacteria, lichens, mosses, and fungi
Other clay/gabbro sensitive species	Nolina interrata (NOIN); Dudleya variegata (DUVA); Deinandra conjugens (DECO)
Standing biomass height	Height of herbaceous vegetation, measured from soil surface
Dead standing biomass	Dead plant material (standing); does not include current year's growth
Overall Native Habitat Quality	Poor, Fair, Good, Very Good (refer to Trudgery scale)
Threat	See Habitat Assessment Form
Threat Ranking	High, Medium, Low
Other Species Observed	Sensitive Species (4-letter code)
Last Fire	Date of last fire within habitat assessment area; information from CalFire Database (http://www.frap.cdf.ca.gov/data/frapgisdata/statewide/fire_perimeter_download.html)
All Fires	Dates of all fires within habitat assessment area; information from CalFire Database (http://www.frap.cdf.ca.gov/data/frapgisdata/statewide/fire_perimeter_download.html)

Appendix B-1: Data Definitions

Attribute	Description/Definition
N Deposition	Nitrogen deposition (kg N ha-1 yr-1) (see Center for Conservaton Biology (CCB). 2002. Map of total annual N deposition in California, CMAQ simulations. University of California, Riverside.

Appendix B.2: Dehesa Nolina Matrix

ID #	EO #	Sampling Point	Species	Site Name	Assessment Date	Investigators	MSP Occurrence ID	Land Owner	Land Manager	GPS Coordinates (E)	GPS Coordinates (N)	Datum and Coordinate System	GPS Accuracy (m)	Site Access	Camera Type	Photo 1	Photo Direction	Photo Height (ft)	Camera Angle	Photo 2	Photo Direction	Photo Height (ft)
2-1	2	1	NOIN	Skyline Truck Trail	7/9/14	JV, JA	---	EHC	EHC	517,776.720	3,621,849.846	NAD 83; UTM Zone 11, meters	< 1	NONE	Canon Powershot SX230HS	1	318°	4.25	-13°			
3-1	3	1	NOIN	Sycuan Peak	6/18/2014	JV, CB	NOIN_3SYCP004	CDFW	CDFW	511,994.494	3,621,650.757	NAD 83; UTM Zone 11, meters	< 1	NONE	Canon Powershot SX230HS	SYC_EO3_1-1	213°	5.5	-1°	SYC_EO3_1-2	24°	5.4
3-3	3	3	NOIN	Sycuan Peak	5/29/2014	PGR, JV	NOIN_3SYCP004	CDFW	CDFW	516664.543	3623593.14	NAD 83; UTM Zone 11, meters	< 1	NONE	Canon Powershot SX230HS	SYC_EO3-3	344°	4.3	-4°			
3-5	3	5	NOIN	Sycuan Peak	5/28/2014	PGR, JV	NOIN_3SYCP004	CDFW	CDFW	517164.9	3,623,883.494	NAD 83; UTM Zone 11, meters	<1	NONE	Canon Powershot SX230HS	SYC_EO3_4	301°	4.3	-5°			
3-8	3	8	NOIN	Sycuan Peak	5/28/2014	PGR, JV	NOIN_3SYCP004	CDFW	CDFW	518161.21	3,624,193.624	NAD 83; UTM Zone 11, meters	< 1	NONE	Canon Powershot SX230HS	SYC_EO3_8	338°	4.2	-12°			
3-1a	3	1a	NOIN	Sycuan Peak	5/28/2014	PGR, JV	NOIN_3SYCP004	CDFW	CDFW	517164.9	3,623,883.493	NAD 83; UTM Zone 11, meters	< 1	NONE	Canon Powershot SX230HS	SYC_EO3-1	301°	4.4	-5°			
5-1	5	1	NOIN	McGinty Mountain	6/25/2014	JV, TS	NOIN_3MGMO00	USFWS	USFWS	511996.974	3621911.364	NAD 83; UTM Zone 11, meters	< 1	NONE	Canon Powershot SX230HS	MGM_5-1-1	338°	4.25	-3°	MGM_5-1-2	181°	4.1

Appendix B.2: Dehesa Nolina Matrix

ID #	Camera Angle	Photo Location	Aspect	Soil Texture	Soil Series	Vegetation Alliance (2012 Map)	Veg. Association (2012 Map)	Vegetation Alliance (Field)	Veg. Association (Field)	Exotic Forb 1	Exotic Forb 1 CC	Exotic Forb 2	Exotic Forb 2 CC	Exotic Forb 3	Exotic Forb 3 CC	Exotic Forb 4	Exotic Forb 4 CC	Exotic Forb 5	Exotic Forb 5 CC	Exotic Forb 6
2-1		CBI	N, NW, SW, W	Stony fine sandy loam	Las Posas	Arctostaphyos glauca	Arctostaphylos glauca-Adenostoma fasciculatum	Adenostoma fasciculatum-Xylococcus bicolor	Adenostoma fasciculatum-Xylococcus bicolor-Ceanothus tomentosus											
3-1	-32°	CBI	SW	Stony fine sandy loam	Las Posas	Adenostoma fasciculatum-Xylococcus bicolor	Adenostoma fasciculatum-(Eriogonum fasciculatum, Artemisia californica, Salvia mellifera)	Adenostoma fasciculatum-Xylococcus bicolor	Adenostoma fasciculatum-Xylococcus bicolor											
3-3		CBI	N, NE, SE	Rocky coarse sandy loam	Cieneba	Adenostoma fasciculatum-Xylococcus bicolor	Adenostoma fasciculatum-Xylococcus bicolor-Ceanothus tomentosus	Adenostoma fasciculatum-Xylococcus bicolor	Adenostoma fasciculatum-Xylococcus bicolor											
3-5		CBI	S, SE, SW, W, E	Sandy loam	Las Posas, Cieneba	Adenostoma fasciculatum; Adenostoma fasciculatum-Xylococcus bicolor	Adenostoma fasciculatum-(Eriogonum fasciculatum, Artemisia californica, Salvia mellifera); Adenostoma fasciculatum-Xylococcus bicolor-Ceanothus tomentosus	Adenostoma fasciculatum-Xylococcus bicolor	Adenostoma fasciculatum-Xylococcus bicolor-Ceanothus tomentosus	CEME	TR									
3-8		CBI	N, NE, NW	Stony fine sand loam (gabbro-derived)	Las Posas	Adenostoma fasciculatum	Adenostoma fasciculatum-(Eriogonum fasciculatum, Artemisia californica, Salvia mellifera)	Arctostaphylos glandulosa	Arctostaphylos glandulosa-Adenostoma fasciculatum											
3-1a		CBI	S, SE, SW, W, E	Rocky coarse sandy loam	Cieneba	Adenostoma fasciculatum	Adenostoma fasciculatum-(Eriogonum fasciculatum, Artemisia californica, Salvia mellifera)	Adenostoma fasciculatum-Xylococcus bicolor	Adenostoma fasciculatum-Xylococcus bicolor	CEME	TR									
5-1	-9°	CBI	E	Stony fine sandy loam (gravel)	Las Posas	Artemisia californica-Salvia mellifera; Bahiopsis laciniata	Bahiopsis laciniata-Artemisia californica-Eriogonum fasciculatum	Adenostoma fasciculatum-Xylococcus bicolor	Adenostoma fasciculatum-Xylococcus bicolor											

