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Mapping of vegetation communities, invasive plants, and sensitive plants at Garrapata State Park, Monterey County, California

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Executive Summary

This report summarizes the results of high-resolution floristic mapping of vegetation communities at the National Vegetation Classification Standard's "Alliance" level and provides an assessment of the relative abundance and distribution of invasive and sensitive plant species in Garrapata State Park, California. The work was done for the California Department of Parks and Recreation (State Parks). As possibly the first attempt to map vegetation communities to the NVCS Alliance level in coastal Big Sur, this report is intended to contribute data to statewide vegetation mapping efforts and provide species-specific information to assist resource managers at a local scale. The results of this work may be used to inform future monitoring and management efforts locally and contributes to the growing knowledge of vegetation community patterns across California. The field research and subsequent report are the work of an eight-week graduate class through the Department of Applied Environmental Science at California State University Monterey Bay.

Originally the site of cattle grazing for almost 200 years, Garrapata State Park encompasses 2,866 acres along the Pacific coast and is largely dominated by steep foothills of the coastal Santa Lucia Range. It is dissected by several steep creeks: Wildcat Creek, Malpas Creek, Soberanes Creek, Doud Creek, and Granite Creek. Elevation ranges from sea level to 2,011 ft atop Rocky Ridge. The park also contains an approximately 4.1-mile stretch of coastal bluff, rocky intertidal zone, and beach west of Highway 1. The park's Mediterranean climate is characterized by dry summers and cool wet winters. Wildfire is a prominent disturbance in this landscape, and the Soberanes Fire in 2016, which originated in the park, was one of the largest fires recorded in California history. Garrapata State Park was not officially recognized as a state park until 1985. Although California has recognized several invasive and special status plant species in the park, there has been no attempt to formally map their locations, nor identify vegetation communities on a larger scale.

Vegetation community mapping comprised preliminary delineation of vegetation communities, field-based alliance classification, and quality assurance. We first delineated vegetation stands using aerial imagery. We delineated communities at the *alliance* level for most classifications but used coarser mapping classes when we encountered stands that could not be readily discriminated from the imagery and/or identified during our fall survey period. We observed 41 unique vegetation communities in the park and mapped a total of 526 polygons with 436 field reconnaissance points.

Baccharis pilularis shrubland alliance covered almost a quarter of the park's area (685.2 acres, 23.9%). Unidentified annual grassland, the second most abundant vegetation community, covered 497 acres (17.36%). Due to the seasonality of annual grass species and the difficulties present in learning grass identification in a short timeframe, we were unable to identify most annual grasses to species. We found

several small stands of native perennial bunchgrasses representative of California coastal prairie: *Nassella* spp. – *Melica* spp. herbaceous alliance (1.4 acres, 0.042%), and stands with prominent *Elymus glaucus*. The *Sequoia sempervirens* forest and woodland alliance, found primarily along Soberanes and Malpasos Creeks, was the third most abundant alliance (358.9 acres, 12.52%).

Many of the more uncommon vegetation communities were mapped along the coastline, including the park's only stand of the *Scirpus microcarpus* herbaceous alliance (0.4 acres, 0.013%). This alliance has a State Rarity Rank of S2, which is considered imperiled due factors including range limitations and small or steeply declining populations (CNDDDB 2020). The coastline also had several invasive alliances, including long stretches of *Carpobrotus* spp. along the coast and numerous gullies occupied by pure stands of *Ageratina adenophora*.

We focused invasive and special status species survey efforts along park trails and along Highway 1. The most prevalent invasive species observed were mustards in the *Brassica* genus (50.3 total acres), followed by *Ageratina adenophora* (33.5 total acres) and *Carpobrotus* spp. (33 total acres). We conducted surveys of sensitive (i.e. CNPS-listed rare or endangered) plant species with a focus on plants that could be confidently identified during the non-blooming season by novice surveyors. We documented five sensitive species: *Pinus radiata*, *Ceanothus rigidus*, *Castilleja latifolia*, *Astragalus nuttalli* var. *nuttalli*, and *Arctostaphylos edmundsii*. *Pinus radiata* (Monterey Pine) occurred in the northeastern part of the park at the southern limit of the species native range in within Monterey County. *Arctostaphylos edmundsii* (Little Sur Manzanita) occurred at the southern end of the park at locations that are being aggressively encroached by *Acacia longifolia* and, to a lesser extent, non-native occurrences of *Pinus radiata*, and *Hesperocyparis macrocarpa*. *Eriogonum parvifolium* was also widespread throughout the park. Although not a listed plant species itself, *E. parvifolium* is a food plant for federally endangered Smith's Blue Butterfly,

This project is intended to strengthen the foundation of knowledge utilized by State Parks and other organizations in vegetation management, both in Garrapata State Park and elsewhere in Big Sur. Recommendations are made for additional study and monitoring, as well as specific management actions. The highest priority recommended action is removal of *Acacia longifolia* from the area where *Arctostaphylos edmundsii* occurs, and installation of more robust fencing in this area east of Highway 1. This has already been identified as a priority by State Parks, and we underscore it. Additional recommendations for management include incremental removal of *Carpobrotus* where it is near *Astragalus nuttalli* var. *nuttalli* and *Castilleja latifolia*, and removal of isolated stands of *Ageratina* and *Cortaderia*. Recommendations for further study and monitoring include surveying in spring, mapping down to the NVCS association level, surveying relevés listing all species (not just dominants), and further study of bunchgrasses, *Astragalus nuttalli* var. *nuttalli*, and *Castilleja latifolia*.

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1 Introduction

High-resolution vegetation mapping is valuable for several aspects of natural resource management including conservation planning, invasive species management, monitoring long-term environmental changes, managing and modeling wildfire, and providing holistic assessments of ecosystem health (Thorne et al. 2004; USNVC 2020, CGS n.d.). The U.S. National Vegetation Classification (USNVC) system was established in 1991 to create a nationally standardized and credible vegetation classification system (USNVC 2020). State and local agencies across California identified a similar need for a statewide high-resolution digital vegetation map to address conservation management, monitoring, and modelling goals throughout the state (CGS n.d.). The Survey of California Vegetation (SCV) aims to address this need in compliance with USNVC standards. Over 40% of the state's vegetation has been mapped using floristic-based classification as of November 2019 but several data gaps remain (CDFW 2020).

Mapping abundance and distribution of invasive and sensitive plant species can assist resource managers with more localized, species-specific monitoring and management needs. Invasive species outcompete native inhabitants, leading to losses in biodiversity locally (Maskell et al. 2006). Additionally, invasive plants can adversely impact natural ecosystems at larger spatial scales by disrupting primary production, natural trophic interactions, and pollinator services (Carpenter et al. 2002; Thiele et al. 2010). Sensitive species are particularly vulnerable to invasion due to their already limited ranges. High-resolution mapping of individual species can lead to early detection of invasives and can provide information on rare and endangered species ranges and distributions with sufficient accuracy for implementing effective monitoring and management strategies (Brundu et al. 2011; Pouteau et al. 2012).

This study is intended to contribute data to statewide vegetation mapping efforts and provide species-specific information to assist resource managers at a local scale. Here we provide the results of high-resolution floristic mapping of vegetation communities at the NVCS "Alliance" level, and an assessment of invasive and sensitive species relative abundance and distribution on the California Central Coast. The results of this work may be used to inform future monitoring and management efforts locally and provide a contribution to the growing knowledge of vegetation community patterns across California.

1.1 Study Area

The study area for this project was Garrapata State Park in northwestern Monterey County, California (Figure 1). Development of Garrapata State Park land by Spanish missionaries began in the late 1700s (Costanoan Rumsen Carmel Tribe 2001). Cattle ranching on the land began in the 1830s with land grants to ranchers, beginning a long stint of grazing on most of the land south of the Carmel River. In 1980, the state of California began purchasing parcels of land and the area was officially classified as a state park in 1985 (Garrapata State Park Monterey Sector 2003).

Garrapata State Park encompasses 2,866 acres along the Pacific coast, immediately south of Carmel Highlands. The area is largely dominated by steep foothills of the coastal Santa Lucia Range and is dissected by several steep creeks: Wildcat Creek, Malpaso Creek, Soberanes Creek, Doud Creek and Granite Creek. Elevation ranges from sea level to 2,011 ft atop Rocky Ridge. The park also contains an approximately 4.1-mile stretch of coastal bluff, rocky intertidal zone, and beach west of Highway. The park's Mediterranean climate is characterized by dry summers and cool wet winters and receives approximately 28 inches of mean annual precipitation (PRISM 2012). Wildfire is a prominent disturbance in this landscape. For example, the Soberanes Fire in 2016 began in Garrapata State Park and at the time was one of the largest fires recorded in California history, burning 132,127 acres (CAL Fire 2016).

1.2 Project Objectives

The project goals in order of priority comprised:

1. Mapping vegetation communities to the NVCS Alliance level.
2. Mapping relative abundance and distribution of invasive plant species along trails.
3. Mapping relative abundance and distribution of sensitive plant species that are detectable in the fall.

The primary deliverables for this project are this technical report, a geodatabase, and maps available at http://ccows.csumb.edu/pubs/proj_pubs/2020/ENVS660_GarrapataSP/index.htm .

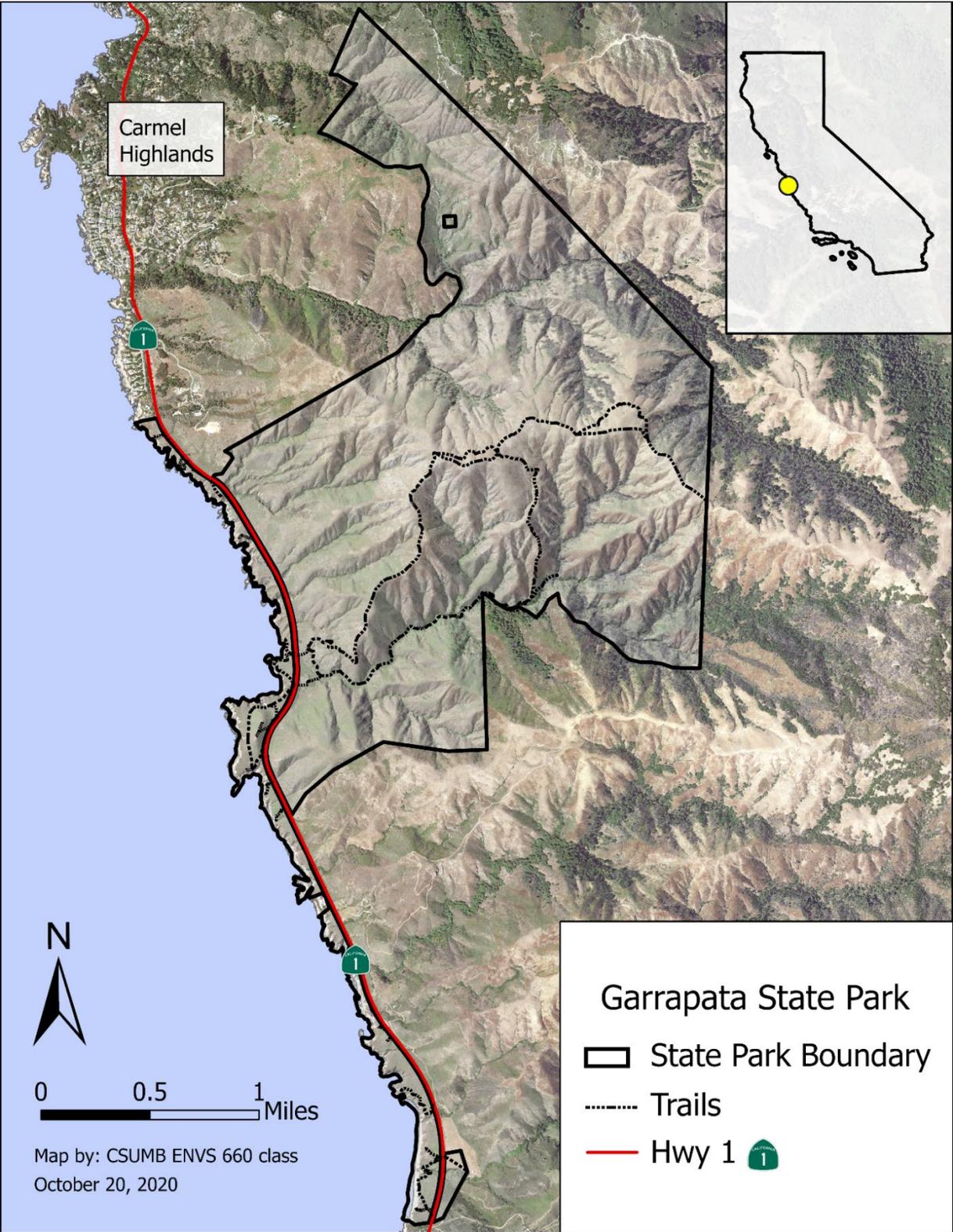


Figure 1. Study Area. Garrapata State Park on the Big Sur coast of Central California.

2 Vegetation Community Mapping

The National Vegetation Classification System allows vegetation to be mapped at three broad levels—physiognomy, biogeography, and floristics—each of which can be broken down into multiple sublevels (USNVC 2020). Floristic-level mapping provides the finest resolution and is the only level to reflect local environmental conditions. Such fine-scale data resolution helps establish a more precise inventory of native and non-native vegetation communities, which benefits land managers interested in protecting valued natural resources, monitoring fuel loads for fire management, and understanding habitat requirements of wildlife. We attempted to map vegetation communities to the *alliance* sublevel, which is the broadest sublevel at the floristic level of mapping. We did not attempt to map *associations*, which occur at the level below alliances.

2.1 Vegetation Community Mapping Methods

Vegetation community mapping comprised preliminary delineation of somewhat homogeneous vegetation *stands*, field-based classification of alliances and other mapping units, and quality assurance. We first estimated the boundaries of stands using aerial and satellite-derived orthoimagery which were later classified through field observations. Most of the stands we mapped were conformant with previously defined alliances. Non-conformant stands were classified within novel mapping units, defined in Appendix B. We also used novel mapping units for two situations where the exact alliance could not be readily determined in fall; these classes were “Willows” and “Unidentified annual grasses”.

2.1.1 Preliminary Vegetation Community Delineation

We examined aerial and satellite imagery to initially digitize polygons around areas where vegetation looked homogenous and distinct from surrounding areas. We used a mosaic of natural color (red, green, blue [RGB] band) and color infrared (CIR) National Agriculture Imagery Program (NAIP) orthophotos to conduct initial digitizing of vegetation alliance polygons (Fig. 2). Polygons were delineated based on areas of visible homogeneity within the landscape; breaks or abrupt changes in color, structure, or relative height of vegetation usually indicated the need to create separate vegetation community polygons. We established minimum mapping units (MMUs) of 0.25 acres for common mapping units and 0.1 acres for uncommon classes, to maximize the level of detail conveyed in vegetation maps given time constraints and clarity of aerial and satellite imagery. The status of each vegetation community polygon was indicated as “unconfirmed” until field crews verified whether initial delineations were correct.



Figure 2. The differences in using RGB and CIR Imagery as a base map.



Figure 3. Example of a digitized polygon representing a stand within the *Populus trichocarpa* Forest and Woodland Alliance.

Polygons were classified based on the dominant species composition of each polygon. Classification rules were based on rules provided by CNPS, and where rules contradicted each other, we adopted a rule based on either the most recent or the most locally relevant CNPS-listed rule. Most rules were based on the percent cover of the tallest stratum of vegetation. Rules for novel mapping units were that the nominate dominant species should have 50% relative cover.

Prior to the majority of fieldwork, we developed an internal guide to alliances and other mapping units in order to ensure consistency and accuracy. This guide appears in Appendix C, and includes photos of dominant species, and the classification rules that we adopted and adapted from CNPS.

2.1.2 Field-based Vegetation Community Classification

Field crews of one to three people classified stands within unconfirmed pre-digitized polygons. To organize field effort into manageable and distributable tasks, the study area was divided into a grid of 325 squares where each square was 33 acres. Field crews were assigned daily groups of squares in which to focus their data collection during each field visit and to prevent duplication of data between field crews. Field crews traveled to unconfirmed polygons within their respective sampling squares and used ESRI ArcGIS Collector to attribute the correct vegetation mapping unit to each area based on the appropriate classification rules applied in the field. Confidence in the classification was recorded within the attributes of each polygon through a hierarchy of confidence levels which were – in decreasing order of confidence:

1. ground-truthed
2. distance-observed
3. estimated through aerial/satellite imagery

Reconnaissance points were collected within or on the edge of each vegetation community polygon. Reconnaissance points were used to provide quantitative and visual evidence for each stand classification by recording relative cover of each dominant species and capturing photographs for each vegetation alliance polygon. Most polygons that were validated in the field contained at least one associated reconnaissance point and larger polygons could have up to three reconnaissance points associated with them. These points were later used for quality assurance of vegetation community classification data.

In areas that field crews were unable to physically visit, polygons were classified based on aerial and satellite imagery observations. Inferences were made by looking at areas ground-truthed by field

crews and comparing them to uncertain polygons. If an unknown polygon showed similar traits within NAIP imagery as a ground-truthed stand, the unknown polygon was classified as the same stand. Georeferenced photographs from the field crews were used to supplement aerial imagery when possible. During post-processing, each polygon was snapped to adjacent polygons to prevent gaps and overlapping of vegetation communities.

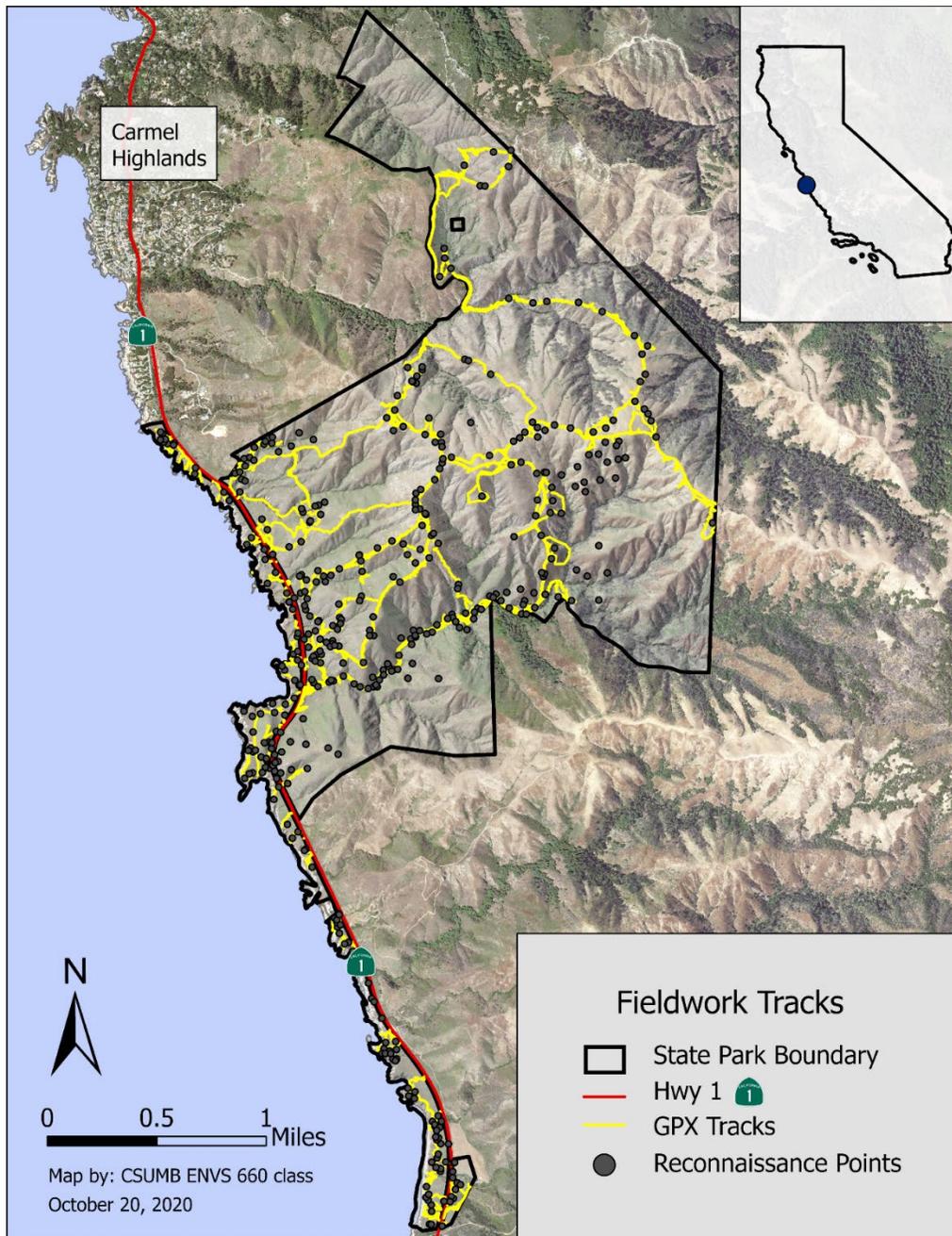


Figure 4. Field work tracks (gpx tracks) with mapped reconnaissance points.

2.2 Vegetation Community Mapping Results and Discussion

The results presented here represent possibly the first attempt to map vegetation communities to the NVCS alliance level in coastal Big Sur (Tables 1 & 2). We observed 41 distinct vegetation communities in the park and mapped a total of 526 polygons with 436 reconnaissance points (Figure 5).

The inland areas of the park was characterized by large stands. Most abundant was the *Baccharis pilularis* shrubland alliance, covering almost a quarter of the park's area (685.2 acres, 23.9%, Table 2). *Baccharis pilularis* dominated the western half of the park, where it sometimes intermixed with *Artemisia californica* alliances (typically on southern-facing slopes) and *Frangula californica* alliances (typically on northern-facing slopes). *Baccharis pilularis* was also present on slopes and in lowland areas across the entire extent of the park.

Unidentified annual grassland was the second most abundant vegetation community, covering 497 acres (17.36%) primarily at higher elevations and often intermingling with the *Lupinus chamissonis*–*Ericameria ericoides* shrubland alliance (253.8 acres, 8.85%) and the *Lotus scoparius* shrubland alliance (247.6 acres, 8.63%). We found several small stands of native perennial bunchgrasses (California coastal prairie—*Nassella* spp. – *Melica* spp. herbaceous alliance; 1.4 acres, 0.042%). There may be additional patches of California coastal prairie that were not detected by field crews. We were unable to identify annual grasses to species due to the difficulty of detecting and identifying them in fall.

The *Sequoia sempervirens* forest and woodland alliance, found primarily along Soberanes and Malpaso creeks, was the third most abundant alliance (358.9 acres, 12.52%). *Ceanothus thrysiflorius* was common upslope of redwoods, particularly along Malpaso creek. Smaller riparian areas were often intermixed with mapping units of *Salix* spp. and invasive *Ageratina adenophora*, which was the most abundant invasive vegetation community mapped in the park (24.8 acres, 0.886%). More information on invasive species can be found in Chapter 3.

Many of the more uncommon vegetation communities were mapped along the coastline, including the park's only stand of the *Scirpus microcarpus* herbaceous alliance (0.4 acres, 0.013%). This alliance has a State Rarity Rank of S2, which is considered imperiled due factors including range limitations and small or steeply declining populations (CNDDDB 2020). *Scirpus microcarpus* was the only S2 alliance mapped in the park; no S1 alliances (critically imperiled) were observed.

Table 1. Vegetation classification system used to map vegetation communities throughout Garrapata State Park. Rows with codes ending in '000' or '00' denote groupings. Groups were not mapped; instead the classes within each grouping were mapped.

Code	Vegetation Map Class
1000	Madrean Forest and Woodland Division
1100	Californian broadleaf forest and woodland Group
1110	Umbellularia californica Forest & Woodland Alliance
1120	Quercus agrifolia Forest & Woodland Alliance
1200	Californian evergreen coniferous forest and woodland Group
1210	Pinus muricata – Pinus radiata Forest & Woodland Alliance
1220	Hesperocyparis macrocarpa – Pinus radiata Semi-Natural Alliance
2000	Cool Temperate Forest Formation
2100	Vancouverian Rainforest Macrogroup
2110	Sequoia sempervirens Forest & Woodland Alliance
2200	Introduced North American Mediterranean woodland and forest Macrogroup
2210	Eucalyptus spp. – Ailanthus altissima – Robinia pseudoacacia Woodland Semi-Natural Alliance
2300	Californian-Vancouverian Montane and Foothill Forest Macrogroup
2310	Arbutus menziesii Forest Alliance
3000	Temperate Flooded and Swamp Forest Formation
3100	Western North America Flooded and Swamp Forest Division
3110	Willow Mapping Unit
3120	Populus trichocarpa Forest & Woodland Alliance
3200	Western North America Warm Temperate Flooded and Swamp Forest Division
3210	Platanus racemosa – Quercus agrifolia Woodland Alliance
4000	California Chaparral Macrogroup
4100	Californian xeric chaparral Group
4110	Adenostoma fasciculatum Shrubland Alliance
4200	Californian pre-montane chaparral Group
4210	Arctostaphylos glandulosa Shrubland Alliance
5000	California Coastal Scrub Macrogroup
5100	Central and south coastal California seral scrub Group
5110	Artemisia californica – (Salvia leucophylla) Shrubland Alliance
5120	Diplacus aurantiacus Shrubland Alliance
5130	Lotus scoparius Shrubland Alliance
5140	Salvia mellifera Shrubland Alliance
5150	Acacia spp. – Grevillea spp. – Leptospermum laevigatum [pending]

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6000	Temperate and Boreal Shrubland and Grassland Formation
6100	Vancouverian Coastal Dune and Bluff Macrogroup
6110	Eriophyllum staechadifolium – Erigeron glaucus – Eriogonum latifolium Herbaceous Alliance
6120	Lupinus chamissonis – Ericameria ericoides Shrubland Alliance
6130	Baccharis pilularis Shrubland Alliance
6140	Frangula californica Shrubland Alliance
6150	Mesembryanthemum spp. – Carpobrotus spp. Herbaceous Semi-Natural Alliance
6160	Lupinus arboreus Shrubland Alliance and Semi-Natural Alliance
6170	Ceanothus thyrsiflorus Shrubland Alliance
6200	Vancouverian Lowland Grassland and Shrubland Macrogroup
6210	Toxicodendron diversilobum Shrubland Alliance
6220	Rubus (parviflorus, spectabilis, ursinus) Shrubland Alliance
6230	Bromus carinatus – Elymus glaucus Herbaceous Alliance
6300	Western North American Freshwater Marsh Macrogroup
6310	Scirpus microcarpus Herbaceous Alliance
6400	Western North America Wet Meadow and Low Shrub Carr Macrogroup
6410	Phragmites australis – Arundo donax Herbaceous Semi-Natural Alliance
7000	California Annual and Perennial Grassland Macrogroup
7100	California Perennial Grassland Group
7110	Nassella spp. – Melica spp. Herbaceous Alliance
7200	Mediterranean California naturalized annual and perennial grassland Group
7210	Brassica nigra – Centaurea (solstitialis, melitensis) Herbaceous Semi-Natural Alliance
7220	Unidentified annual grasses
9000	Miscellaneous Classes
9100	Anthropogenic Areas of Little or No Vegetation
9110	Built up & Urban Disturbance
9200	Natural Areas of Little or No Vegetation
9210	Cliffs & Rock Outcroppings, Talus & Scree
9220	Undefined areas with little or no vegetation
9300	Exotic Vegetation
9310	Ageratina mapping unit
9320	Prickly Pear Mapping Unit
9330	Pride of Madeira
9400	Native Vegetation
9410	Chaparral Currant Mapping Unit
9420	Little Sur Manzanita Mapping Unit
9430	Wood Mint Mapping Unit

Table 2. Map classes listed from largest to smallest, along with mapping unit numbers and abbreviations.

Code + Alliance	Abbrev.	# of Polygons	Acres	% of Park
6130 – Baccharis pilularis Shrubland Alliance	BaPi	88	685.1	23.901%
7220 – Unidentified annual grasses	Ann	55	497.9	17.369%
2110 – Sequoia sempervirens Forest & Woodland Alliance	Seq	10	360.3	12.568%
6120 – Lupinus chamissonis – Ericameria ericoides Shrubland Alliance	LH	27	253.8	8.855%
5130 – Lotus scoparius Shrubland Alliance	LoSc	42	247.6	8.639%
6170 – Ceanothus thyrsiflorus Shrubland Alliance	CeTh	31	137.6	4.802%
5110 – Artemisia californica – (Salvia leucophylla) Shrubland Alliance	ArCa	35	121.3	4.233%
9210 – Cliffs & Rock Outcroppings, Talus & Scree	CR	31	72.5	2.528%
6140 – Frangula californica – Rhododendron occidentale – Salix breweri Shrubland Alliance	FrCa	15	70.0	2.441%
1120 – Quercus agrifolia Forest & Woodland Alliance	QuAg	10	65.5	2.285%
4110 – Adenostoma fasciculatum Shrubland Alliance	AdFa	12	58.1	2.027%
3110 – Willow Mapping Unit	Wil	24	51.4	1.792%
7210 – Brassica nigra – Centaurea (solstitialis, melitensis) Herbaceous Semi-Natural Alliance	BrNi	13	41.9	1.461%
6110 – Eriophyllum staechadifolium – Erigeron glaucus – Eriogonum latifolium Herbaceous Alliance	Eri	19	34.2	1.194%
4210 – Arctostaphylos glandulosa Shrubland Alliance	ArGl	10	31.0	1.081%
9310 – Ageratina mapping unit	Ager	20	24.8	0.866%
6210 – Toxicodendron diversilobum Shrubland Alliance	ToDi	19	20.0	0.698%
6150 – Mesembryanthemum spp. – Carpobrotus spp. Herbaceous Semi-Natural Alliance	Ice	15	17.2	0.600%
6160 – Lupinus arboreus Shrubland Alliance and Semi-Natural Alliance	LuAr	6	16.3	0.567%
1210 – Pinus muricata – Pinus radiata Forest & Woodland Alliance	PiRa	4	11.7	0.407%
1110 – Umbellularia californica Forest & Woodland Alliance	UmCa	5	8.2	0.285%
1220 – Hesperocyparis macrocarpa – Pinus radiata Semi-Natural Alliance	HeMa	6	8.0	0.277%
3120 – Populus trichocarpa Forest & Woodland Alliance	PoTr	3	6.9	0.241%
9320 – Prickly Pear Mapping Unit	PP	1	6.2	0.216%
5150 – Acacia spp. – Grevillea spp. – Leptospermum laevigatum [pending]	Aca	1	3.5	0.121%
2310 – Arbutus menziesii Forest Alliance	ArMe	1	2.4	0.082%
6230 – Bromus carinatus – Elymus glaucus Herbaceous Alliance	ElGl	3	2.2	0.076%
5120 – Diplacus aurantiacus Shrubland Alliance	DiAu	1	1.8	0.064%
9330 – Pride of Madeira	PoM	1	1.8	0.064%
9410 – Chaparral Currant Mapping Unit	Cur	1	1.7	0.058%
7110 – Nassella spp. – Melica spp. Herbaceous Alliance	NaPu	7	1.2	0.042%
6220 – Rubus (parviflorus, spectabilis, ursinus) Shrubland Alliance	Rub	1	1.1	0.039%
6410 – Phragmites australis – Arundo donax Herbaceous Semi-Natural Alliance	ArDo	1	0.8	0.028%
2210 – Eucalyptus spp. – Ailanthus altissima – Robinia pseudoacacia Woodland Semi-Natural Alliance	Euc	1	0.6	0.022%
3210 – Platanus racemosa – Quercus agrifolia Woodland Alliance	PlaRa	1	0.5	0.017%
9220 – Undefined areas with little or no vegetation	NV	1	0.4	0.015%
9420 – Little Sur Manzanita Mapping Unit	LSM	1	0.4	0.014%
6310 – Scirpus microcarpus Herbaceous Alliance	ScMi	1	0.4	0.013%
9430 – Wood Mint Mapping Unit	WM	1	0.2	0.008%
5140 – Salvia mellifera Shrubland Alliance	SaMe	1	0.1	0.003%
9110 – Built up & Urban Disturbance	Urb	1	0.0	0.001%

Potential sources of error include:

- Polygons that contained multiple stands but were not sub-divided due to lack of time
- Polygons in remote areas that were misclassified due to lack of field reconnaissance
- Polygon boundaries that were misdrawn due to the coarseness of the imagery and steep terrain with heterogeneous solar shading
- Reconnaissance points that were mis-described due to limitations in field crew expertise
- Alliances that were under-counted due to reduction in plant cover in fall. An example of this could be alliances based on *Lotus scoparius* or *Eriogonum parvifolium*.
- Alliances that were omitted due to lack of detectability in fall. An example of this could be the *Eschscholzia (californica) – Lupinus (nanus)* Herbaceous Alliance (California poppy – lupine fields).

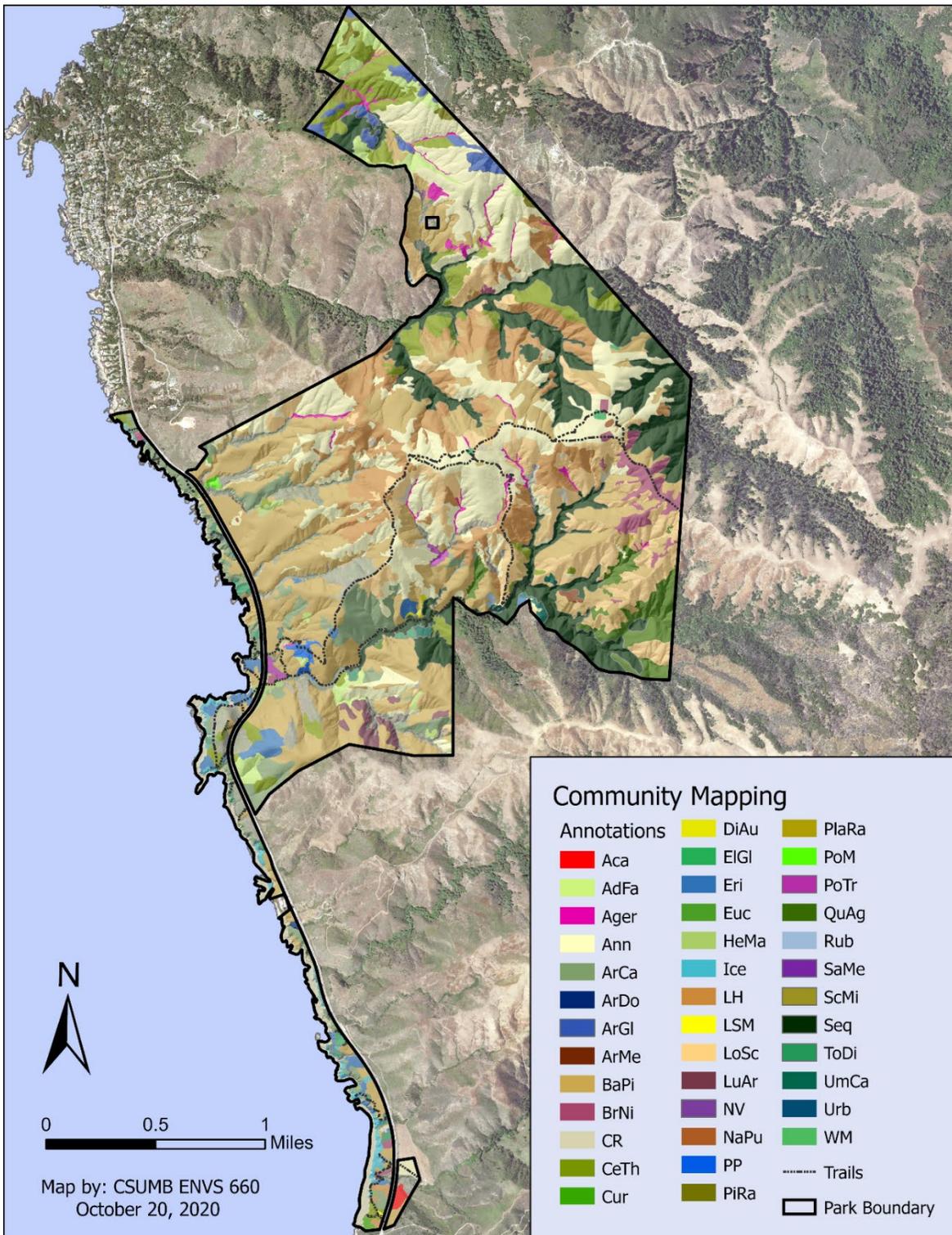


Figure 5. Alliance level vegetation map of Garrapata State Park. The data underlying this map are posted at: <http://sep.csUMB.edu/class/ENVS660/>

3 Invasive Plant Species Mapping

Invasive plants have been shown to outcompete native species, threatening natural biodiversity at the local scale (Maskell et al. 2006; Powell et al. 2013). Management of invasive species is therefore essential for maintaining diverse ecosystems. Inventorying and high-resolution mapping of individual species provides valuable information to assist in early detection and implementation of effective management actions (Brundu et al. 2011). Monitoring and management efforts should focus on areas under the highest threat of invasion because resources are typically limited for floristic surveys and species inventories (Charlet 2000).