Appendix B.2: Dehesa Nolina Matrix

ID #	Exotic Forb 6 CC	TOTAL EX. FORB COVER CLASS	Exotic Grass 1	Exotic Grass 1 CC	Exotic Grass 2	Exotic Grass 2 CC	Exotic Grass 3	Exotic Grass 3 CC	Exotic Grass 4	Exotic Grass 4 CC	Exotic Grass 5	Exotic Grass 5 CC	TOTAL EX. GRASS COVER	Native Forb 1	Native Forb 1 CC	Native Forb 2	Native Forb 2 CC	Native Forb 3	Native Forb 3 CC	Native Forb 4	Native Forb 4 CC	Native Forb 5	Native Forb 5 CC	Native Forb 6	Native Forb 6 CC	Native Forb 7	Native Forb 7 CC	TOTAL NATIVE FORB COVER
2-1		0											0	GAAN	TR	CHPA	TR	DEFA	TR	CAMA	TR	CASP	TR					1
3-1		0	BRMA	TR									TR	DEFA	TR	CHPO	TR	GAAN	TR									TR
3-3		0											0															0
3-5		TR	BRDIS	TR	BRMA	TR							TR	HAPA	TR	DEFA	TR	AL(SP)	TR	CHFI	TR	SIBE	TR	GAAP	TR			1
3-8		0	BRMA	TR									TR	LODA	TR	MOHYLA	TR	ERFO	TR	PAGA	TR	SIBE	TR	CHFI	TR	POCA	TR	1
3-1a		TR	BRDIS	TR	BRMA	TR							TR	HAPA	TR	DEFA	TR	AL(SP)	TR	CHFI	TR	SIBE	TR					TR
5-1		0	BRMA	TR									TR	CHPO	TR													TR

ID #	Native Grass 1	Native Grass 1 CC	Native Grass 2	Native Grass 2 CC	Native Grass 3	Native Grass 3 CC	TOTAL NATIVE GRASS COVER	Native Shrub 1	Native Shrub 1 CC	Native Shrub 2	Native Shrub 2 CC	Native Shrub 3	Native Shrub 3 CC	Native Shrub 4	Native Shrub 4 CC	Native Shrub 5	Native Shrub 5 CC	Native Shrub 6	Native Shrub 6 CC	Native Shrub 7	Native Shrub 7 CC	Native Shrub 8	Native Shrub 8 CC	Native Shrub 9	Native Shrub 9 CC	Native Shrub 10	Native Shrub 10 CC	TOTAL NATIVE SHRUB COVER
2-1	ST(SP)	TR					TR	ADFA	3	XYBI	3	TEDI	2	SACL	2	CETO	1	NOIN	1	RHOV	1	HEWH	1	RHCR	1	ERFA	1	5
3-1	STLE	1					1	ADFA	3	XYBI	1	BALA	1	ERFA	1	HEWH	1	ARCA	1	CETO	1	NOIN	1	GU(SP)	1			4
3-3							0	ADFA	4	XYBI	2	RHOV	1	TECI	1	ARGL	1	NOIN	TR	GUSA	TR							5
3-5	ARAS	TR	STLE	TR	BOBA	TR	TR	ADFA	4	XYBI	1	ARGL	1	HEAR	1	MALA	1	RHCR	1	RHOV	1	NOIN	1	HEWH	1	CETO	TR	5
3-8	STLE	TR	CAOB	TR			TR	ADFA	5	ARGL	3	NOIN	TR	XYBI	1	RHCR	1	TEDI	1	HASQ	TR	GAVE	TR	HEAR	TR			6
3-1a	STLE	TR	ARAS	TR			TR	ADFA	4	XYBI	1	ARGL	1	HEAR	1	MALA	1	RHCR	1	RHOV	1	NOIN	1	HEWH	1	CETO	TR	5
5-1							0	ADFA	3	NOIN	3	BALA	2	ARCA	1	ERFA	1	XYBI	1	CNDU	1	MALA	1	HEWH	1			5

ID #	Bare Ground/ Rock CC	Thatch CC	Thatch Depth (cm)	Cryptobiotic Crust (1=Y,2=N)	Cryptobiotic Crust CC	Standing Biomass HT (M)	Dead Standing Biomass CC	Dead Standing Biomass SP #1	Dead Standing Biomass SP #2	Overall Native Habitat Quality	No. Plants	% Vegetative	% Flowering	% Fruiting	Predation or Herbivory (Y or N)	Disease (Y or N)	Stunted Growth (Y or N)	Dead Plants (Y or No)	Threat 1	Threat 1_Rank	Threat 2	Threat 2_Rank	Threat 3	Threat 3_Rank	Threat 4
2-1	4	0	0	1	2	0.3-1.5	1	ADFA	GU(SP)	VG	52	100	0	0	N	N	N	N	TRAILS	L					
3-1	5	3	2	1	2	1	TR	ADFA	GU(SP)	G	3	67	33	0	N	N	N	N	DUMPING/TRASH	M	ROAD CONSTRUCTION/MAINTENANCE	M			
3-3	3	TR	0	1	1	1.5	1	ADFA		VG	23	100	0	0	N	N	N	N	ROAD CONSTRUCTION/MAINTENANCE	M	VEGETATION CLEARING	M			
3-5	4	TR	0	1	1	1.5	0			VG	41	100	0	0	N	N	N	N	ROAD CONSTRUCTION/MAINTENANCE	M	ALTERED FIRE REGIME	H	VEGETATION CLEARING	M	TRAILS
3-8	3	TR	0	1	1	1.25				VG	780	100	0	0	N	N	N	N	ROAD CONSTRUCTION/MAINTENANCE	M					
3-1a	4	TR	0	1	1	1.25				VG	41	100	0	0	N	N	N	N	ALTERED FIRE REGIME	M	ROAD CONSTRUCTION/MAINTENANCE	M	VEGETATION CLEARING	M	
5-1	4	3	10	1	2	3	3	ADFA		VG	20	100	0	0	N	N	N	N	VEGETATION CLEARING/FUEL MODIFICATION	M	INVASIVE SPECIES	H	TRAILS	h	EROSION

ID #	Threat 4_Rank	Other Species Observed	Last Fire	All Fires	N Deposition	NOTES
2-1			1970	1945, 1970	9.63	Additional species: Guiterrezia sp., Quercus sp., Cercocarpus betuloides, Artemisia californica, Eriophyllum confertiflorum, Mimulus aurantiacus, Haplopappus squarrosus,
3-1			1970	1945, 1970	9.63	
3-3		TEDI	1970	1928, 1945, 1970	9.63	
3-5	L	TEDI, HAPA	2001	1921, 1970, 2001	9.63	Invasive grasses along lower trail (but not really in habitat); Garrya veatchii
3-8		TEDI, MOHYLA, PAGA	1970	1921, 1945, 1970	9.87	Garrya veatchii
3-1a		TEDI, HAPA	1970	1945, 1970	9.63	
5-1	M		1970	1970	9.31	Invasive species occur outside of sampling polygon along trail; may eventually invade habitat

ID #	EO #	Sampling Point	Species	Site Name	Assessment Date	Investigators	MSP Occurrence ID	Land Owner	Land Manager	GPS Coordinates (E)	GPS Coordinates (N)	Datum and Coordinate System	GPS Accuracy (m)	Site Access	Camera Type	Photo 1	Photo Direction	Photo Height (ft)	Camera Angle	Photo 2	Photo Direction	Photo Height (ft)
5-2	5	2	NOIN	McGinty Mountain	6/25/2014	JV, TS	NOIN_3MGMO00	TNC	TNC	512505.93	3622385.511	NAD 83; UTM Zone 11, meters	< 1	NONE	Canon Powershot SX230HS	MGM_5-2-1	270°	4.6	-8°			
5-4	5	4	NOIN	McGinty Mountain	6/25/2014	JV, TS	NOIN_3MGMO00	TNC	TNC	1683080.5	3623019.224	NAD 83; UTM Zone 11, meters	< 1	NONE	Canon Powershot SX230HS	MGM_5-4-1	257°	4.5	-3°			
5-5	5	5	NOIN	McGinty Mountain	5/29/2014	PGR, JV	NOIN_3MGMO00	TNC, USFWS, PVT	TNC, USFWS, PVT	513090.858	3624249.327	NAD 83; UTM Zone 11, meters	< 1	NONE	Canon Powershot SX230HS	MM_5_1	185°	4.6	-6°			
5-8	5	8	NOIN	McGinty Mountain	6/26/2014	JV, CB	NOIN_3MGMO00	USFWS	USFWS	512075.247	3623781.038	NAD 83; UTM Zone 11, meters	< 1	NONE	Canon Powershot SX230HS	1	131°	5.8	-10°	2	288°	5.5
6-1	6	1	NOIN	South Crest	5/8/14	PGR, JV	NOIN_3SOCR003	EHC	EHC	512043.555	3627891.262	NAD 83; UTM Zone 11, meters	< 1	4WD	Canon Powershot SX230HS	6-1-1	235°	3	0°	6-1-2	98° E	3
6-2	6	2	NOIN	South Crest	5/8/14	PGR, JV	NOIN_3SOCR003	EHC	EHC	512548.628	3627933.325	NAD 83; UTM Zone 11, meters	< 1	4WD	Canon Powershot SX230HS	6-2-1	237°	4	-41.6°	6-2-2	315° NW	4
11-1	11	1	NOIN	Sycuan Peak	5/28/2014	PGR, JV	NOIN_3SYCP005	CDFW	CDFW	518858.859	3623797.941	NAD 83; UTM Zone 11, meters	< 1	NONE	Canon Powershot SX230HS	SYC_E01 1_1	299°	4.5	-3°			
6-3	6	3	NOIN	Michelson	5/12/2014	JV, JA	NOIN_3SOCR003	EHC	EHC	512680.57	3628069.307	NAD 83; UTM Zone 11, meters	Not GPSed, obtained in ArcMAP	NONE								