We surveyed invasive species in order to identify high priority areas for future management. We focused invasive species survey efforts along park trails and along Highway 1.

3.1 Invasive Plant Species List

We comprehensively mapped relative abundance and distribution of several invasive species throughout Garrapata State Park. We initially derived a list of 24 invasive species to look for from the CalFlora Illustrated Plant List for Garrapata State Park (CSP 1990). After commencing field surveys, we added invasive species that were encountered in the field but were not previously listed by CNPS. We grouped species that could not be confidently identified to the species level during the non-blooming season by novice identifiers (Table 3).

Table 3. Invasive plant species found in Garrapata State Park, with associated California Invasive Plant Council Rating (Cal-IPC).

Common Name	Scientific Name	Cal IPC Rating
Cape Ivy	<i>Delairea odorata</i>	high
Acacia	<i>Acacia spp</i>	watch/moderate
Himalayan Blackberry	<i>Rubus armeniacus</i>	high
Calla Lily	<i>Zantedeschia aethiopica</i>	limited
Eucalyptus (group)	<i>Eucalyptus</i>	limited/watch
European grasses (group)		
Fennel	<i>Foeniculum vulgare</i>	moderate
French Broom	<i>Genista monspessulana</i>	high
Ice Plant (group)		
Sea Fig	<i>Carpobrotus chilensis</i>	moderate
Iceplant	<i>Carpobrotus edulis</i>	high
Mullein	<i>Verbascum thapsus</i>	N/A
Mustards (group)		
Wild radish	<i>Raphanus sativus</i>	limited
Black mustard	<i>Brassica nigra</i>	moderate
Field mustard	<i>Brassica rapa</i>	limited
Sahara mustard	<i>Brassica tournefortii</i>	high
New Zealand Spinach	<i>Tetragonia tetragonioides</i>	limited
Jubata grass	<i>Cortaderia jubata</i>	high
Pampass grass	<i>Cortaderia selloana</i>	high
Periwinkle	<i>Vinca major</i>	moderate
Poison Hemlock	<i>Conium maculatum</i>	moderate
Prickly Pear	<i>Opuntia spp</i>	N/A
Scotch Broom	<i>Cytisus scoparius</i>	high
Sticky Ageratina	<i>Ageratina adenophora</i>	moderate
Thistles (group)		
Plumeless thistle	<i>Carduus acanthoides</i>	limited
Musk thistle	<i>Carduus nutans</i>	moderate
Italian thistle	<i>Carduus pycnocephalus</i>	moderate
Slenderflower thistle	<i>Carduus tenuiflorus</i>	limited
Woolly distaff thistle	<i>Carthamus lanatus</i>	high
Pride of Madeira	<i>Echium candicans</i>	limited
Giant Reed	<i>Arundo donax</i>	high
Sweet Alyssum	<i>Lobularia maritima</i>	limited

3.2 Invasive Plant Species Mapping Methods

We focused invasive species survey efforts along trails using methods adapted from Mountain Invasion Research Network protocols (MIRN 2020). Field crews hiked every designated trail and recorded

invasive plants within a 2-meter buffer on either side of an official, maintained trail using ESRI ArcGIS Collector. Each record included GPS location, photographic documentation, species identification, and an estimate of the number of individuals. If individual plants were distinguishable from each other and did not extend beyond the buffer zone, we recorded each point. If there was a group of plants where individuals were indiscernible, but patches began within the 2-meter buffer we recorded the species as a polygon feature.

In addition to direct ground survey methods, we also explored the potential utility of methods for documentation of invasive species in inaccessible areas photos and spotting-scope surveys from distant vantage points. This is described further in Appendix D.

3.3 Invasive Plant Species Survey Results and Discussion

We mapped 860 occurrences of invasive species throughout the park (Figure 6 and Table 4). The most prevalent invasive species observed were mustards in the *Brassica* genus (approximately 32% of all invasive species points surveyed). The second most abundant invasive species we found were thistles. Thistles represented approximately 17% of all invasive species points surveyed and were most abundant along hiking trails. We did not identify thistles to species but identified them as an ambiguous group which likely led to erroneous mapping of some native thistles as invasive data points. *Cortaderia* (Jubata/Pampas grass) represented approximately 11% of invasive species points surveyed.

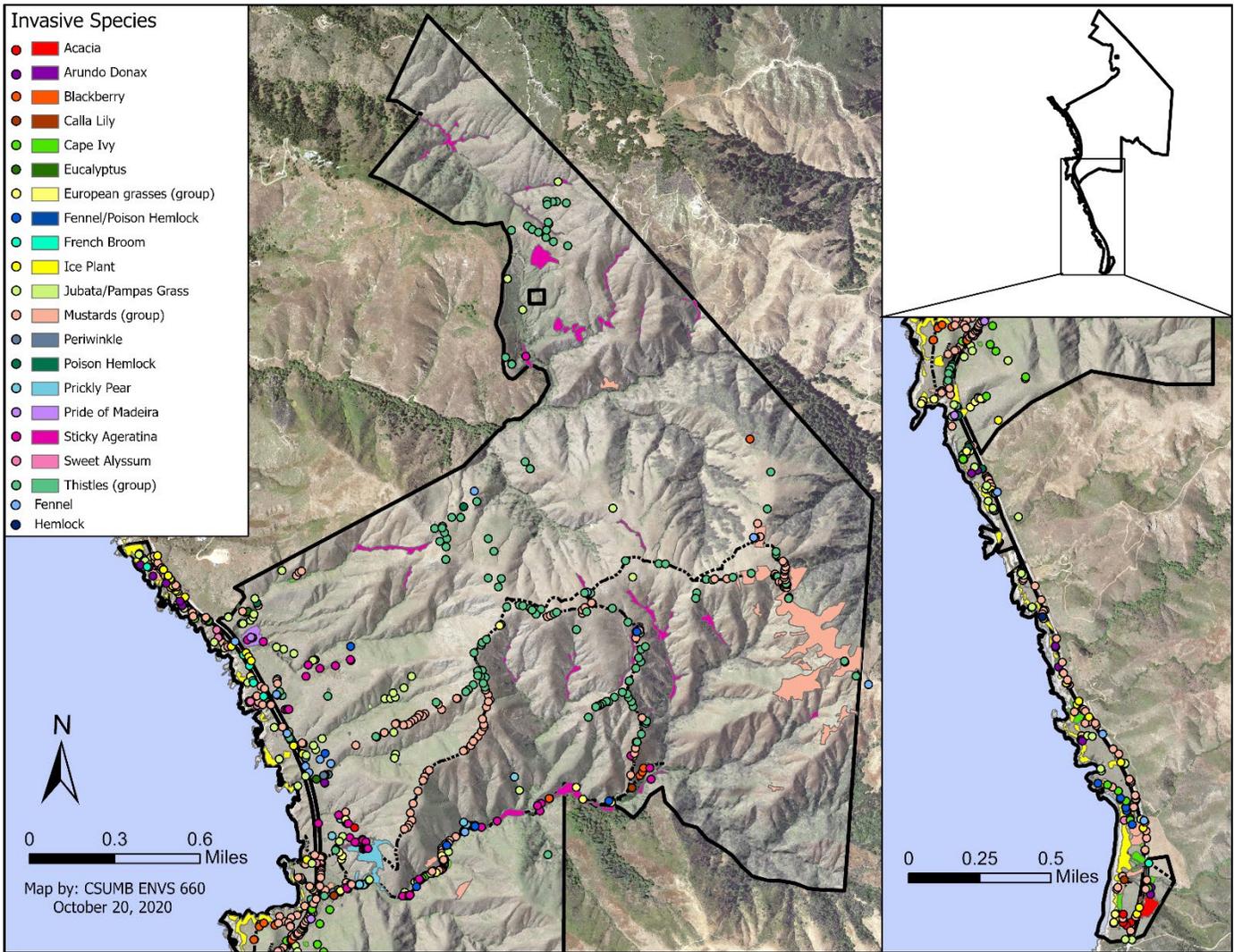


Figure 6. Locations of invasive species detected at Garrapata State Park. Points represent small groups of individuals; polygons signify areas of more extensive coverage.

Table 4. Acreage of invasive species mapped in Garrapata State Park.

Species	# of Polygons Acres	
Mustards (group)	45	50.3410
Sticky Ageratina	44	33.4894
Ice Plant	86	33.0727
Cape Ivy	40	9.3808
Prickly Pear	7	6.6990
Acacia	3	2.8394
Pride of Madeira	1	2.5879
Arundo Donax	10	0.9153
Fennel/Poison Hemlock	11	1.0912
Jubata/Pampas Grass	15	0.5941
Blackberry	3	0.1906
Calla Lily	3	0.1644
Periwinkle	1	0.1476
European grasses (group)	4	0.0790
Eucalyptus	1	0.0665
Thistles (group)	3	0.0352
French Broom	2	0.0100
Sweet Alyssum	1	0.0005

4 Sensitive Plant Species Mapping

Approximately 20% of plant species worldwide are at risk of extinction (CPC 2020). California, in particular, is floristically diverse and hosts a large proportion of endemic, rare, threatened, or endangered plants, making the state influential in nation-wide and international plant conservation programs (Holsinger and Gottlieb 1991). Biodiversity conservation efforts rely on detailed knowledge of rare and endangered species ranges and distributions (Pouteau et al. 2012) but data for individual taxa are often scarce and lack locational accuracy (Engler et al. 2004).

We conducted surveys of sensitive (i.e. CNPS-listed rare or endangered) plant species with a locational accuracy of between two and five meters. This work should be used to direct future monitoring efforts and to focus management actions on areas that are highly impacted or at high risk of impact from human foot-traffic or aggressively spreading non-native species.

4.1 Sensitive Plant Species List

We derived a list of 18 CNPS-listed special status species to look for from the CNPS Illustrated Plant List for Garrapata State Park, the California Natural Diversity Database (CNDDDB), and local expert insight (Table 5). We focused survey efforts on plants that could be confidently identified to species during the non-blooming season by novice surveyors.

Table 5. Potential special status plants present at Garrapata State Park.

Common Name	Scientific Name	CNPS Listing	Blooming Period	Found/Not Found
Little Sur Manzanita	<i>Arctostaphylos edmundsii</i>	1B.2	Dec – Jan	Found
Hooker's Manzanita	<i>Arctostaphylos hookeri</i>	1B.2	Feb – Apr	
Monterey Ceanothus	<i>Ceanothus rigidus</i>	4.2	Feb – May	Found
Pinnacles Buckwheat	<i>Eriogonum nortonii</i>	1B.3	May – Aug	
Lewis' Clarkia	<i>Clarkia lewisii</i>	1B.2	Apr – May	
Jolon Clarkia	<i>Clarkia Jolonensis</i>	4.3	Apr – June	
Seaside Painted Cup, Monterey Indian [Coast] Paintbrush	<i>Catilleja latifolia</i>	4.3	Mar – Sep	Found
Douglas' Spineflower, San Benito Spineflower	<i>Chorizanthe douglasii</i>	4.3	Apr – July	
Huchinson's Larkspur	<i>Delphinium hutchinsoniae</i>	1B.2	Apr – May	
Large-flowered Leptosiphon	<i>Leptosiphon grandiflorus</i>	4.2	Apr – July	
Monterey Pine	<i>Pinus radiata</i>	1B.1	Feb – Mar	Found
Pine Rose	<i>Rosa pinetorum</i>	1B.2	May – June	
Michael's Rein Orchid	<i>Piperia michaelii</i>	4.2	Apr – Aug	
Yadon's Rein Orchid	<i>Piperia yadonii</i>	1B.1	June – July	
Adobe Sanicle	<i>Sanicula maritima</i>	1B.1	Feb – May	
Coast [Sand-loving] Wallflower	<i>Erysimum ammophilum</i>	1B.2	Mar – June	
Nuttall's Milkvetch, Gray Locoweed	<i>Astragalus nuttallii</i> var. <i>nuttallii</i>	4.2	All year	Found
California Screw Moss	<i>Tortula californica</i>	1B.2	NA	

Abbreviations for CNPS rare plant ranks

- 1B.1 = Rare, threatened, or endangered in CA and elsewhere; >80% of occurrences threatened
 1B.2 = Rare, threatened, or endangered in CA and elsewhere; 20–80% of occurrences threatened
 1B.3 = Rare, threatened, or endangered in CA, more common elsewhere; <20% of occurrences threatened
 4.2 = Limited distribution; 20–80% threatened
 4.3 = Limited distribution; <20% threatened

4.2 Trail Surveys

Trail surveys followed the same protocols as those used for mapping invasive species. Field crews hiked every designated trail and recorded special status species within a 2-meter buffer on either side of an official, maintained trail using ESRI ArcGIS Collector. Each record included GPS location, photographic documentation, species identification, and an estimate of the number of individuals. If individual plants were distinguishable from each other and did not extend beyond the buffer zone we recorded plants as individual point features. If there were groups of plants where individuals were indiscernible, but patches began within the 2-meter buffer we recorded the species as a polygon feature.

4.3 CNDDDB Re-surveys

We re-surveyed historic occurrences of Little Sur Manzanita (*Arctostaphylos edmundsii*) based on CNDDDB data. We adapted survey techniques from CDFW (2018) to re-survey coarse-resolution polygons. We conducted surveys by moving through the polygons in a “lawn-mowing” fashion maintaining gaps of approximately 15 ft between each path wherever vegetation was not too dense to navigate through (Fig. 9). We mapped individual plants as point features and mats of manzanita were mapped as polygons using ESRI ArcGIS Collector. Each feature included the GPS location, a picture, species identification, apparent threats (i.e. invasive encroachment or foot traffic). We identified plants in the field using the Kauffmann et al. (2015) and Matthews and Mitchell (2015) field guides.

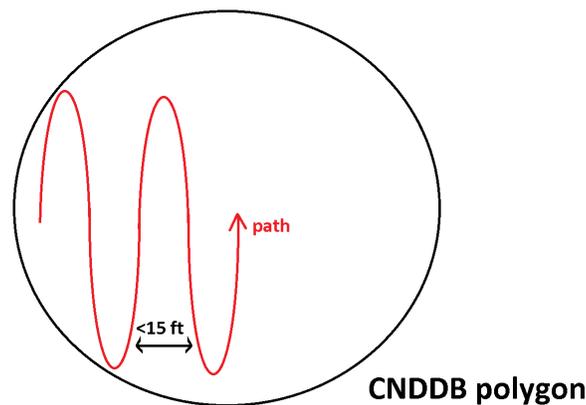


Figure 7. CNDDDB Sensitive Plant Species Surveying Methodology.

4.4 Sensitive Plant Species Mapping Results and Discussion

Five sensitive species were mapped: *Pinus radiata*, *Astragalus nuttalli* var. *nuttalli*, *Castilleja latifolia*, *Ceanothus rigidus*, and *Arctostaphylos edmundsii* (Fig. 8).

Eriogonum parvifolium was also widespread throughout the park. Although not a listed plant species itself, *E. parvifolium* is a food plant for federally endangered Smith’s Blue Butterfly, which occurs in the region encompassing GSP (Hameister 2006, based on Arnold et al. 2001).

4.4.1 *Pinus radiata* native stands

Pinus radiata was mapped in northern areas of the park (Fig. 8). Stands within the far northeastern part of the park were clearly within the native range (Bates et al. 2011). A stand in the mid-northwestern portion of the park was potentially outside the previously documented native range but was close enough to the native range (Malpaso Canyon) that it may be native. The northeastern stands were not ground-truthed because they were in difficult terrain remote from public access points. We confirmed their presence through distance observations and by looking at multiple sources of aerial and satellite imagery. The *P. radiata* stands in GSP should be monitored in the future. It would be beneficial to know how they have responded to recent fire and what competitive plant species may threaten them.

There were isolated instances of *P. radiata* along the Rocky Ridge trail as well as in other southern coastal areas. In these locations well south of Malpaso Creek, *P. radiata* is perhaps outside its native range and may be considered non-native. Notably, *P. radiata* was present by an area of *Arctostaphylos edmundsii*, along with a large stand of *Acacia longifolia* – where both tree species are encroaching on *Arctostaphylos edmundsii*.

4.4.1 *Astragalus nuttalli* var. *nuttalli* and *Castilleja latifolia*

Astragalus nuttalli var. *nuttalli* and *Castilleja latifolia* were mapped primarily in coastal areas west of Highway 1. They are being encroached by *Carpobrotus* spp. In several areas.

4.4.2 *Ceanothus rigidus*

Numerous individuals of *Ceanothus rigidus* were mapped in a single area on the spur descending from Doug Peak north down into Malpaso canyon. It occurred in a *Ceanothus thyrsiflorus* stand along with *Arctostaphylos glandulosa*., directly west of a large *Sequoia sempervirens* stand. It is possible that finer-scale mapping could divide the *C. thyrsiflorus* stand into separate stands.

4.4.3 *Arctostaphylos edmundsii*

Arctostaphylos edmundsii was first described in the area in 1964 and 1966 in the vicinity of the Highway 1 bridge over Garrapata Creek, about 200 ft south of GSP (CNDDDB records). The first documentation of colony of *A. edmundsii* within GSP itself was in 2014 on the west side of the highway (CNDDDB record by M. Brodie), and then in 2016 on the east side of the highway (CNDDDB/CalFlora record by M. Hyland). The location data for both of these records was approximate, with an accuracy

of a few hundred feet. A much more accurate GPS point survey was conducted in 2019 (Kwan–Davis 2019), and our 2020 survey supplemented Kwan–Davis’ survey with additional points, attributes, and polygon outlines of the larger patches.

We found *A. edmundsii* within the same areas as Kwan–Davis (Fig. 9). There is no clear evidence yet of contraction of the range within GSP, but there is a strong evidence of imminent range contradiction or extirpation due to competition with rapidly expanding stands of *Acacia longifolia*, some isolated *Pinus radiata* and *Hesperocyparis macrocarpa*, and trampling by people seeking privacy near parked cars on the east side of the highway.

There is some uncertainty in the identification of some *Arctostaphylos* individuals in the area, but it seems clear that all the *Arctostaphylos* west of the highway are *A. edmundsii*, and likely that most of the *Arctostaphylos* east of the highway are *A. edmundsii*. Some individuals east of the highway have an erect form and may be *A. crustacea* ssp. *rosei*. Further identification work is warranted.

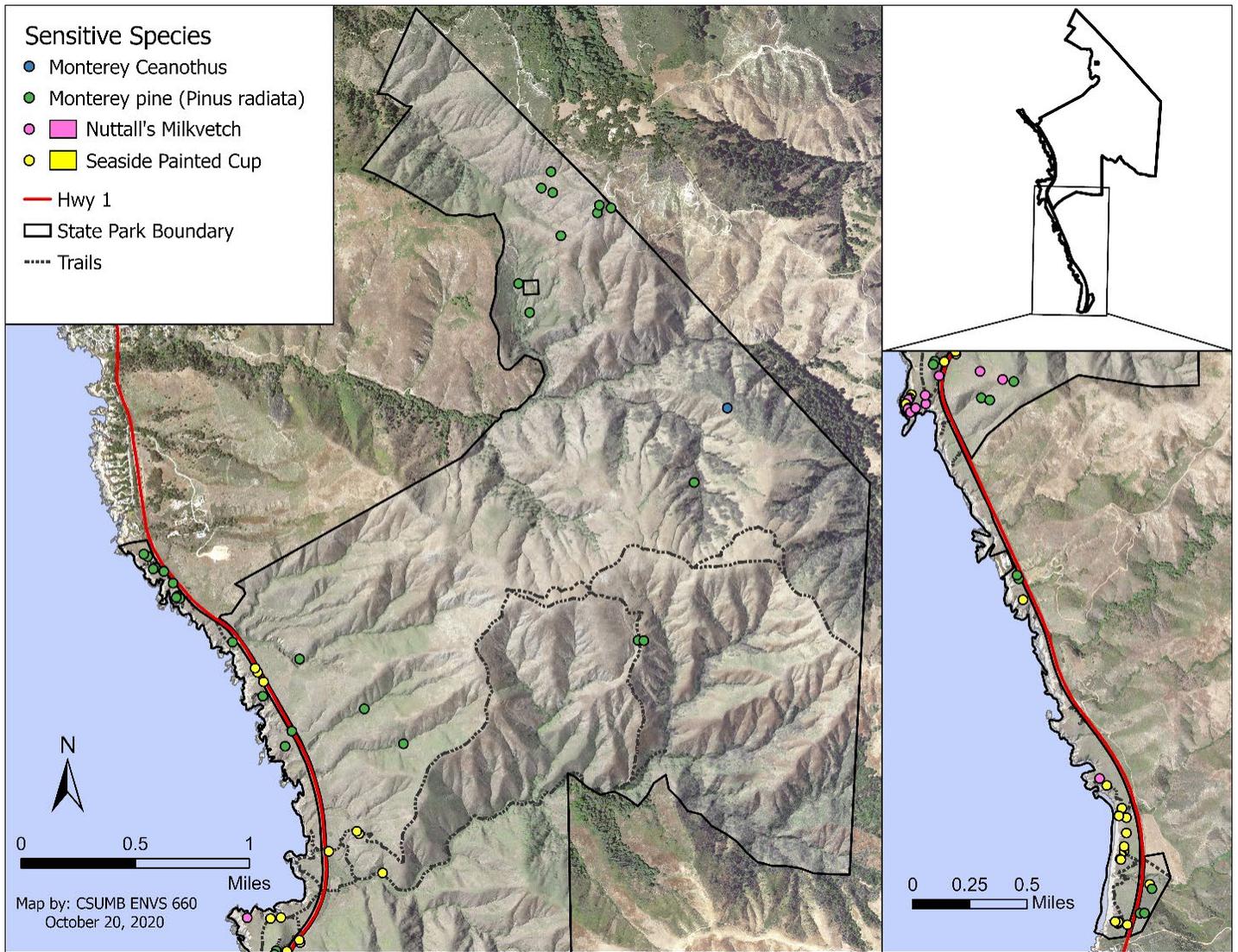


Figure 8. Sensitive plant species detectable in fall in Garrapata State Park.

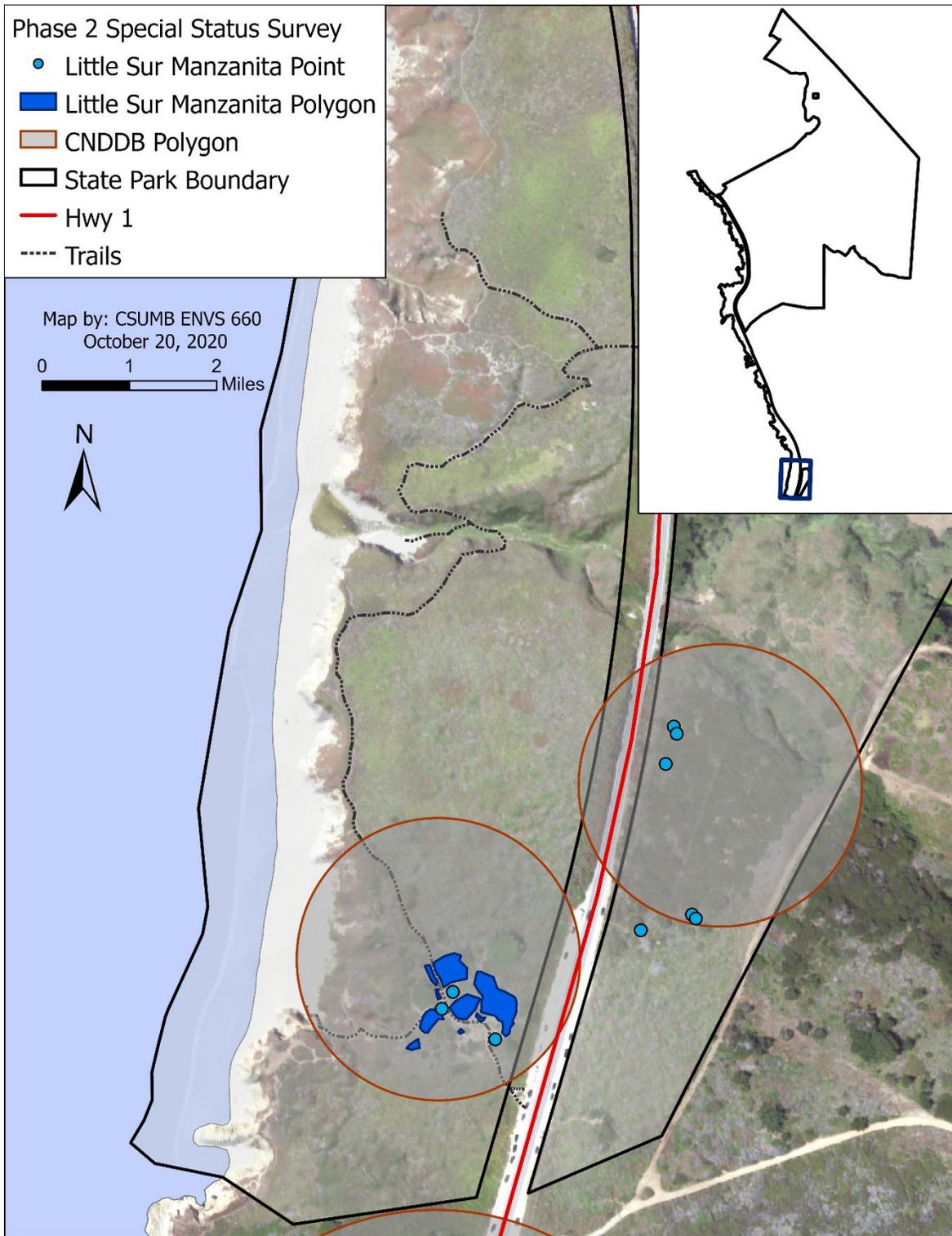


Figure 9. *Arctostaphylos edmundsii* (Little Sur Manzanita) in Garrapata State Park. Some individuals east of the highway may be *A. crustacea* ssp. *rosei*.

5 Management Recommendations and Future Monitoring

Future work should include both further monitoring and management of vegetation.

Monitoring should:

- Increase the precision of vegetation community mapping to include:
 - GIS mapping at the level of floristic *associations*, i.e. finer than *alliances*.
 - Field survey at the level of *relevés*, where the relative abundance of all plant species is recorded i.e. more detailed than *reconnaissance* points that just record the dominant species cover.
 - Review of the local rarity and conservation significance of potentially important alliances such as the perennial bunchgrass alliances that are indicative of California coastal prairie.
 - Closer study of the level of threat posed by *Carpobrotus* to *Astragalus nuttallii* var. *nuttalli* and *Castilleja latifolia*.
 - Survey in spring for invasive and sensitive plants that could not be identified in fall
 - Survey in spring for alliances that are difficult to detect in spring, such as specific annual grass alliances, as well as the *Eschscholzia (californica) – Lupinus (nanus)* Herbaceous Alliance (California poppy – lupine fields).
- Management should:
 - Remove invasive species that threaten sensitive species – particularly *Acacia longifolia* that threaten *Arctostaphylos edmundsii* and *Carpobrotus* spp. that threaten *Castilleja latifolia* and *Astragalus nuttalli* var. *nuttalli*.
 - Attempt to control native species that threaten natural communities – such as *Ageratina adenophora* that threaten lowland riparian communities and upland springs, and *Cortaderia* spp. That threaten a variety of coastal shrub and *Baccharis pilularis* communities.

Specific areas for future monitoring and management are described in more detail as follows.

5.1.1 *Arctostaphylos edmundsii*

Arctostaphylos edmundsii that occurs adjacent to Garrapata State Beach is under immediate threat by several invasive species, particularly *Acacia longifolia* and *Carpobrotus edulis*. As resource management field crews prepare to manage the *Acacia longifolia* in this area, they should pay special attention to identification and avoidance of the *Arctostaphylos edmundsii* individuals that remain beside and beneath the exotic stands located here. Symbolic fencing appears to have been recently installed west of the highway and this appears to be effectively controlling trampling of *Arctostaphylos edmundsii*. But in the absence of foot-traffic, *Acacia longifolia* appears to be outcompeting *Arctostaphylos edmundsii* in the race to establish in bare-ground areas behind fences. There are small areas east of the highway where foot traffic continues to urination areas that overlap *Arctostaphylos edmundsii*, and sturdy fencing could be installed to prevent this.

5.1.2 California coastal prairie

Native California grasslands are highly threatened ecosystems (Hayes & Holl 2011). Almost all the grasslands we visited were dominated by non-native annual grasses. We found a few small stands of native bunchgrasses on Rocky Ridge. Some were characterized by *Nassella pulchra* and others by *Elymus glaucus*. The pattern differed from neighboring Palo Corona Regional Park (PCRP), where Hepburn et al. (2013) mapped larger areas of "California coastal prairie" characterized by native bunchgrasses. This is probably related to the fact that PCRP is grazed by cattle, which presumably has altered both grass species composition and detectability. We visited a large coastal prairie stand in PCRP; *Nassella pulchra* were not particularly more or less abundant than in much of the grasslands dominated by non-native annuals in GSP, and we did not find *Elymus glaucus*.

State Parks should prioritize identifying and protecting additional stands of native grasses given that they are very difficult to restore (Hayes & Holl 2011).

5.1.3 Invasive Hotspots

We detected several stands of invasive species that we considered "hotspots" throughout the park. The following invasive species were abundant enough in some areas that they were mapped as stands exceeding the 0.25 acre minimal mapping unit: *Acacia longifolia*, *Cortaderia* spp. (Cal IPC rating = high), *Ageratina adenophora* (Cal IPC rating = moderate), *Brassica nigra* (Cal IPC rating = moderate), *Echium candicans* (Cal IPC rating = limited), *Opuntia* spp. (Cal IPC rating not available), and *Carpobrotus* spp. (Cal IPC rating varies by species). Additionally, *Delairea odorata* (Cal IPC rating =

high) was widespread but never simultaneously dominant and extensive enough to be considered a 'stand'.

We recommend that *Cortaderia* spp. removal be prioritized due to its high IPC rating, encroachment on southern coastal alliances, and relative feasibility of removal. If resources are not available to begin removal of these stands soon, the Natural Resources Division, future graduate students, or interns should at least monitor these locations periodically to measure their rate of invasion.

We found abundant stands of *Ageratina Adenophora* throughout the park. It was perhaps most abundant in the riparian zone of Soberanes Creek but most dominant in numerous steep upland gullies. Each time we entered these dense gully stands, we found running water completely concealed beneath the *Ageratina*. The stands may rely on small springs, which they completely shade, causing water to flow at the surface rather than evaporate as might be the case if the gullies were vegetated with willows. *Ageratina* is also widespread as a component dense of *Baccharis pilularis* stands. We observed that where *Ageratina* is present, native plants appear noticeably less healthy compared to those found in non-infested areas.

Ageratina adenophora has invaded much of GSP and surrounding areas (Hepburn et al. 2013) and may be continuing to spread. State Parks staff should remain vigilant with monitoring and management of this species. Further study is required in order to identify the specific ways in which this weed may be impacting natural biodiversity and ecosystem function.

5.1.4 *Eriogonum parvifolium*

Eriogonum parvifolium occurs throughout Garrapata State Park, occasionally as a stand (classified within the *Eriophyllum staechadifolium* – *Erigeron glaucus* – *Eriogonum latifolium* Herbaceous Alliance), but more often as a sub-dominant within very widespread stands of *Lotus scoparius*, for example. Although not itself listed, it is a food plant for the federally listed, endangered Smith's blue butterfly (*Euphilotes enoptes smithi*), which occurs throughout the region that includes GSP (Hameister 2006, based on Arnold et al. 2001). Garrapata State Park is listed as the location of the Safe Harbor Agreement issued for *E. enoptes smithi* by the U.S. Fish and Wildlife Service beginning in 2015 (USFWS 2020). For *E. enoptes smithi* populations to maintain viability, they need healthy populations of their host plant, coastal habitats with appropriate levels of disturbance regimes to support these plants, and connectivity between occupied spaces to facilitate natural recolonization. The primary threat to *E. enoptes smithi* is habitat loss caused by invasive, nonnative vegetation. Other threats include sea level rise and wildfire (USFWS VFWO 2020).

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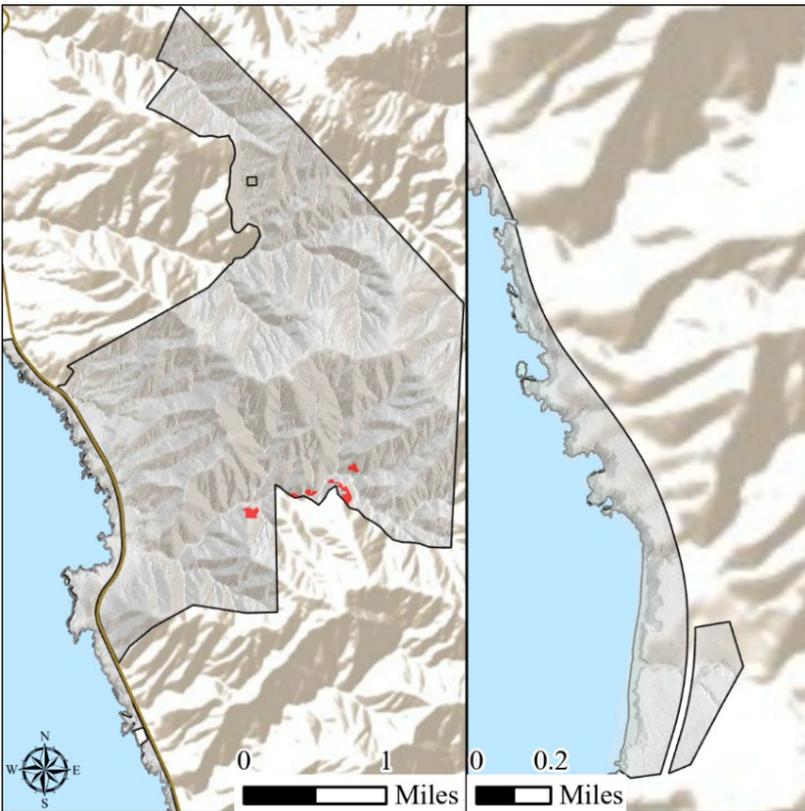
Appendix A. Scope of Work

- Client: CA Dept of Parks & Rec.
 - Matthew Allen: Senior Environmental Scientist Supervisor
- Collaborators/advisors:
 - CA Dept of Fish & Wildlife VegCAMP program.
 - Diana Hickson, Rachelle Boul, et al.
 - CNPS
 - Julie Evens, Jennifer Buck-Diaz, et al.
- Initial brief from client
 - Map vegetation communities
 - Map invasive plants
 - Map special status plants
 - List potential focus items for a future management plan e.g. "eradicate weed X"
- Final products
 - Public online report
 - Oral presentation to client & collaborators
 - Web-posted data set: GDB, XLSX, photos
- Examples of past projects: <http://sep.csumb.edu/class/ENVS660/>

Appendix B: Description of Vegetation Alliances and Mapping Units

The 41 vegetation alliances and other mapping units used to map vegetation communities within Garrapata State Park are described in the following pages.