Appendix B.2: Dehesa Nolina Matrix

ID #	Camera Angle	Photo Location	Aspect	Soil Texture	Soil Series	Vegetation Alliance (2012 Map)	Veg. Association (2012 Map)	Vegetation Alliance (Field)	Veg. Association (Field)	Exotic Forb 1	Exotic Forb 1 CC	Exotic Forb 2	Exotic Forb 2 CC	Exotic Forb 3	Exotic Forb 3 CC	Exotic Forb 4	Exotic Forb 4 CC	Exotic Forb 5	Exotic Forb 5 CC	Exotic Forb 6
5-2		CBI	W	Stony fine sandy loam	Las Posas	Adenostoma fasciculatum	Adenostoma fasciculatum-Ceanothus tomentosus	Adenostoma fasciculatum-Xylococcus bicolor	Adenostoma fasciculatum-Xylococcus bicolor-Ceanothus tomentosus											
5-4		CBI	NE, SW	Stony fine sandy loam	Las Posas	Adenostoma fasciculatum	Adenostoma fasciculatum-Ceanothus tomentosus	Adenostoma fasciculatum-Xylococcus bicolor	Adenostoma fasciculatum-Xylococcus bicolor	CEME	TR									
5-5		CBI	SW, W	Stony fine sandy loam	Las Posas	Adenostoma fasciculatum	Adenostoma fasciculatum-(Eriogonum fasciculatum, Artemisia californica, Salvia mellifera)	Arctostaphylos glandulosa	Arctostaphylos glandulosa-Adenostoma fasciculatum	SOAS	TR	ANAR	TR							
5-8	-8°	CBI	W	Stony fine sandy loam (clayey)	Las Posas	Nassella pulchra	Nassella pulchra	Artemisia californica-Eriogonum fasciculatum	Artemisia californica-Eriogonum fasciculatum-Malosma laurina	ERCI	1	CEME	1	HECR	1	LOGA	1	ERBO	1	ANAR
6-1	0°	CBI	SW, W	Clay	Auld	Stipa pulchra	Stipa pulchra	Stipa pulchra	Stipa pulchra	HECR	TR	CEME	TR							
6-2	-15°	CBI	SW, W	Sandy clay loam	Las Posas	Artemisia californa-Eriogonum fasciculatum	Artemisia californa-Eriogonum fasciculatum-Malosma laurina	Rhamnus crocea Provisional	Rhamnus crocea Provisional	ERCI	TR	BRNI	TR	CEME	TR					
11-1		CBI	N, NE, S, SE, E	Stony fine sandy loam	Las Posas	Adenostoma fasciculatum	Adenostoma fasciculatum-(Eriogonum fasciculatum, Artemisia californica, Salvia mellifera)	Arctostaphylos glandulosa	Arctostaphylos glandulosa-Adenostoma fasciculatum	CEME	TR									
6-3																				

Appendix B.2: Dehesa Nolina Matrix

ID #	Exotic Forb 6 CC	TOTAL EX. FORB COVER CLASS	Exotic Grass 1	Exotic Grass 1 CC	Exotic Grass 2	Exotic Grass 2 CC	Exotic Grass 3	Exotic Grass 3 CC	Exotic Grass 4	Exotic Grass 4 CC	Exotic Grass 5	Exotic Grass 5 CC	TOTAL EX. GRASS COVER	Native Forb 1	Native Forb 1 CC	Native Forb 2	Native Forb 2 CC	Native Forb 3	Native Forb 3 CC	Native Forb 4	Native Forb 4 CC	Native Forb 5	Native Forb 5 CC	Native Forb 6	Native Forb 6 CC	Native Forb 7	Native Forb 7 CC	TOTAL NATIVE FORB COVER
5-2		0											0	GAAN	1													1
5-4		TR	BRMA	TR									TR	GAAN	TR													TR
5-5		TR	BRDIS	TR									TR	HEGR	TR	DEFA	TR	LODA	TR	ACIL	TR							TR
5-8	TR	2	BRDIS	2	AV(SP)	1	BRMA	1	BRHO	TR	GAVE	TR	2	COFI	1	SIBE	1	CAMA	1	ERCO	1	DEFA	TR	ALHA	TR	SEBI	TR	1
6-1		TR	BRDIS	4	AVBA	1	BRDI	TR	BRMA	TR			4	COVI	1	BRCA	TR	SIBE	TR	COSI	TR	DEFA	TR	AMPS	TR	FRBI	TR	1
6-2		TR	BRDIS	TR	BRMA	TR	BRHO	TR					TR	MILA	1	CHPA	TR	ERCO	TR	SIBE	TR	PLER	TR	CAMA	TR	DIPU	TR	1
11-1		TR	BRDIS	TR	BRMA	TR							TR	LODA	TR	PAGA	TR	NEGL	TR	MOHYLA	TR	CHPA	TR	ERCO	TR	POGR	TR	TR
6-3																												

ID #	Native Grass 1	Native Grass 1 CC	Native Grass 2	Native Grass 2 CC	Native Grass 3	Native Grass 3 CC	TOTAL NATIVE GRASS COVER	Native Shrub 1	Native Shrub 1 CC	Native Shrub 2	Native Shrub 2 CC	Native Shrub 3	Native Shrub 3 CC	Native Shrub 4	Native Shrub 4 CC	Native Shrub 5	Native Shrub 5 CC	Native Shrub 6	Native Shrub 6 CC	Native Shrub 7	Native Shrub 7 CC	Native Shrub 8	Native Shrub 8 CC	Native Shrub 9	Native Shrub 9 CC	Native Shrub 10	Native Shrub 10 CC	TOTAL NATIVE SHRUB COVER
5-2	ARPU	1					1	ADFA	3	TEDI	3	NOIN	1	SACL	1	XYBI	1	MALA	1	CETO	1	CNDU	1	ARGL	1	RHCR	1	4
5-4	STLE	3					3	XYBI	3	ARCA	2	TEDI	2	NOIN	1	ERCO	1	RHCR	1	ADFA	1	RHOV	1	ERCR	1	MALA	1	5
5-5							0	ADFA	4	ARGL	1	RHOV	1	CNDU	1	NOIN	1	TEDI	1	SACL	TR	RHCR	TR	HASQ	TR	HEWH	TR	5
5-8	STPU	2					2	ARCA	2	MALA	1	NOIN	1	RHCR	1	GU(SP)	1	ERFA	TR	ISME	1	SAAP	TR					3
6-1	STPU	1					1	NOIN	2	ISME	1	ACGL	TR															3
6-2	STLE	TR					TR	NOIN	4	RHCR	1	MALA	2	ERFA	TR	ARCA	TR	BALA	TR	SAAP	TR	ACGL	TR	CLPA	TR	MAFA	TR	4
11-1	ST(SP)	TR	CAOB	TR			TR	ADFA	TR	ARGL	3	TEDI	1	NOIN	1	HEAR	1	SACL	1	QUBE	1	RHCR	TR	RHOV	TR	HEWH	TR	5
6-3																												