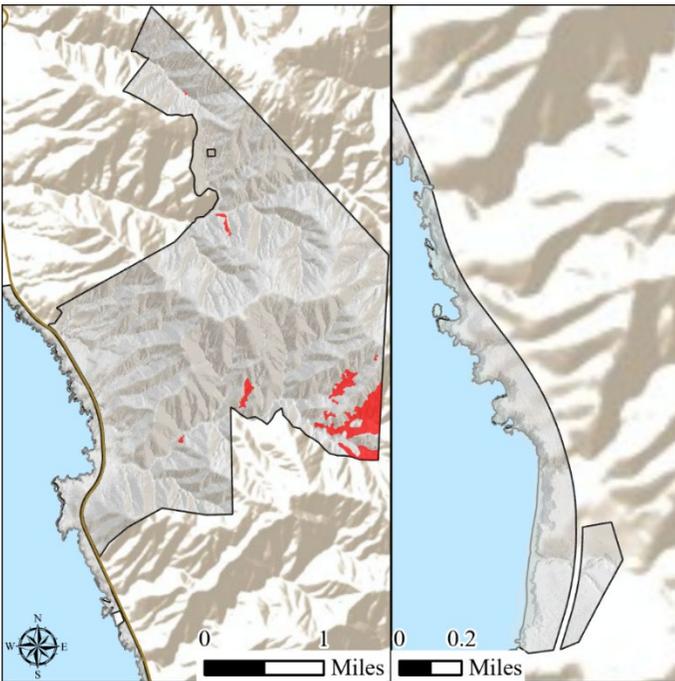
1110 – *Umbellularia californica* Forest & Woodland Alliance



DESCRIPTION: The *Umbellularia californica* alliance only occurs in the study area in small stands adjacent to *Sequoia sempervirens* stands. This alliance is characterized by greater than 50% relative cover of *U. californica* in the overstory in either the tree or shrub layer (Klein et al. 2007).

State Rarity: **S3** Global Rarity: **G4**

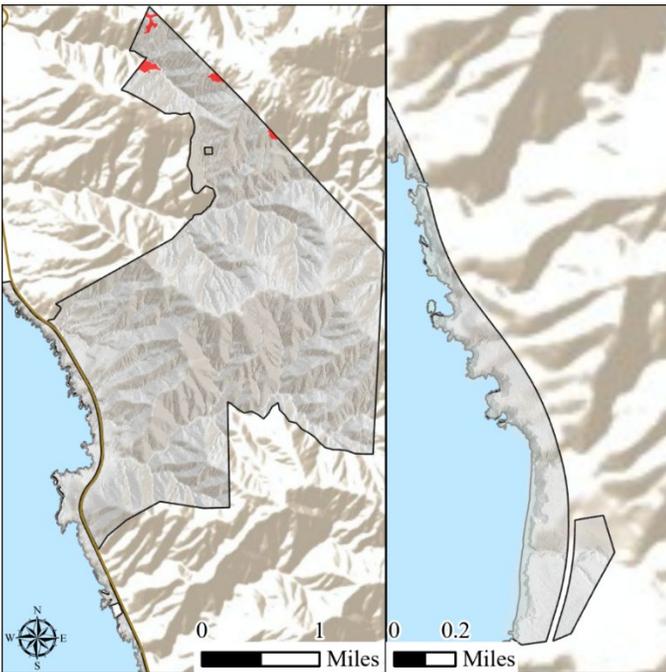
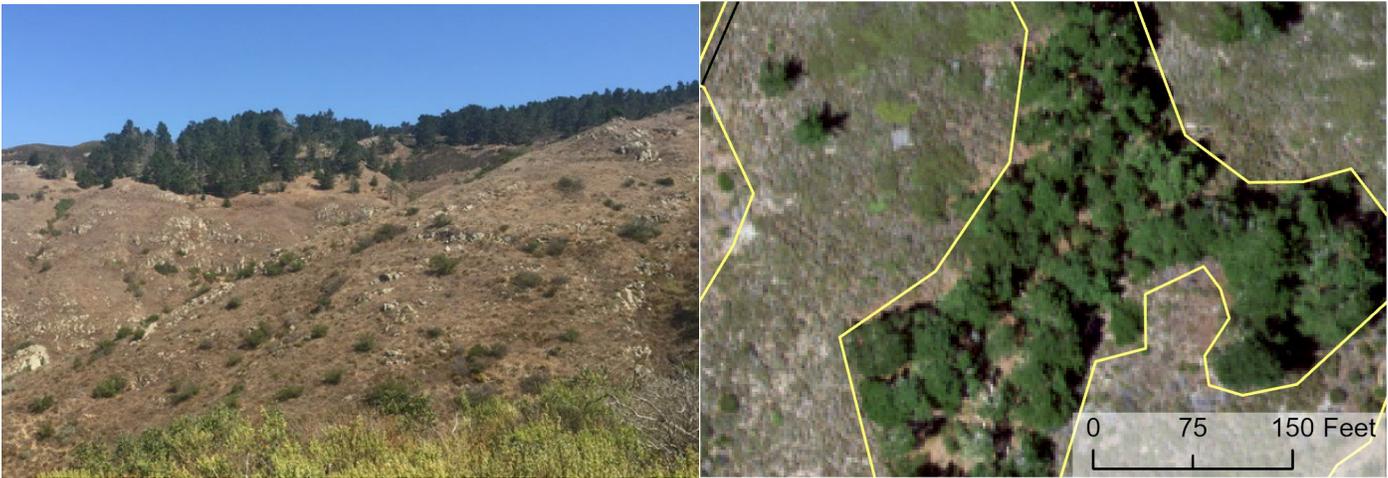
1120 – *Quercus agrifolia* Forest & Woodland Alliance



DESCRIPTION: Often found upland of *Sequoia sempervirens* stands, primarily in the southern portion of the study area near Soberanes Creek, the *Quercus agrifolia* alliance is assigned where *Q. agrifolia* is greater than 50% relative cover in the tree layer, or less than 33% relative cover in the tree layer when *Umbellularia californica* is present (Keeler-Wolf et al. 2003a, Evens and San 2004, Keeler-Wolf and Evens 2006)

State Rarity: **S4** Global Rarity: **G5**

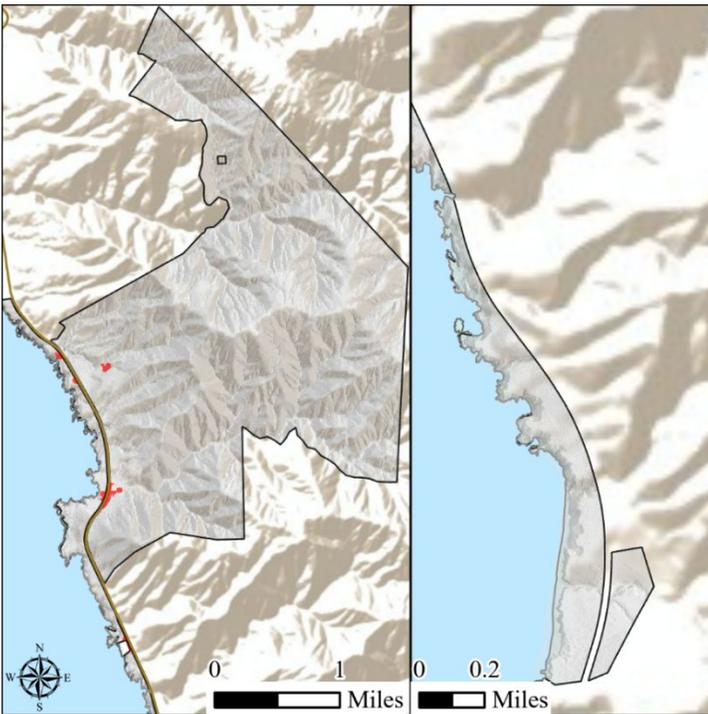
1210 – *Pinus muricata* – *Pinus radiata* Forest & Woodland Alliance



DESCRIPTION: Stands with greater than 25% cover of *Pinus radiata* are designated as a *Pinus muricata*-*Pinus radiata* alliance (Sawyer and Keeler-Wolf 1995). This alliance is mapped within the known **native** range of *Pinus radiata* in northeastern section of the park, as well as in the mid-northwest where there is a stand that is **possibly** within the native range (not shown on the above map).

State Rarity: **S3.2** Global Rarity: **G3**

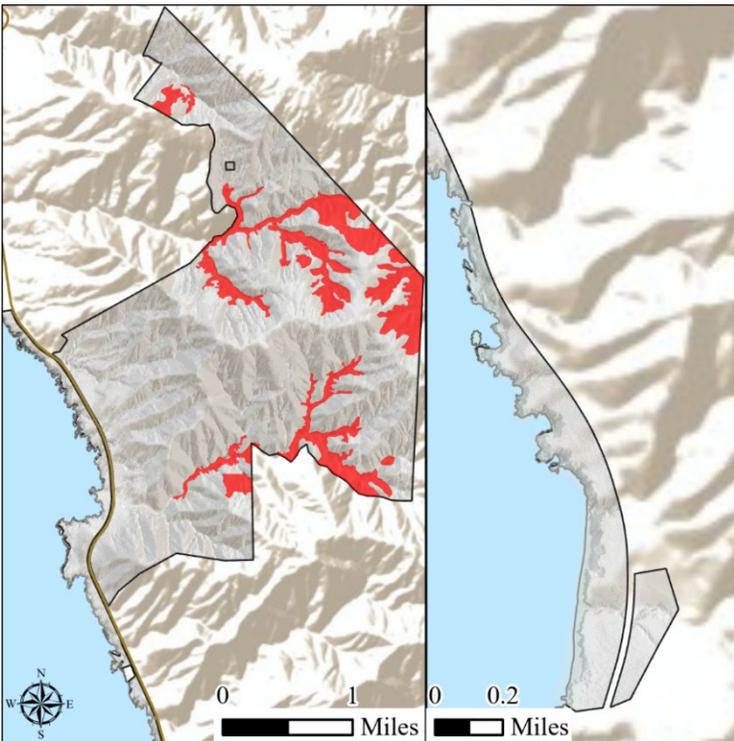
1220 – *Hesperocyparis macrocarpa* – *Pinus radiata* Semi-Natural Alliance



DESCRIPTION: Mapped where non-native *Hesperocyparis macrocarpa* has greater than 50% coverage in the tree layer or where non-native *Pinus radiata* has greater than 25% coverage in the tree layer. This mapping unit is present in four stands of *H. macrocarpa* along Highway 1, possibly joined by one stand of *P. radiata* for which the native status is uncertain (in the mid-northwest on the eastern side of the highway).

State Rarity: N/A Global Rarity: N/A

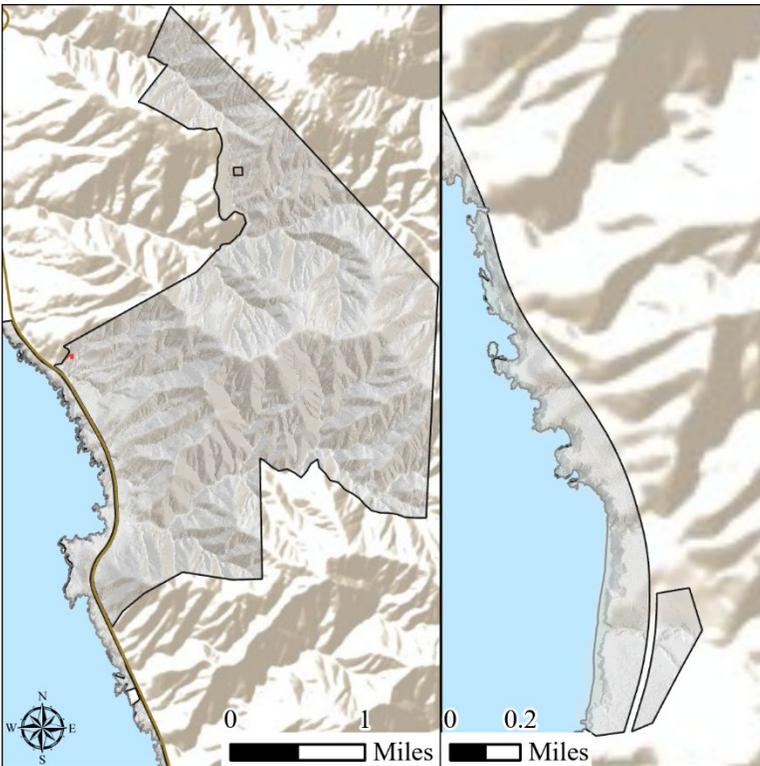
2110 – *Sequoia sempervirens* Forest & Woodland Alliance



DESCRIPTION: The *Sequoia sempervirens* alliance is mapped where *S. sempervirens* has greater than 50% relative cover in the tree canopy (Keeler-Wolf et al. 2003a, Evens and Kentner 2006). This alliance is mainly present in the study area along Malpaso and Soberanes creeks and their tributaries, with several stands in other riparian areas.

State Rarity: **S3.2** Global Rarity: **G3**

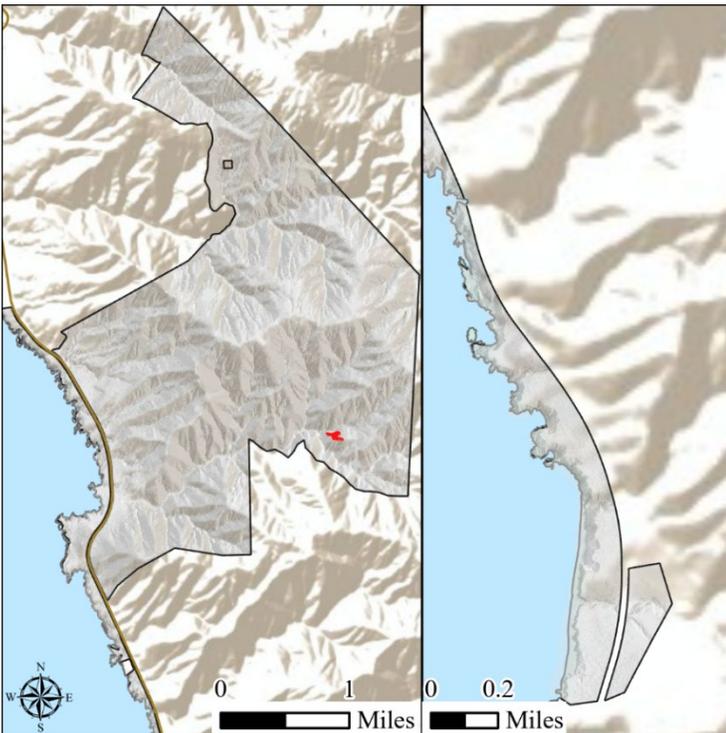
2210 - *Eucalyptus* spp. - *Ailanthus altissima* - *Robinia pseudoacacia* Woodland Semi-Natural Alliance



DESCRIPTION: We mapped one stand of this alliance, designated by *Eucalyptus* spp. having greater than 80% cover in the tree canopy (cf. Evens and San 2005, Klein and Evens 2005, Keeler-Wolf and Evens 2006), near the northwest park boundary east of Highway 1.

State Rarity: **GNA** Global Rarity: **GNA**

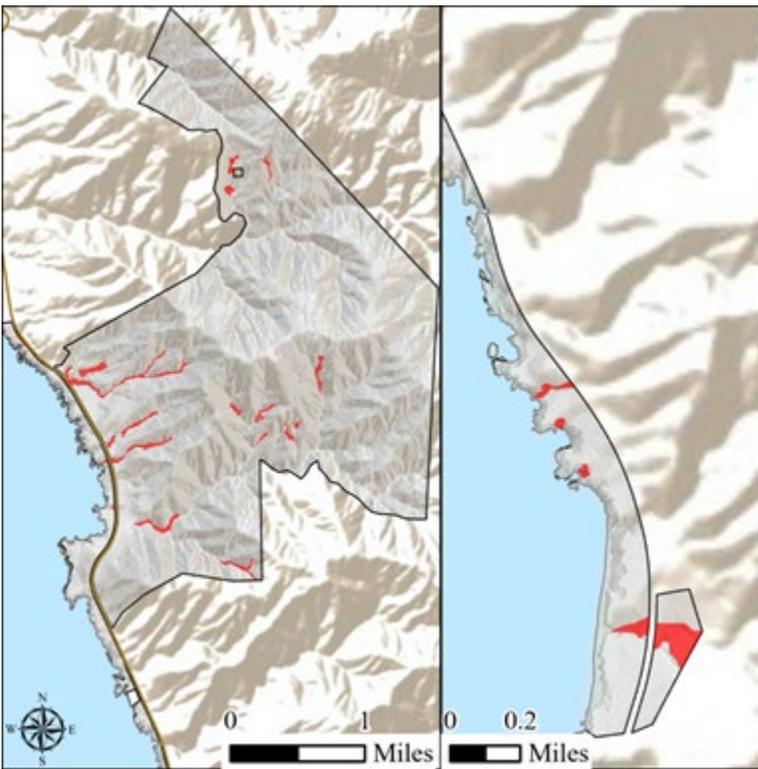
2310– *Arbutus menziesii* Forest Alliance



DESCRIPTION: We only mapped one *Arbutus menziesii* stand, and while we did not ground-truth it, we encountered several *Arbutus menziesii* individuals and observed this stand from a distance. The stand was adjacent to *Sequoia sempervirens* stands along upper Soberanes Creek. The alliance is mapped where *A. menziesii* is greater than 50% relative cover in the tree layer (Evens and Kentner 2006).

State Rarity: **S3.2**. Global Rarity: **G4**

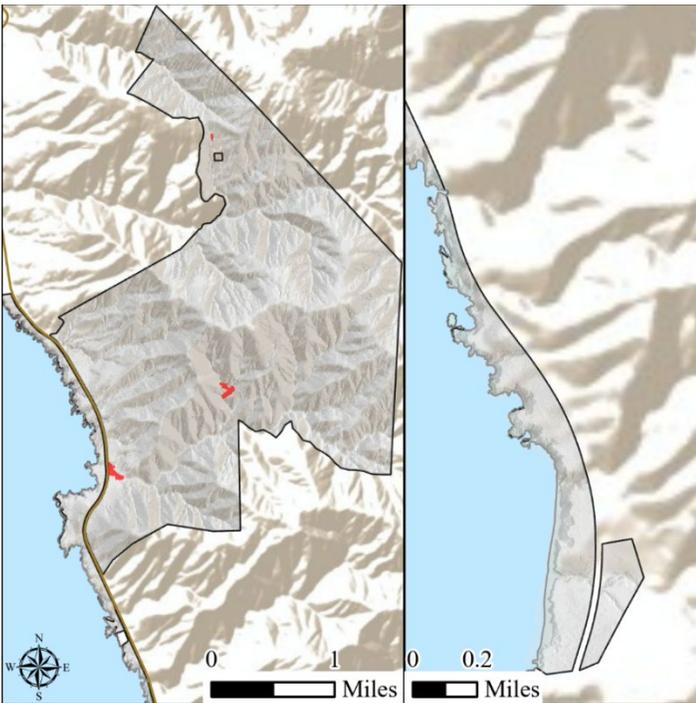
3110 – Willow Mapping Unit



DESCRIPTION: The willow mapping unit was assigned where any *Salix* species had greater than 50% relative cover in the tree canopy. *Salix* was found in riparian areas, mostly at lower elevations on the western side of the study area. Willow stands often had high *Ageratina adenophora* cover at the herbaceous level.

State Rarity: N/A Global Rarity: N/A

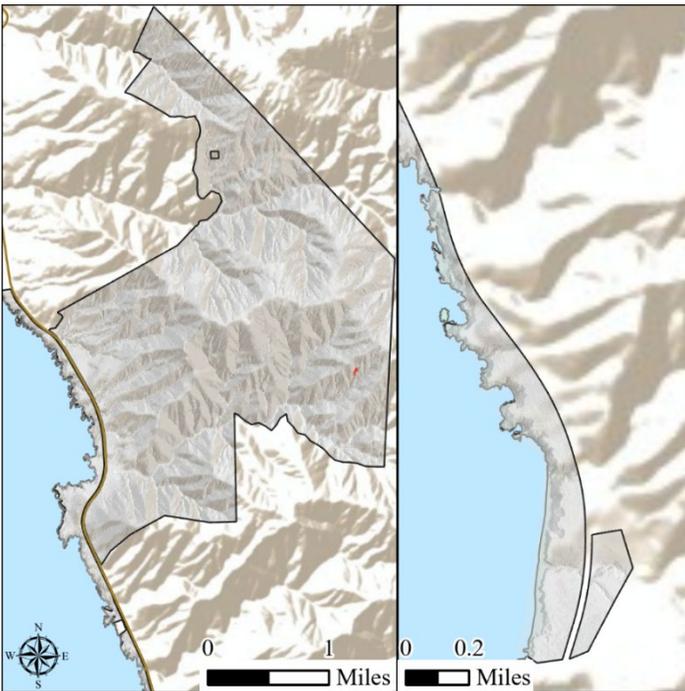
3120 – *Populus trichocarpa* Forest & Woodland Alliance



DESCRIPTION: An uncommon alliance in the study area, stands of *Populus trichocarpa* have greater than 30% coverage in the tree canopy along persistent streams (VegCAMP 2020) and are found in lowland riparian habitat, often adjacent to willow stands. (Notes: (1) The stand mapped in the middle of the park was not ground-truthed and may instead be *Umbellularia*. (2) The stand mapped in the west could be split in two. It has *Populus* in its western half, and *Salix* in the eastern half)

State Rarity: **S3** Global Rarity: **G5**

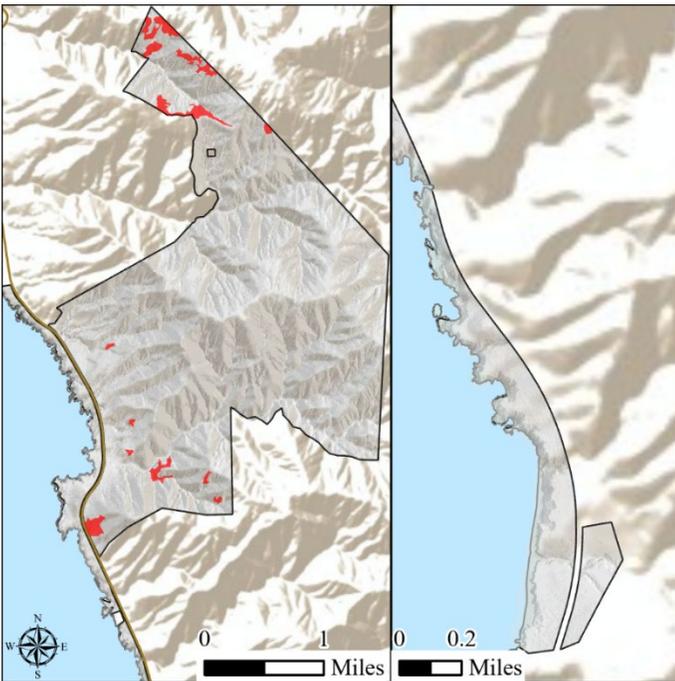
3210 – *Platanus racemosa* – *Quercus agrifolia* Woodland Alliance



DESCRIPTION: This alliance occurs where *Platanus racemosa* has greater than 30% relative cover in the canopy layer, possibly codominant with *Quercus agrifolia*, *Salix* species, or *Populus fremontii* (Evens and San 2005, Klein and Evens 2005, Keeler-Wolf and Evens 2006, Stillwater Sciences and URS 2007). We only located one stand of *P. racemosa* within GSP, found in an upland riparian area adjacent to a *Q. agrifolia* stand. We did not ground-truth it, but we did visit a *P. racemosa* stand nearby just east of the GSP boundary in PCR.

State Rarity: **S3**. Global Rarity: **G3**

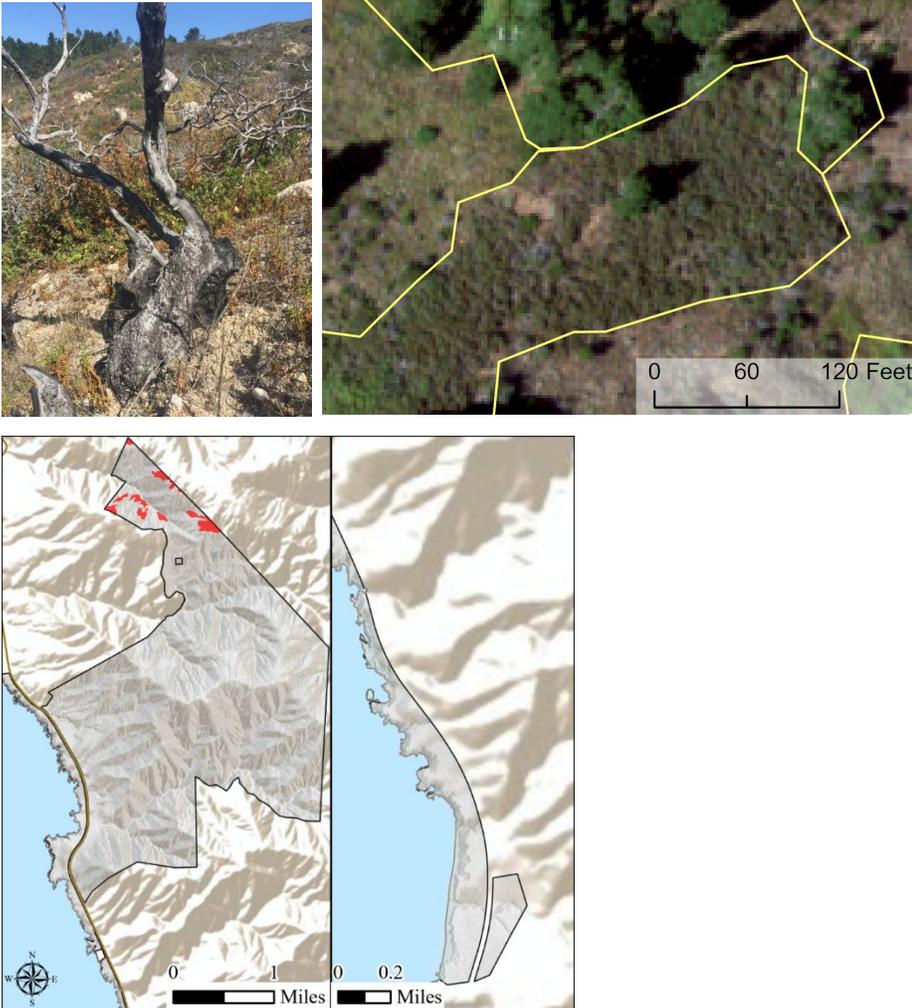
4110 – *Adenostoma fasciculatum* Shrubland Alliance



DESCRIPTION: This alliance was assigned where *Adenostoma fasciculatum* is greater than 50% relative cover in the shrub layer and not codominant with *A. sparsifolium*, *Arctostaphylos glauca*, *A. glandulosa*, *Ceanothus crassifolius*, *C. cuneatus*, and *C. greggii* (cf. Keeler-Wolf et al. 1998b). While scattered patches are present in the southern half of the mapping area, *A. fasciculatum* stands were larger and more prevalent in the northeastern portion of the park. Ground-truthing of the northeastern ones was limited by steep terrain remote from public access points.

State Rarity: **S5**. Global Rarity: **G5**

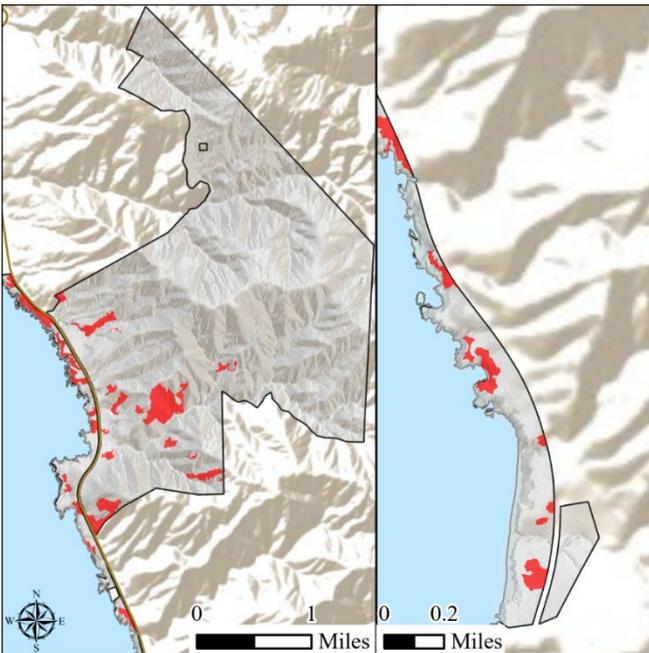
4210 – *Arctostaphylos glandulosa* Shrubland Alliance



DESCRIPTION: This alliance is mapped where *Arctostaphylos glandulosa* has greater than 60% relative cover in the shrub canopy (Gordon and White 1994, Borchert et al. 2004, Klein and Evens 2005, Keeler-Wolf and Evens 2006) or where both *A. glandulosa* and *Adenostoma fasciculatum* have between 30% and 60% relative cover (Gordon and White 1994, Borchert et al. 2004, Evens and San 2005, Klein and Evens 2005, Keeler-Wolf and Evens 2006). This alliance was present exclusively in the northeastern section of the park, where *A. glandulosa* is often codominant with *Adenostoma fasciculatum* on slopes and ridges in previously burned areas. Some *Arctostaphylos crustacea* may also occur in these areas (and were assumed to occur by Hepburn et al. (2013) based on location alone) and we had limited opportunity for field verification, but the samples we collected in the area all keyed out to *A. glandulosa* under a compound microscope.

State Rarity: **S4**. Global Rarity: **G4**

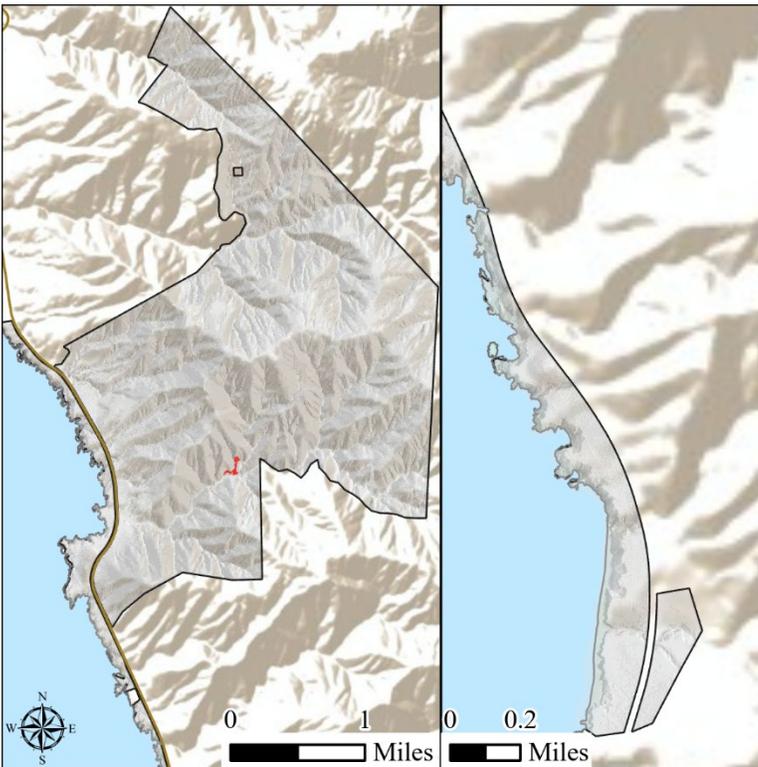
5110 – *Artemisia californica* – (*Salvia leucophylla*) Shrubland Alliance



DESCRIPTION: A common alliance along the coast and on the western slopes of the parks, *Artemisia californica* often grows in the study area in areas with *Baccharis pilularis* and *Toxicodendron diversilobum*. This alliance is mapped where *A. californica* has greater than 60% relative cover in the shrub layer (Gordon and White 1994, Borchert et al. 2004), or where *A. californica* is codominant with *B. pilularis* and has at least thrice the abundance (Keeler-Wolf et al. 2003).

State Rarity: **S5** Global Rarity: **G5**

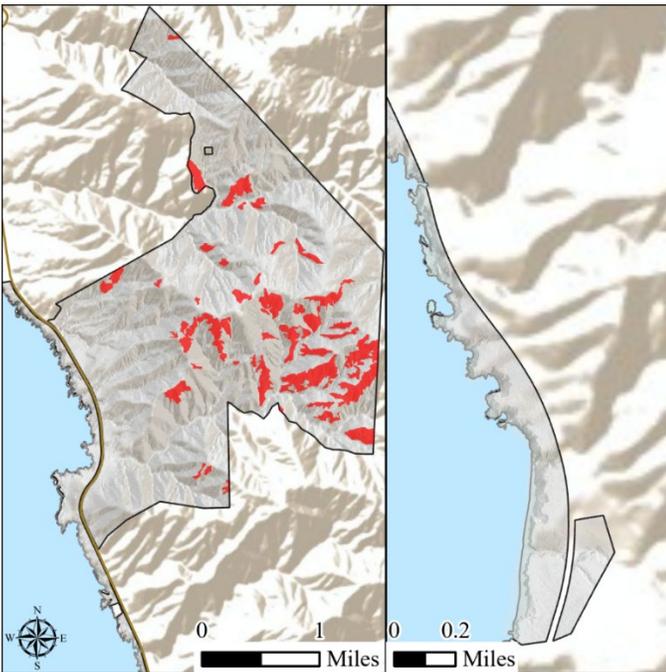
5120 – *Diplacus aurantiacus* Shrubland Alliance



DESCRIPTION: Only one stand of *Diplacus aurantiacus* was mapped in the study area, found in bottomland habitat off the Soberanes Canyon trail. This alliance is assigned where *D. aurantiacus* has greater than 50% relative cover in the shrub layer (Keeler-Wolf and Evens 2006).