ID #	Bare Ground/ Rock CC	Thatch CC	Thatch Depth (cm)	Cryptobiotic Crust (1=Y,2=N)	Cryptobiotic Crust CC	Standing Biomass HT (M)	Dead Standing Biomass CC	Dead Standing Biomass SP #1	Dead Standing Biomass SP #2	Overall Native Habitat Quality	No. Plants	% Vegetative	% Flowering	% Fruiting	Predation or Herbivory (Y or N)	Disease (Y or N)	Stunted Growth (Y or N)	Dead Plants (Y or No)	Threat 1	Threat 1_Rank	Threat 2	Threat 2_Rank	Threat 3	Threat 3_Rank	Threat 4
5-2	4	0	0	1	3	2	1	NOIN	HEWH	VG	18	100	0	0	N	N	N	N	INVASIVES	H	EROSION	M	MODIFICATION/VEG CLEARING	M	ILLEGAL TRAIL USE
5-4	3	1	1	1	2	1.3	1	MALA		FAIR - GOOD	9	100	0	0	Y	N	N	N	INVASIVES	H	EROSION	M	MODIFICATION/VEG CLEARING	M	ILLEGAL TRAIL USE
5-5	4	TR	0	1	2	1.5	0				6	100	0	0	N	N	N	N	ALTERED FIRE REGIME	M	ROAD CONSTRUCTION/MAINTENANCE	M	TRAILS	M	
5-8	1	4	20	1	1	1	2	AV(SP)	ARCA	F	9	100	0	0	Y	N	N	N	GOPHERS/RABBITS	H	SOIL COMPACTION	M	ALTERED FIRE REGIME	H	
6-1	1	4	4	1	TR	0.5	TR	GRCA											ALTERED FIRE REGIME	H	ALTERED HYDROLOGY	M	HISTORIC AG	L	ROADS, TRAILS
6-2	5	2	1-2	1	1	1.5	TR	RHCR		VG									ALTERED FIRE REGIME	M	EROSION	L	FERAL PIGS	M	TRAILS
11-1	4	TR	0	1	1	1.25	TR	ADFA	ARGL	VG	120	100	0	0	N	N	N	N	ALTERED FIRE REGIME	M					
6-3											15	100	0	0				N	ALTERED FIRE REGIME	H	INVASIVES	M	EROSION	M	ROADS, TRAILS

ID #	Threat 4_Rank	Other Species Observed	Last Fire	All Fires	N Deposition	NOTES
5-2	H	TEDI	1970	1945, 1950, 1970	9.31	Invasive species occur outside of sampling polygon along trail; may eventually invade habitat. Illegal trail use
5-4	H	TEDI	1970	1970	9.31	Invasive species occur outside of sampling polygon along trail; may eventually invade habitat. Illegal trail use
5-5		TEDI, ACIL	1970	1950 (part), 1970	9.31-11.12	ACIL FLOWERING; BRDIS DENSE ALONG TRAIL
5-8			1970	1950, 1970	9.31	Evidence of recent fire; trail use. Population in disturbed habitat resembling grassland. Manage BRDIS around Nolina? Dethatch or treat with Fusilade? Population extent is very large - likely greater than 15-20 acres. Number of plants provided is only in small sampling area.
6-1	M	CAGN	2003	1953, 1956, 1970, 2003	11.12	
6-2	M	ACIL	2003	1953, 1956, 1970, 2003	11.12	
11-1		TEDI, MOHYLA, PAGA	1970	1915, 1945, 1970	8.32	
6-3	L					

Appendix C

Natural Drivers and Threats and Stressors

Appendix C

Natural Drivers and Threats and Stressors

This appendix provides detailed descriptions and analyses of factors regulating Dehesa nolina occurrence and threats, based on existing information, and is intended to supplement information in the Conservation Vision and Management Strategy (strategy) and Appendix A and guide future monitoring, management, and research.

C.1 Natural Drivers

We examined two natural drivers — soils and vegetation — to identify potential correlates that might be used to target areas for focused Dehesa nolina surveys or restoration efforts.

Potential Vegetation Correlates

Dehesa nolina is generally described as occurring in *Adenostoma*-dominated chaparral habitat, often with other sensitive plants such as Cleveland sage (*Salvia clevelandii*), Parry's tetracoccus (*Tetracoccus dioicus*), San Diego thornmint (*Acanthomintha ilicifolia*), felt-leaved monardella (*Monardella hypoleuca* ssp. *lanata*), and chocolate lily (*Fritillaria biflora*) (Oberbauer 1979, USFWS 1995, Calflora 2014). In some locations (e.g., Dehesa Mountain - South Crest and McGinty Mountain), Dehesa nolina is found in coastal sage scrub and native grassland habitats.

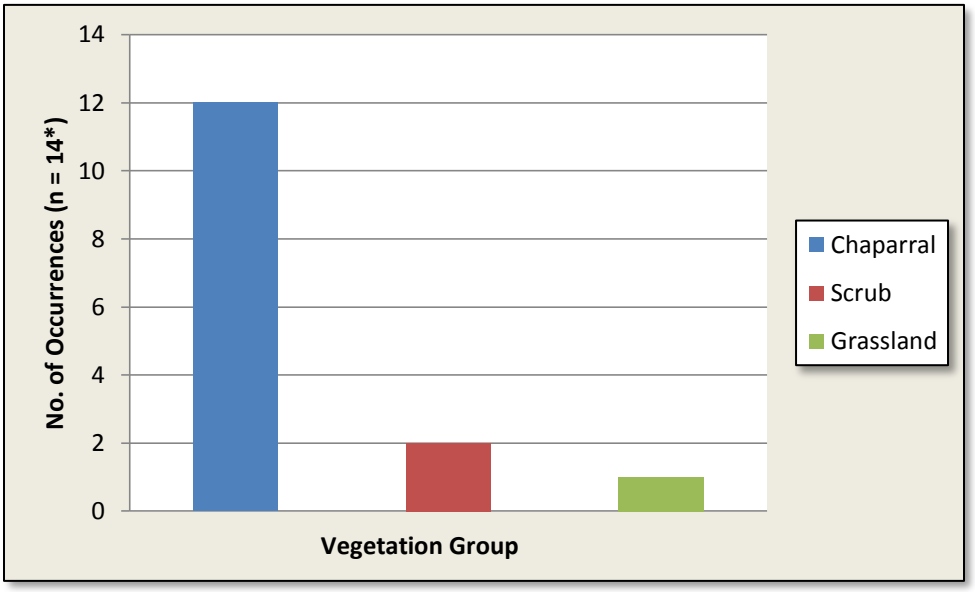
For this assessment, we reviewed vegetation data collected during habitat assessments or rare plant monitoring for this project (field-collected data) and the 2012 San Diego vegetation map (vegetation map) (SANDAG 2012) to determine (1) whether additional information on vegetation correlates could be detected at the group, alliance, and association levels and (2) whether the regional vegetation map was sufficient for preserve-level vegetation data collection for this species. For this project, we collected vegetation data at 14 locations, which included multiple sites within some populations or element occurrences (Figure C-1).

Group-level Vegetation

Based on field-collected data, 86% of nolina locations sampled are associated with chaparral, 7% with coastal sage scrub, and 7% with grasslands. An overlay of these same locations with the vegetation map indicates that 72% are associated with chaparral, 2% with coastal sage scrub, and 2% with grasslands. At the group level, differences between field-collected data and the vegetation map are relatively small.