State Rarity: **S3?** Global Rarity: **G3**

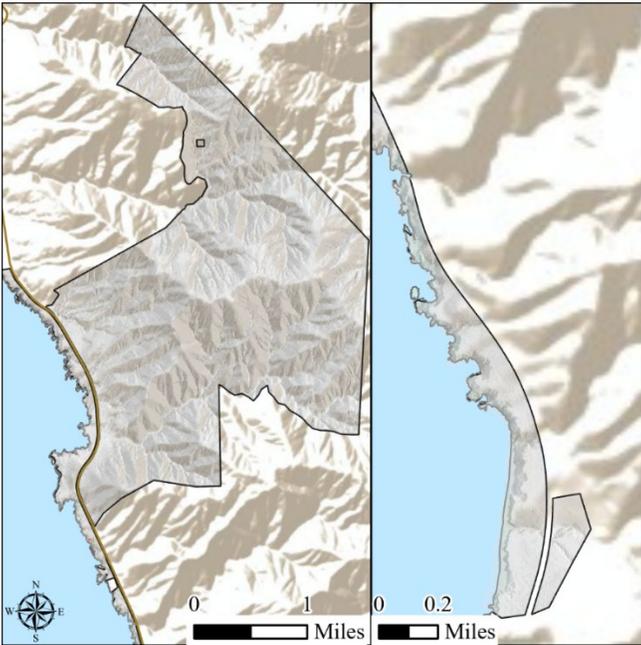
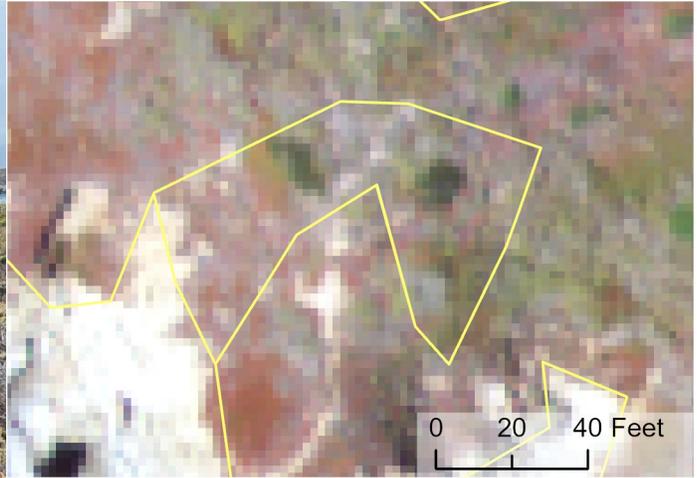
5130 – *Lotus scoparius* Shrubland Alliance



DESCRIPTION: This alliance is mapped where *Lotus scoparius* has greater than 50% relative cover in the shrub canopy (Evens and San 2005, Keeler-Wolf and Evens 2006, Klein and Evens 2005). A widespread alliance in the study area, *L. scoparius* was found primarily on slopes and at higher elevations among grassland habitat. It is often codominant with *Lupinus chamissonis* and *Ericameria ericoides*.

State Rarity: S5 Global Rarity: G5

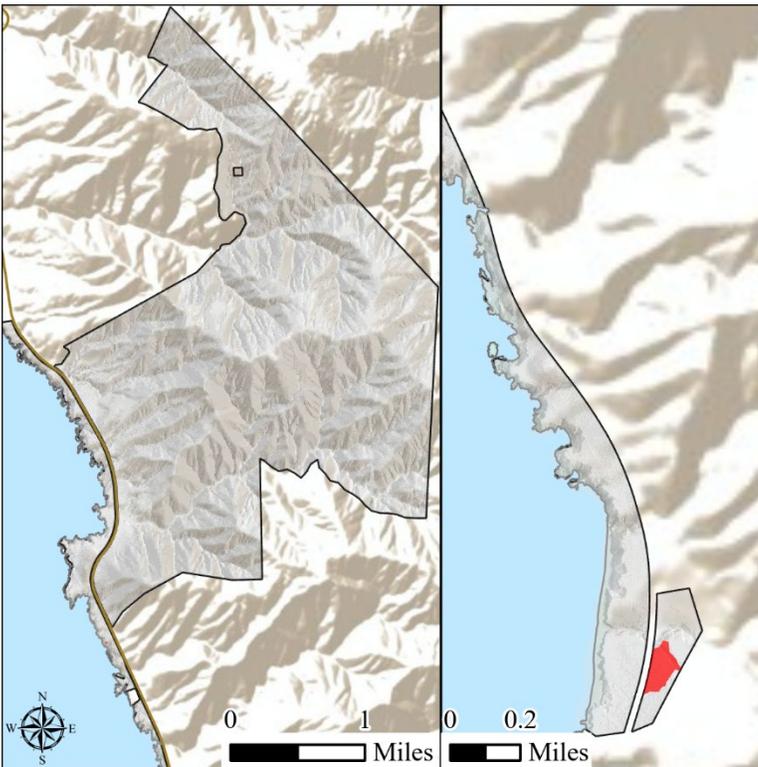
5140 – *Salvia mellifera* Shrubland Alliance



DESCRIPTION: This alliance is mapped where *Salvia mellifera* has greater than 50% relative cover, or greater than 30% relative cover when *Rhus integrifolia* or *Opuntia littoralis* is present (Rodriguez et al. 2019). We mapped one stand of *Salvia mellifera* along the coast where it grows alongside a stand of *Artemisia californica*.

State Rarity: **S4** Global Rarity: **G4**

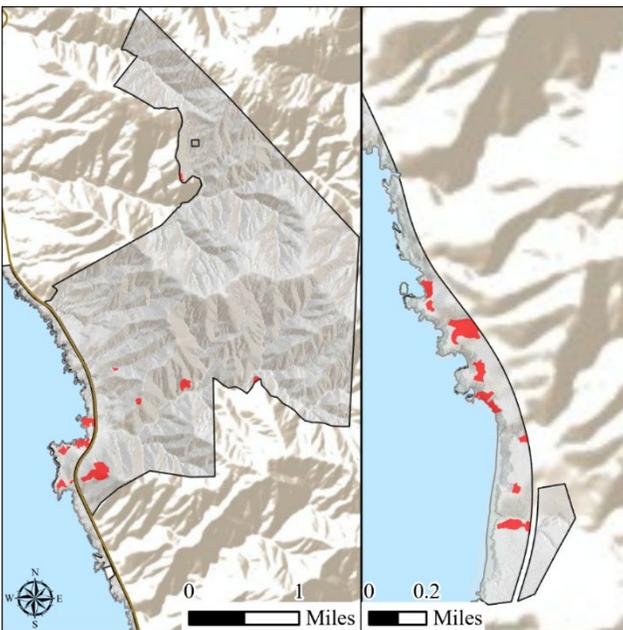
5150 – *Acacia* spp. – *Grevillea* spp. – *Leptospermum laevigatum* (Pending)



DESCRIPTION: Mapped where *Acacia* spp. has greater than 50% relative cover in the shrub layer, this mapping unit is present in two locations in the far south of the study area where *Acacia longifolia* encroaches on areas of *Arctostaphylos edmundsii*.

State Rarity: N/A Global Rarity: N/A

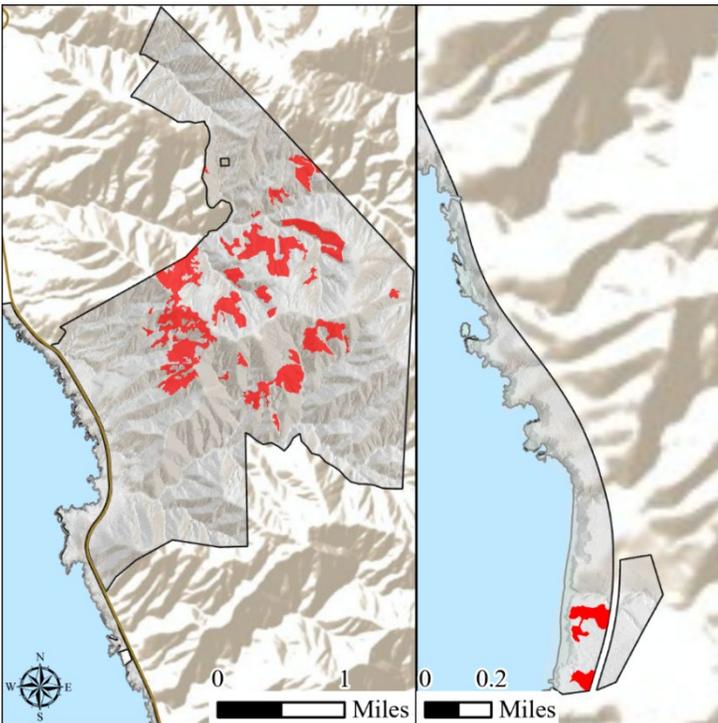
6110 – *Eriophyllum staechadifolium* – *Erigeron glaucus* – *Eriogonum latifolium* Herbaceous Alliance



DESCRIPTION: Present mostly along the coast with only a few upland stands in the mapping area, this alliance is assigned where (perhaps confusingly) *Erigeron parvifolium* is greater than 50% relative cover in the herbaceous layer (WRA 2017) or where *Erigeron glaucus*, *Eriophyllum staechadifolium*, *Fragaria chiloensis*, and/or *Eriogonum latifolium* has greater than 50% relative cover in the herbaceous layer, while shrubs may be present at low cover (Buck-Diaz et al. 2020). *Erigeron parvifolium* was widespread as a species, but only infrequently as a stand-defining species.

State Rarity: S3 Global Rarity: G3

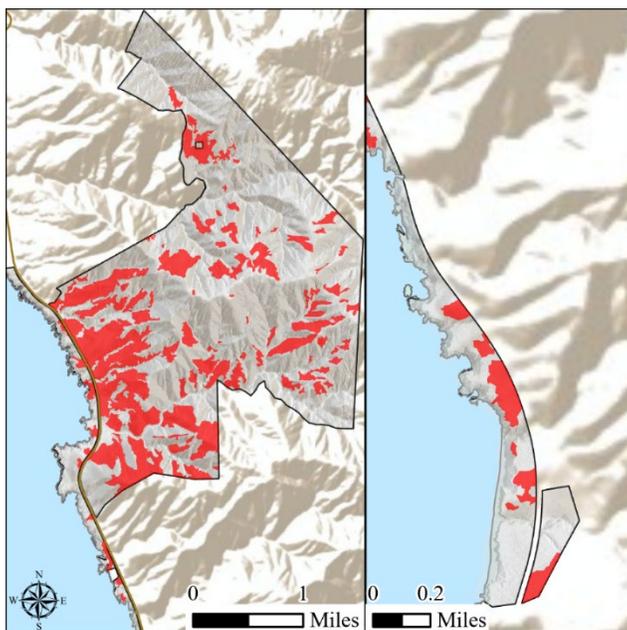
6120 – *Lupinus chamissonis* – *Ericameria ericoides* Shrubland Alliance



DESCRIPTION: This alliance is mapped where either *Lupinus chamissonis* or *Ericameria ericoides* is conspicuous (Keeler-Wolf et al. 2003a), although the two species frequently grow together in the study area. This alliance is widespread in the park, typically on slopes at mid-to-high elevations, often codominant with *Baccharis pilularis*, *Eriogonum parvifolium*, or *Lotus scoparius*.

State Rarity: **S3**. Global Rarity: **G3**

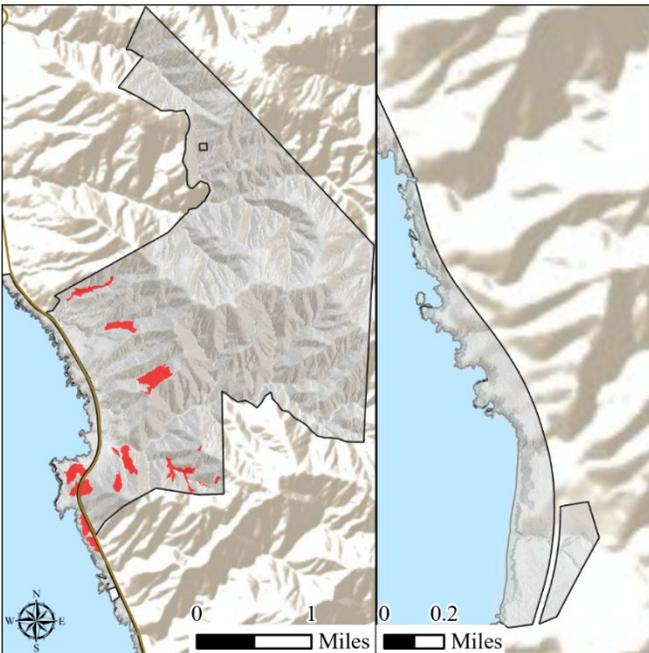
6130 – *Baccharis pilularis* Shrubland Alliance



DESCRIPTION: The most widespread alliance in the study area, this alliance is mapped where *Baccharis pilularis* has greater than 50% absolute cover in the shrub layer (Borchert et al. 2004) or greater than 15% cover over grassy understory (Keeler-Wolf et al. 2003a). Often codominant with *Artemisia californica*, *Diplacus aurantiacus*, or *Toxicodendron diversilobum*, stands of *B. pilularis* are found at all elevations in the study area, but are more prevalent at lower elevation and on north-facing slopes.

State Rarity: **S5** Global Rarity: **G5**

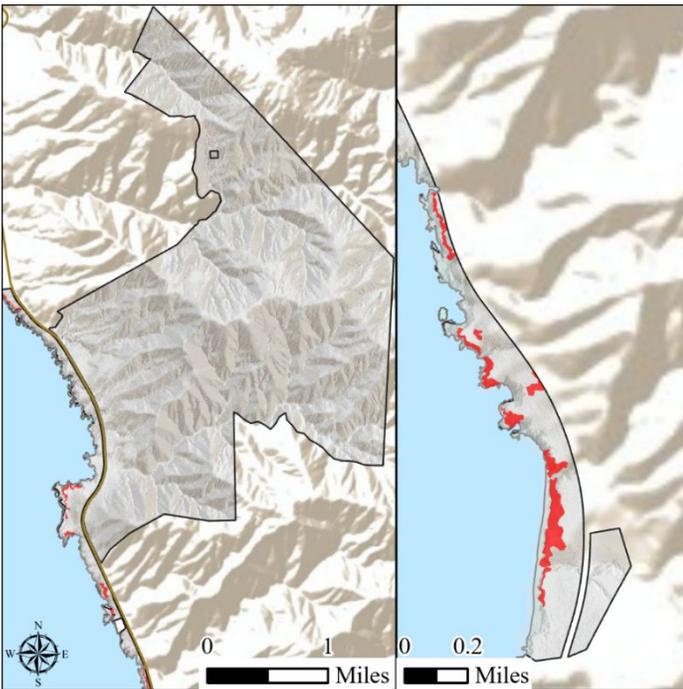
6140 - *Frangula Californica* - *Rhododendron occidentale* - *Salix breweri* Shrubland Alliance



DESCRIPTION: This alliance is mapped where *Frangula californica* has greater than 50% relative cover in the shrub canopy and greater 8% absolute cover (Evens and San 2004). Stands in the mapping area are found along the coast and on north-facing slopes in the western half of the park, often adjacent to stands of *Baccharis pilularis*.

State Rarity: **S3**. Global Rarity: **G3**

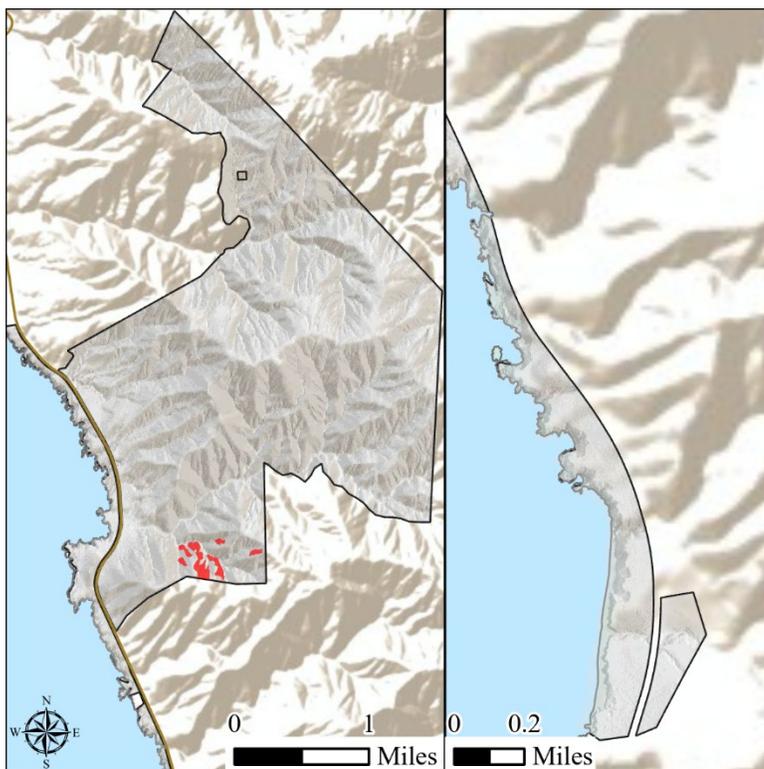
6150 – *Mesembryanthemum* spp. – *Carpobrotus* spp. Herbaceous Semi-Natural Alliance



DESCRIPTION: This non-native alliance, present along much of the coastline in the park, is mapped where *Carpobrotus edulis*, *Mesembryanthemum crystallinum*, or another ice plant species have greater than 80% relative cover (cf. Keeler-Wolf et al. 2003a, Evens and San 2005, HDR 2014b, Rodriguez et al. 2017, Verdone and Evens 2010).

State Rarity: **SNA**. Global Rarity: **GNA**.

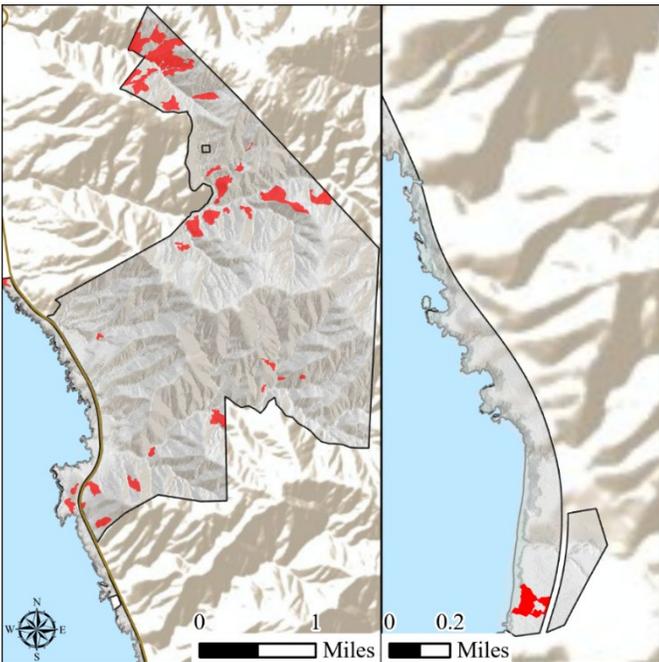
6160 – *Lupinus arboreus* Shrubland Alliance and Semi-Natural Alliance



DESCRIPTION: Present only on the upland slopes south of Soberanes Creek, this alliance is mapped where *Lupinus arboreus* has greater than 50% relative cover in the shrub canopy (Keeler-Wolf et al. 2003a). Although we observed numerous individuals of *Lupinus arboreus*, steep terrain limited our ability to ground-truth the areas mapped as *stands* of this species.