Figure C-1

Field-assessed Group-level Vegetation



* One vegetation type (*Rhamnus crocea* Provisional Alliance) occurs in two different groups, so is represented in both groups on graph.

Alliance-level Vegetation

We identified 5 alliances in the field that supported Dehesa nolina in contrast to 7 alliances identified on the vegetation map. Of the 5 alliances, only 3 corresponded to alliances on the vegetation map for the same general location. Differences may be due to mapping scale, vegetation complexity and sampling site, or the inherent difficulties in assessing vegetation from imagery.

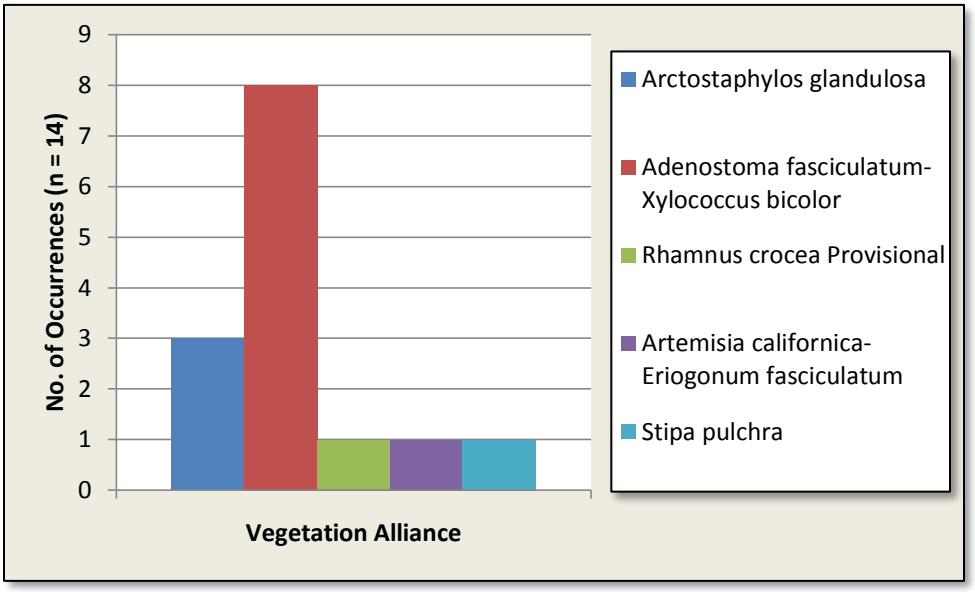
Field-collected data indicate that 57% of Dehesa nolina locations sampled occur within *Adenostoma*-dominated alliances and 28% occur in other chaparral alliances. Refer to Figure C-2 for the distribution of Dehesa nolina in field-assessed vegetation alliances; Appendix X provides the data for these determinations.

Association-level Vegetation

We identified six associations in the field that supported Dehesa nolina in contrast to seven associations identified on the vegetation map. Of the six associations, only three corresponded to associations on the vegetation map for the same general location. These differences may be due to mapping scale, vegetation complexity and sampling site, or the inherent difficulties in assessing vegetation from imagery.

Figure C-2

Field-assessed Vegetation Alliances



Field-collected data indicate that 57% of Dehesa nolina locations sampled occur within *Adenostoma*-dominated associations and 28% occur in other chaparral associations. Refer to Figure C-3 for the distribution of Dehesa nolina in field-assessed vegetation associations; Appendix X provides the data for these determinations.

Summary

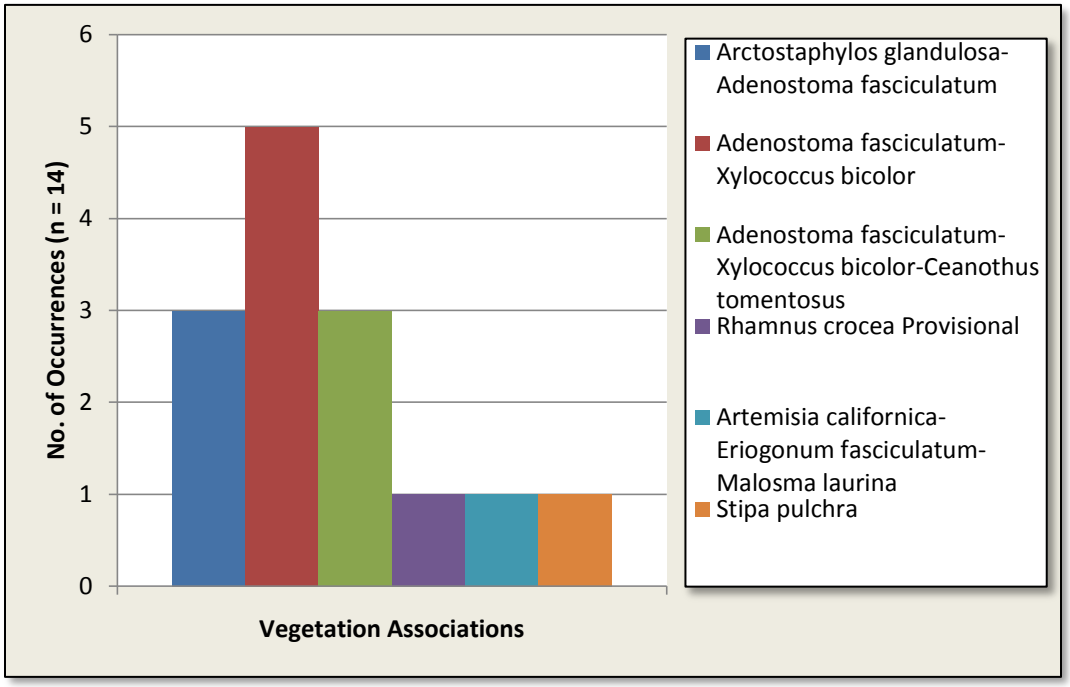
At the group level, the relationship between Dehesa nolina and chaparral is consistent with previous reports. At the alliance and association-levels, Dehesa nolina appears to be more common in some vegetation types than others, although the sample size is too small to be conclusive. Detecting fine-scale vegetation relationships could be valuable as a predictive tool for identifying additional stands of this rare species. Differences between field-collected data and the regional vegetation map suggest the importance of refined mapping at the preserve-level.

Potential Soil Correlates

Dehesa nolina is an edaphic species that occurs primarily in gabbro-derived soils (Oberbauer 1979, USFWS 1998, McNeal and Dice 2013). For this assessment, we overlaid the nolina distribution in San Diego County on the SSURGO soils dataset (USDA, NRCS 1973) to examine the species-soil relationship.

Figure C-3

Field-assessed Vegetation Associations



Dehesa nolina populations are mapped on six soil series: Auld, Las Posas, Cieneba, Cieneba-Fallbrook, Fallbrook, and Vista. Nolina mapping at some of these locations is general, so the species-soil relationship may not be precise. In addition, the soils mapping is relatively coarse, which may also contribute to mapping inaccuracies.

Of the six soil series, only Las Posas soils formed from gabbro rock. However, Cieneba and Fallbrook soils can include gabbro inclusions, and the Auld series consists of clay soils. Excluding the element occurrences where we did not detect Dehesa nolina (EOs 10, 12), 44% of nolina locations occur on Las Posas soils, while 83% occur on either gabbro soils, soils that include gabbro inclusions, or clay soils. Half of the occurrences on gabbro soils are on Las Posas stony fine sandy loam type (30-65% slopes).

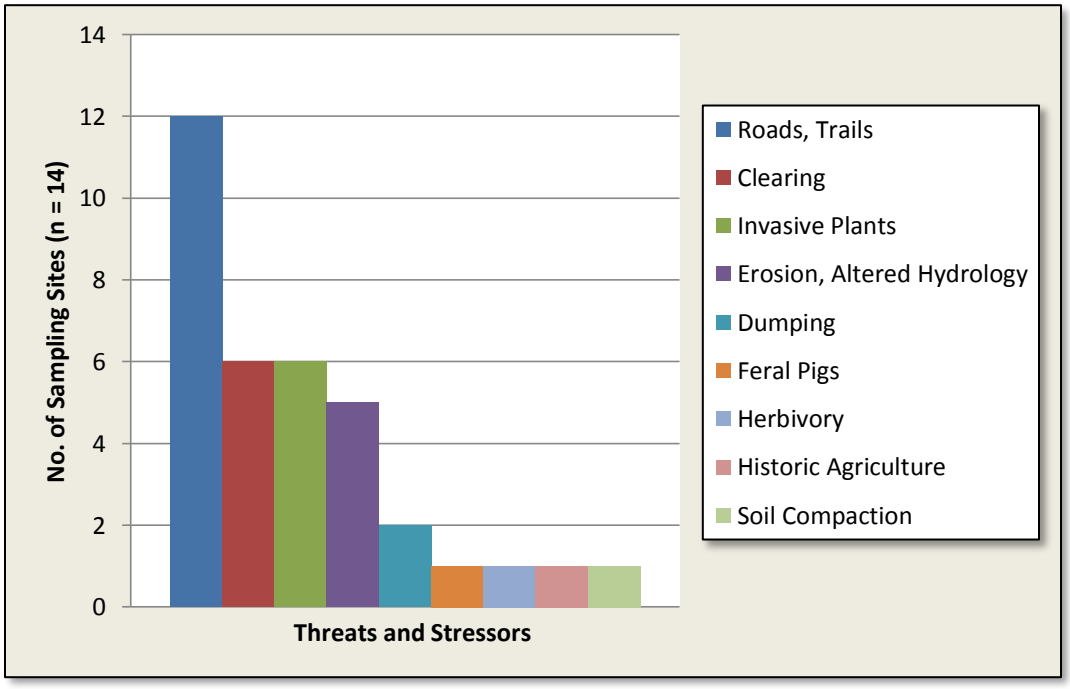
Of the two element occurrences where we did not observe Dehesa nolina, EO 10 supports Las Posas fine sandy loams (9-30% slopes), which are found at only one other element occurrence (a small portion of EO 6), and EO 12 supports neither gabbro or clay soils nor soils with gabbro inclusions.

C.2 Threats and Stressors

Threats and stressors are factors or processes that may impact Dehesa nolina populations or habitat and which may require management to ensure species persistence. Threats and stressors ─ both natural (e.g., fire) and anthropogenic (e.g., invasive species) ─ were identified through field assessments, data review, and input from land managers. Figure C-4 summarizes threats and stressors identified through habitat assessments. Most of these are a result of direct disturbance or edge effects and should be managed at the preserve level.

Figure C-4

Preserve-level Threats and Stressors



Additional threats and stressors are more widespread; these may affect regional population persistence and require management within or among preserve complexes for effective control:

- Invasive plants
- Altered fire regime
- Genetic diversity
- Population structure
- Habitat fragmentation
- Nitrogen deposition
- Climate change

Invasive Plant Species

Nonnative, invasive plants pose one of the greatest threats to native species and habitats because of their ability to displace native species, degrade wildlife habitat, and alter ecosystem processes (Belnap et al. 2005, Ehrenfeld 2003, Evans et al. 2001, Cox 1999, Wilcove et al. 1998, D'Antonio and Vitousek 1992, Huenneke et al. 1990, Vitousek et al. 1990, and many others). Invasive plant species have been recognized as a potential threat to Dehesa nolina by several sources (e.g., USFWS 1995, CBI 2012, CBI et al. 2012, CBI 2014).

Of primary concern to Dehesa nolina is the nonnative grass, purple false-brome (*Brachypodium distachyon* [*Brachypodium*]), which forms dense stands on clay and gabbro soils, and is still spreading in the region (CBI 2014). *Brachypodium* thatch may provide a short-term, beneficial effect by retaining soil moisture and thus, increasing nolina growth (CBI 2012). Despite this potential benefit, the dense litter may (1) increase fire intensity (e.g., fine fuels), (2) alter nutrient cycling (e.g., increased biomass); and (3) eliminate bare ground for recruitment. Although sexual reproduction is considered infrequent in nolina except after fire or disturbance (USFWS 1995, CBI 2012), we observed a number of small plants[1] on South Crest that may be a different cohort than the majority of plants onsite and may have arisen through seed germination rather than clonal growth (CBI 2012). The presence of potential recruitment sites should be a component of healthy, functioning Dehesa nolina habitat, regardless of the frequency with which sexual reproduction takes place.

Figure C-5. Dehesa nolina & *Brachypodium,* South Crest.

To date, dense *Brachypodium* stands occur with Dehesa nolina on South Crest (Figure C-5) and McGinty Mountain, primarily in coastal sage scrub or grassland habitats. On Sycuan Peak, *Brachypodium* is confined to trails adjacent to Dehesa nolina stands; however, the concern is the potential spread of this invasive species into currently uninvaded habitat following a fire.

Altered Fire Regime

Altered fire regimes have been identified as a risk to Dehesa nolina (Regan et al. 2006), and may affect long-term species persistence. Fire suppression result in increased fuel loads and fire

[1] 'Small' plants averaged 0.25 meter (m) tall versus an average of >1 m tall for all other individuals on South Crest (CBI 2012). These plants were not in proximity to larger individuals, but were near a road, so above-ground growth may have been removed through road clearing/maintenance.

intensity, senescent populations, and reduced flowering. Increased fire frequency may prevent plants from reaching maturity and contributing to the soil seedbank. Invasion of habitat by *Brachypodium* may increase fire intensity by introducing fine fuels into habitat typically characterized by low grass cover. Effects of altered fire regimes may include direct mortality, population decline or extirpation, and loss of genetic diversity (USFWS 1995). Additional impacts include habitat type conversion and an increase in invasive plants.

The Dehesa-South Crest population appears to be the conserved population that is most affected by increased fire frequency, with 4 recorded fires in a 50-year period (1953, 1956, 1970, 2003). The most recent fire was the 2003 Cedar fire; pre- and post-Cedar fire surveys on South Crest indicated some loss of nolina plants as a result of this event (CBI 2012). This site is the most disturbed of the EOs on conserved lands, which may be due, in part, to fire frequency. The other EOs on conserved lands have lower fire frequencies and/or longer fire intervals (Table C-1).

Table C-1

Fire History at Dehesa Nolina Populations on Conserved Lands

EO Name[1]	EO #[2]	Sampling Points[3]	Recorded Fires (Year)[4]	# of Fires
Skyline Truck Trail[5]	2	1	1945, 1970	2
Sycuan Peak Ecological Reserve	3	1, 1a	1945, 1970	2
		3	1928, 1945, 1970	3
		5, 8	1921, 1970, 2001	3
McGinty Mountain Ecological Reserve	5	1, 4	1970	1
		2	1945, 1950, 1970	3
		5, 8	1950, 1970	2
Dehesa Mountain - South Crest	6	1, 2	1953, 1956, 1970, 2003	4
Jamul Butte	10	---[6]	1912, 1943, 1970	3
Sycuan Peak Ecological Reserve	11	1	1915, 1945, 1970	3
McGinty Mountain Ecological Reserve	12	---[6]	1950, 1970	2

[1] EO Name = CNDDB Element Occurrence name.
[2] EO Number = CNDDB Element Occurrence number. Refer to X for corresponding MOM occurrence number.
[3] Sampling point refers to 2014 habitat assessment point (Appendix A).
[4] Refer to CalFire 2011for information on recorded fires. Note that not all fires may be included in the CalFire database.
[5] Includes only that portion EO 2 that is currently being considered for conservation acquisition.
[6] Dehesa nolina not observed at this location in 2014.

Genetic Diversity

Dehesa nolina is a clonal species that also reproduces sexually through a dioecious breeding system. Flowering is extremely sporadic and appears to be enhanced by fire or other disturbance (Dice 1988, USFWS 1995, and others). Some research has been conducted on the genetic diversity within this species (Rombouts 1996; Heaney pers. comm.). Dehesa nolina exhibits moderate clonal diversity and extremely low genetic variation. It is hypothesized that the dioecious mating system, which usually maintains high levels of polymorphism and heterozygosity, may have evolved *after* low levels of genetic diversity were established and may be preventing further loss of genetic variation (Rombouts 1996). Clonal growth may buffer ramet populations from environmental stochasticity that might otherwise cause local extinction.

Heaney (pers. comm.) determined that chloroplast DNA was identical in the Dehesa and McGinty Mountain populations, but found some sequence divergence between Baja and U.S. populations. Based on this work, he indicated that seed exchange between the two U.S. sites would not pose an adverse threat to the genetic diversity or integrity of these populations. Further genetic studies would refine our understanding of genetic diversity at the population-level and the distribution of genetic populations to assess whether ecological or geographic barriers are isolating mechanisms (CDFG 2009). These studies, along with field studies to assess flowering frequency and sex ratios, are necessary to determine whether low genetic diversity is a threat to the long-term persistence of Dehesa nolina.

Population structure

Dehesa nolina reproduces both sexually and asexually. Sexual reproduction (flowering, seed production) occurs primarily after fire or other disturbance, and is necessary to maintain genetic diversity. Where flowering occurs in the absence of these factors, we have observed relatively low seed set and seed viability (CBI in progress). Asexual reproduction occurs by cloning a new plant from an underground caudex and appears to be the primary mode of population expansion for this species.

Figure C-6. Dehesa nolina flower (photo: J. Vinje).

Individuals produced sexually are termed genets and have the potential for high genetic variation between individuals. Individuals produced asexually or by cloning are ramets, and possess low or no genetic variation between individuals. Populations that include multiple genets and ramets are likely to be most resilient to environmental, demographic, and genetic stochasticity.

Dehesa nolina flowers are considered dioiecious (separate male and female flowers). In describing the genus, however, Trelease (1911) noted that ‘abortive stamens are found in fertile flowers and more or less recognizable rudimentary pistils in those that are functionally

staminate.' Trelease further reports that partly developed fruits may occasionally occur on staminate plants, well-developed stamens may be found in some pistillate flowers, and flowers may transform from staminate to pistillate individuals. On South Crest, we observed the presence of both pistils and stamens in flowers that produced capsules (Figure C-6), although seed produced (if any) was often deformed (Figure C-7) and inviable.[2]

Sex ratio within populations is a potentially important factor for population persistence. At least one subpopulation of Dehesa nolina (Dehesa-South Crest, along Dehesa Road) may consist entirely of female plants. A preliminary survey of genetic variability within this population indicated that the 50 sampled clusters represented a single genet (Dice 1988). This suggests that counts of clusters or rosettes may indicate ramet size but not necessarily number of genetic individuals. If populations are entirely female, pollen from disjunct populations would be required for flower fertilization. However, flowers in disjunct populations may not bloom simultaneously since flowering is, in part, dependent upon fire (Dice 1988). Field studies that assess population sex ratios may complement genetic studies in determining whether low genetic diversity is a threat to the long-term persistence of Dehesa nolina.

Figure C-7. Dehesa nolina fruit (photo: J. Vinje).

Habitat Fragmentation

Conserved populations of Dehesa nolina occur primarily within relatively large preserves that allow for some degree of natural ecosystem functions. A larger concern for this species is loss of habitat between populations (fragmentation), particularly if these gaps affect or disrupt gene flow. At this time, the Dehesa-South Crest population is separated from the more southerly populations by Dehesa Road and adjacent development. Recent conservation acquisitions north of Dehesa Road by the Endangered Habitats Conservancy bolster the Dehesa-South Crest population numbers and reduce the distance to other populations south of Dehesa Road. Rural residential development is a potential concern between the Sycuan and McGinty Mountain populations, as well as between these populations and smaller populations along Skyline Truck Trail Road.

[2] Refer to the Rancho Santa Ana Botanic Garden seed image database for an image of healthy Dehesa nolina seed (http://www.hazmac.biz/090629/090629NolinaInterrata.html)

Nitrogen Deposition

Petroleum burning vehicles are a major producer of nitrogen emissions, and deposition of these nutrients on terrestrial and aquatic environments can degrade sensitive ecosystems (Weiss 2006). Impacts can be direct or indirect and may include decreased plant function, altered plant community composition, nonnative species invasions, toxic effects on freshwater species, eutrophication of water bodies from excess nutrients, and loss of biodiversity (e.g., Weiss 2006, Fenn et al. 2003, Allen et al. 1998, Fenn et al. 2005). Among the impacts most relevant to Dehesa nolina are the potential increase in invasive grass biomass and the subsequent alteration of fire regimes (grass-fire cycle) and decrease in native plant species (D'Antonio and Vitousek 1992, Rao et al. 2010, Ochoa-Hueso et al. 2011, Fenn et al. 2010).

Figure C-8 presents total nitrogen deposition levels in the vicinity of Dehesa nolina populations. Deposition levels were derived from modeled results by the University of California, Riverside (CCB 2002) and indicate the amount of monthly total nitrogen deposited in southern California in 2002. Model results were compared with critical load thresholds (Fenn et al. 2010) for key Dehesa nolina habitats at each population to identify habitats and, by inference, populations at risk for impacts from chronic nitrogen deposition (Table C-2). Results indicate that all populations in MU 3 are affected by elevated nitrogen levels (Figure C-9). Although land managers will not be able to reduce nitrogen deposition levels, invasive plant control may partially offset impacts from chronically high levels of nitrogen deposition.

Climate Change

Climate change has the potential to adversely affect plant species in various ways, including (1) altered climatic conditions (e.g., temperature, rainfall) that may affect a species' ability to persist in a given location; (2) shifts in flowering times that may result in lowered pollination success and/or loss of compatible pollinators; (3) altered photosynthetic rates and nutrient uptake that may result in increased growth and competition or an increase in herbivores; (4) increased rate of spread of invasive species that may outcompete native plant species; and (5) increased fire frequency that may result in loss of individuals or habitat type conversion (Anacker et al. 2013, Loarie et al. 2008, Parmesean and Yohe 2003, Walther et al. 2002, and others). In addition, climate change poses a particular threat to plants due to their relative lack of mobility. While plant species' ranges shift naturally, the rate of shift may be outpaced by changing climatic conditions, thus affecting the ability of some species to persist. The most vulnerable species are those that occur in small populations, are limited in distribution, or are closely associated with certain habitats or edaphic conditions (Loarie et al. 2008). For the latter, the presence of suitable habitat near existing habitat and within range of dispersal capabilities may be important to long-term survival.

Figure C-8

Nitrogen Deposition Levels Across the MSPA

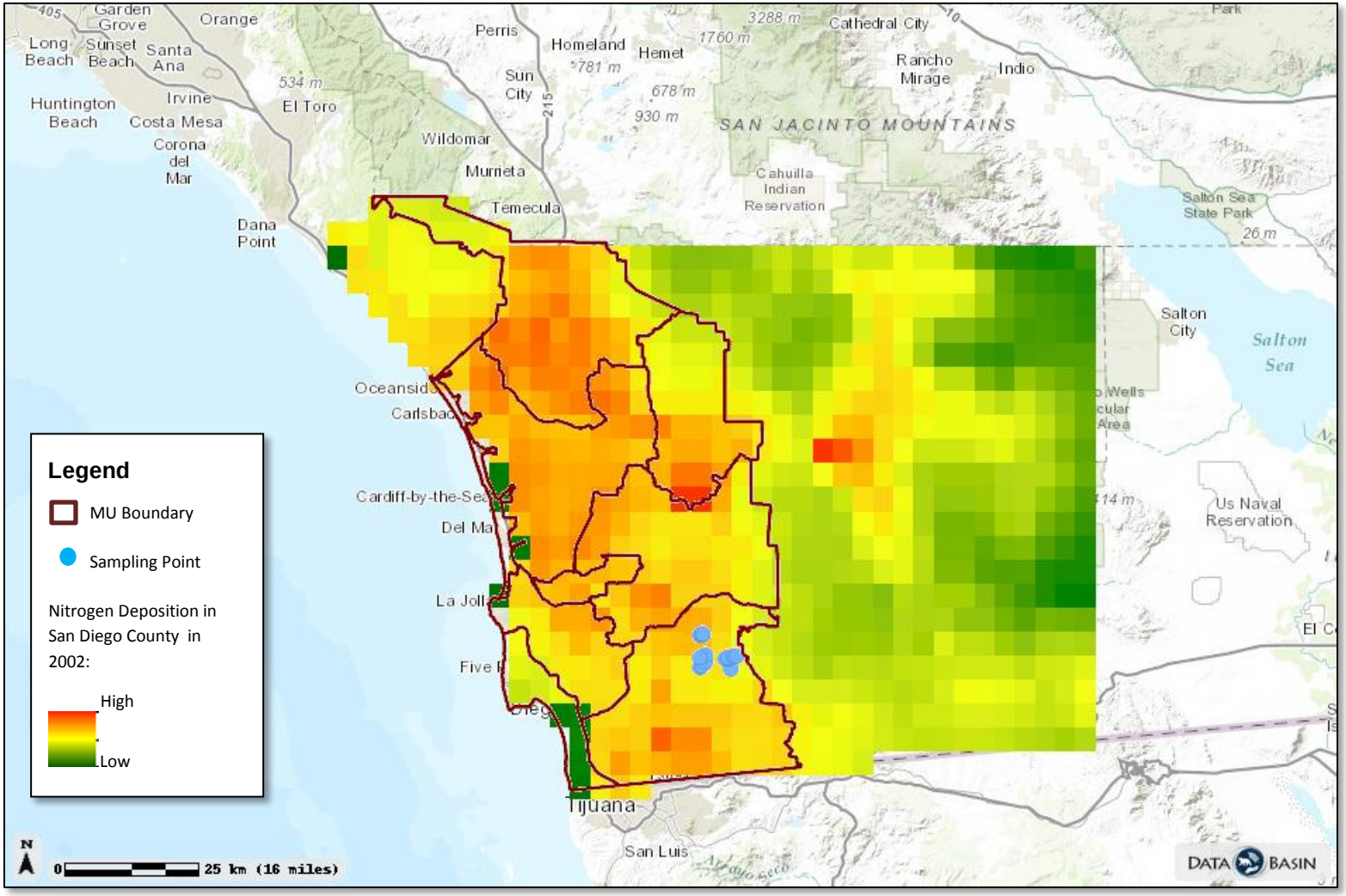


Table C-2

Habitats Potentially Affected by Nitrogen Deposition

EO[1]	Average Nitrogen Deposition[2] (kg N ha^{-1} yr^{-1})	Critical Load Levels (kg N ha^{-1} yr^{-1})[3]		
		Chaparral (5.5-[10.0]-14.0)	Coastal Sage Scrub (7.8-10.0)	Grassland (6.0-7.5)
2	9.63	X	NA	NA
3	9.67	X	X	NA
5	9.49	X	X	X
6	11.12	X	X	X
11	8.32	X	NA	NA

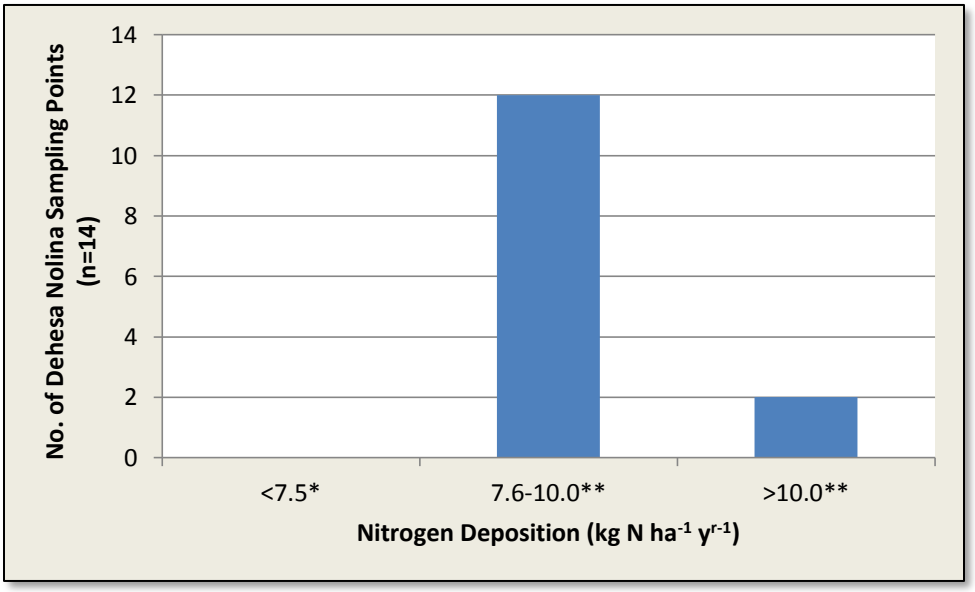
[1] EO = Element occurrence (population). EO 2 = Skyline Truck Trail Preserve, EO 3, 11 = Sycuan Peak Ecological Reserve, EO 5 = McGinty Mountain Ecological Preserve, EO 6 = Dehesa Mountain-South Crest, EO 11 = Sycuan Peak Ecological Preserve.

[2] Average nitrogen deposition levels are derived from modeled results (CCB 2002).

[3] Critical Load = A quantitative estimate of an exposure to one or more pollutants below which significant harmful effects on specified sensitive elements of the environment do not occur according to present knowledge (UBA 2004); Number range = thresholds at which habitat in California is impacted by chronic N deposition (Fenn et al. 2010); X = habitat within MU affected by elevated N levels based on average N deposition; NA = not applicable (habitat not present).

Figure C-9

Dehesa Nolina and Nitrogen Deposition[1]



* = potentially impacted by nitrogen deposition; ** = likely impacted by nitrogen deposition.

To our knowledge, modeling has not been conducted to specifically evaluate the threat of climate change to Dehesa nolina. Modeling for other rare and invasive species that occur in similar habitat and often with Dehesa nolina indicates that both invasive plants and fire frequency might pose threats under changing climatic conditions (Conlisk et al. 2013, Cal-IPC 2012).

In addition to managing climate change-related threats to Dehesa nolina, it will be important to ensure linkages to facilitate movement to future suitable habitat. Edaphic species may have an increased risk from the effects of climate change because of the patchy nature of suitable habitat, which may present limited opportunities for colonization (see Damschen et al. 2012), particularly where dispersal capabilities are limited. In this case, conservation and management of chaparral habitats supporting gabbro-derived soils east of the current species' range might benefit Dehesa nolina in the future.

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Appendix D

San Diego Management and Monitoring Program (SDMMP) Rare Plant Forms

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San Diego Management and Monitoring Program (SDMMP) Rare Plant Forms

Table D-1 lists SDMMP rare plant forms compiled for Dehesa nolina element occurrences (populations) as part of this study. These forms have been submitted to SDMMP for inclusion in the MSP Master Occurrence Matrix (MOM) database. Contact CBI directly for copies of forms.

Location	Element Occurrence[1]	Sampling Point[2]
Skyline Truck Trail	2	001
Sycuan Peak Ecological Reserve	3	001
		003
		008
	11	001
McGinty Mountain Ecological Reserve	5	001
		002
		004
		005
		008
Dehesa Mountain – South Crest	6	001
		002

[1] Element occurrence = CNDDB element occurrence.

[2] Although habitat assessment data were collected at 14 sampling points; SDMMP rare plant monitoring forms were completed at only 12 of the 14 sampling points.