State Rarity: **S4**. Global Rarity: **G4**

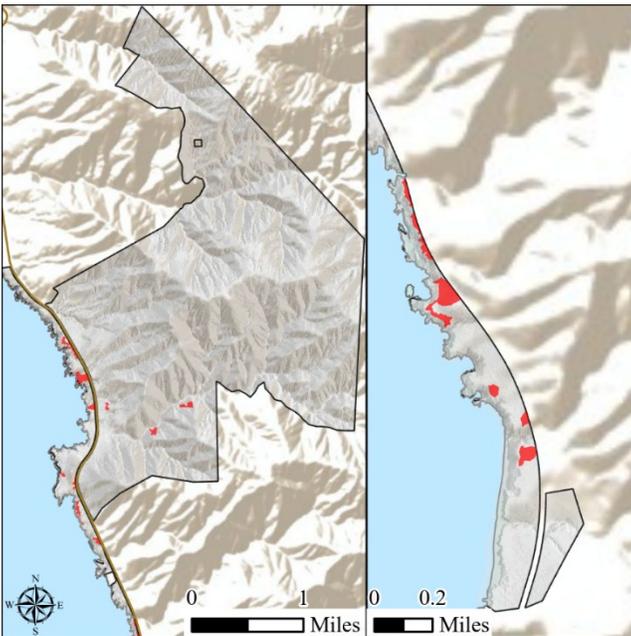
6170 – *Ceanothus thyrsiflorus* Shrubland Alliance



DESCRIPTION: The *Ceanothus thyrsiflorus* alliance is mapped where *C. thyrsiflorus* has greater than 35% relative cover in the shrub layer (Keeler-Wolf *et al* 2003a). Stands are found over most of the inland part of the park, although the alliance is more common in the northern extent. *C. thyrsiflorus* is often found upslope from stands of *Sequoia sempervirens*.

State Rarity: **S4** Global Rarity: **G4**

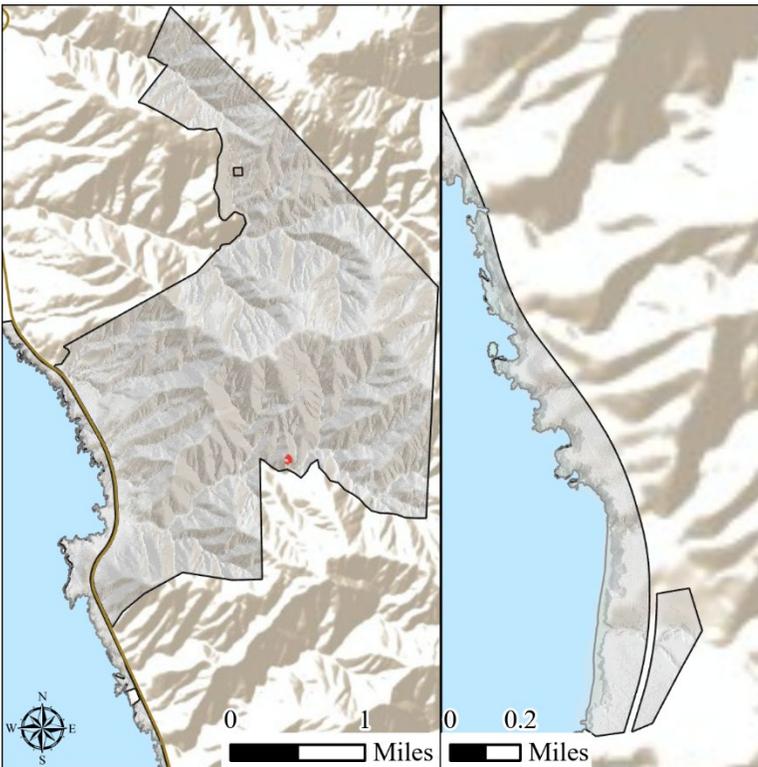
6210 – *Toxicodendron diversilobum* Shrubland Alliance



DESCRIPTION: This alliance is mapped where *Toxicodendron diversilobum* has greater than 50% relative cover in the shrub canopy (Evens *et al.* 2004, Keeler-Wolf and Evens 2006, Rodriguez *et al.* 2017, Sproul *et al.* 2011), or where *T. diversilobum* has greater than 30% relative cover and *Artemisia californica* also has greater 30% relative cover (Buck-Diaz and Evens 2015) layer (Buck-Diaz *et al.* 2012). While *T. diversilobum* is frequently encountered over the entire mapping area, stands are limited to coastal habitat and a few lowland areas along Soberanes Creek.

State Rarity: **S4**. Global Rarity: **G4**

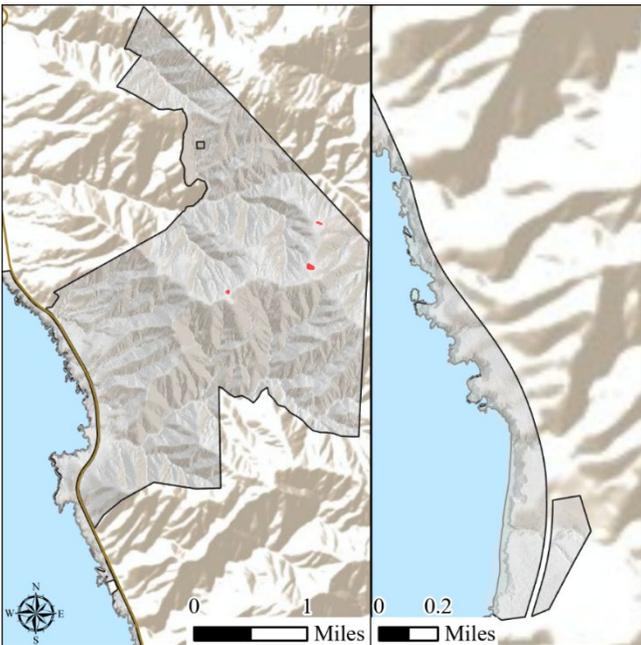
6220 – *Rubus* (*parviflorus*, *spectabilis*, *ursinus*) Shrubland Alliance



DESCRIPTION: This alliance is mapped in areas where *Rubus spectabilis* has greater than 50% relative cover in shrub canopy (Keeler-Wolf et al. 2003a). We only documented one stand in the mapping area, just north of Soberanes Creek.

State Rarity: **S3**. Global Rarity: **G4**

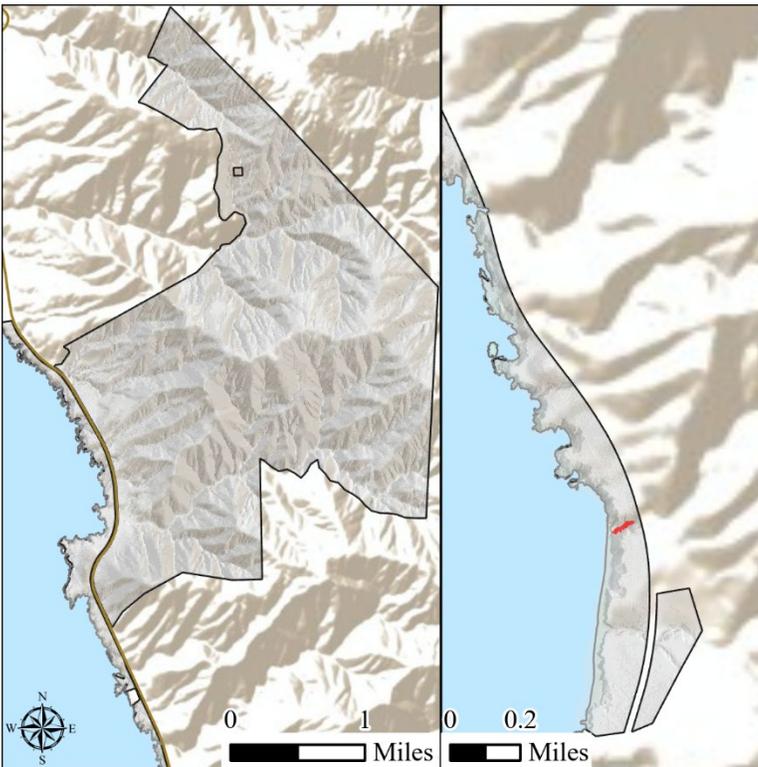
6230 – *Bromus carinatus* – *Elymus glaucus* Herbaceous Alliance



DESCRIPTION: This alliance is mapped where *Bromus carinatus*, *B. maritimus*, *Elymus glaucus*, or *Pteridium aquilinum* has greater than 30% relative cover in the herbaceous layer (Klein *et al.* 2015, Rodriguez *et al.* 2017). We mapped three small stands of *E. glaucus* intermixed with annual grasses along the Peak Trail, although more stands are possible in the study area. We also mapped one stand of *P. aquilinum* on the upland edge of a *Sequoia sempervirens* alliance near the park's eastern boundary.

State Rarity **S3** Global Rarity: **G3**

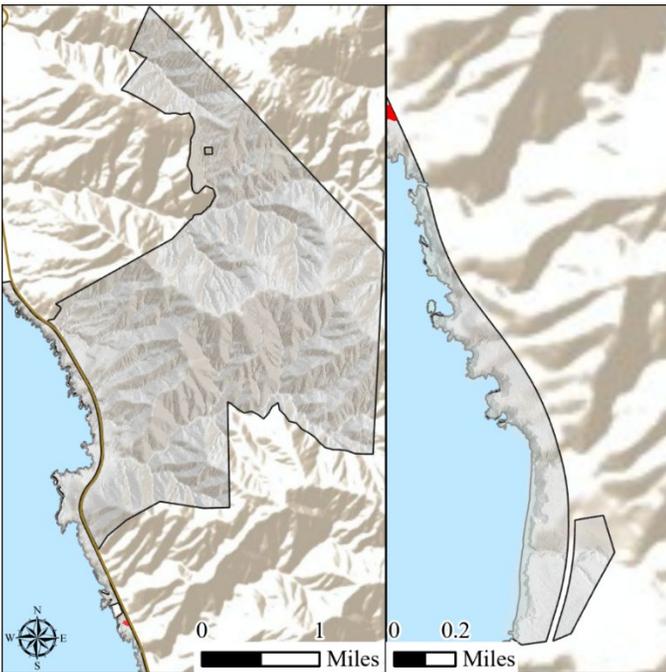
6310 – *Scirpus microcarpus* Herbaceous Alliance



DESCRIPTION: Present in one location in the southern coastal extent of the park, this alliance is assigned where *Scirpus microcarpus* has greater than 30% relative cover in the herbaceous layer (VegCAMP 2020).

State Rarity: S2 Global Rarity: G4

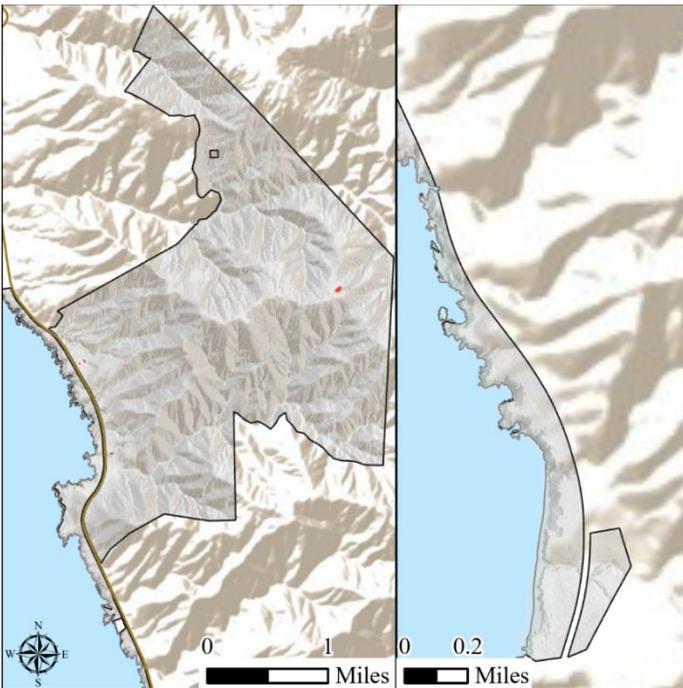
6410 – *Phragmites australis* – *Arundo donax* Herbaceous Semi-Natural Alliance



DESCRIPTION: *Phragmites australis* has at least 2% absolute cover (Thomas *et al.* 2004) and at least 50% relative cover in the herbaceous layer (Keeler-Wolf and Vaghti 2000, Evens *et al.* 2014) or where *Arundo donax* has greater than 60% relative cover in the herbaceous and shrub layers (Evens and San 2005, Sproul *et al.* 2011, Buck-Diaz *et al.* 2012). This alliance is present in one southern coastal location adjacent to Highway 1, dominated by *Arundo donax*.

State Rarity: SNR. Global Rarity: GNR

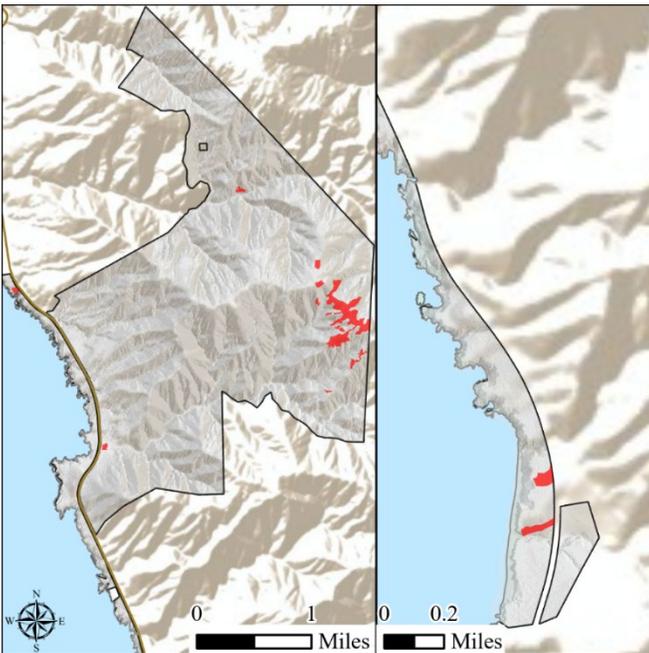
7110 – *Nassella* spp. – *Melica* spp. Herbaceous Alliance



Several small stands of this alliance characterized by *Nassella pulchra* are found in lowland areas in the northwest section of the mapping area, east of Highway 1. One additional stand is located in the high elevations of the park east of Doud Peak. *Nassella pulchra* is fairly widely distributed at low density but only occasionally abundant to the point of characterizing a stand. This alliance is mapped where either *Nassella* spp. or *Melica* spp. have greater than 30% relative cover in the herbaceous layer, while other species may intermix as dominant or codominant (Klein et al. 2015).

State Rarity: **S3**. Global Rarity: **G3**

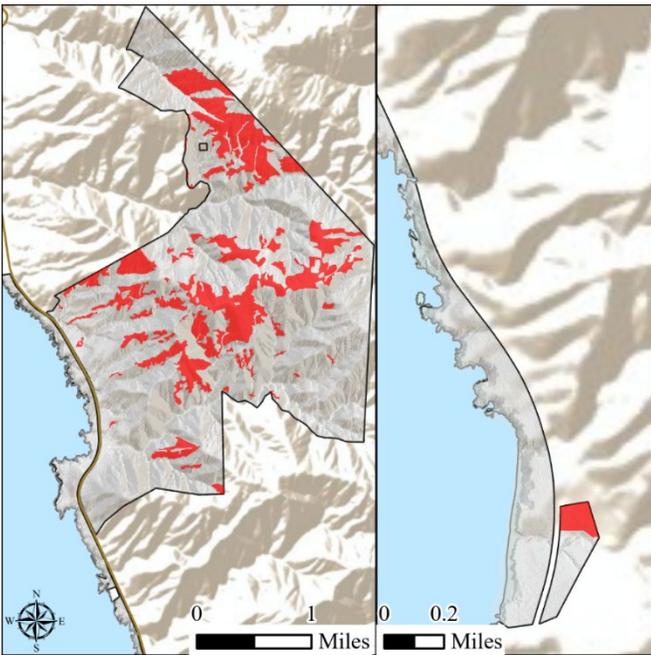
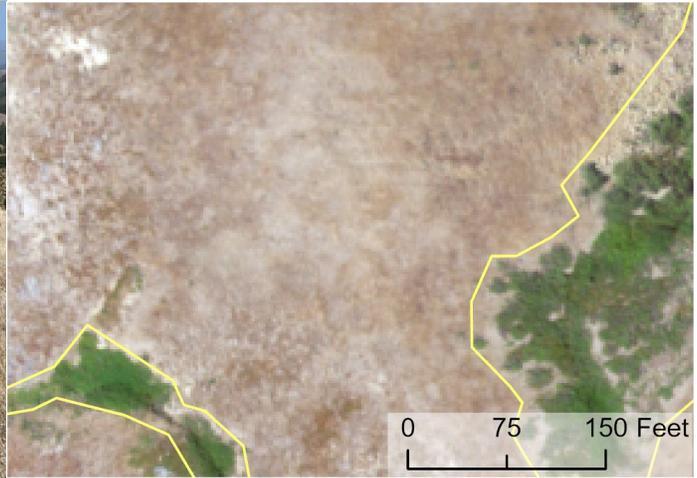
7210 – *Brassica nigra* – *Centaurea (solstitialis, melitensis)* Herbaceous Semi-Natural Alliance



DESCRIPTION: Heavily present along the eastern third of the Peak Trail, with some smaller stands found closer to the coast, this alliance is mapped where *Brassica nigra*, *Raphanus sativus*, *Carduus pycnocephalus*, *Centaurea solstitialis*, or another non-native forb has 50% relative cover in the herbaceous layer (Buck-Diaz et al. 2020).

State Rarity: **SNA**. Global Rarity: **RNA**

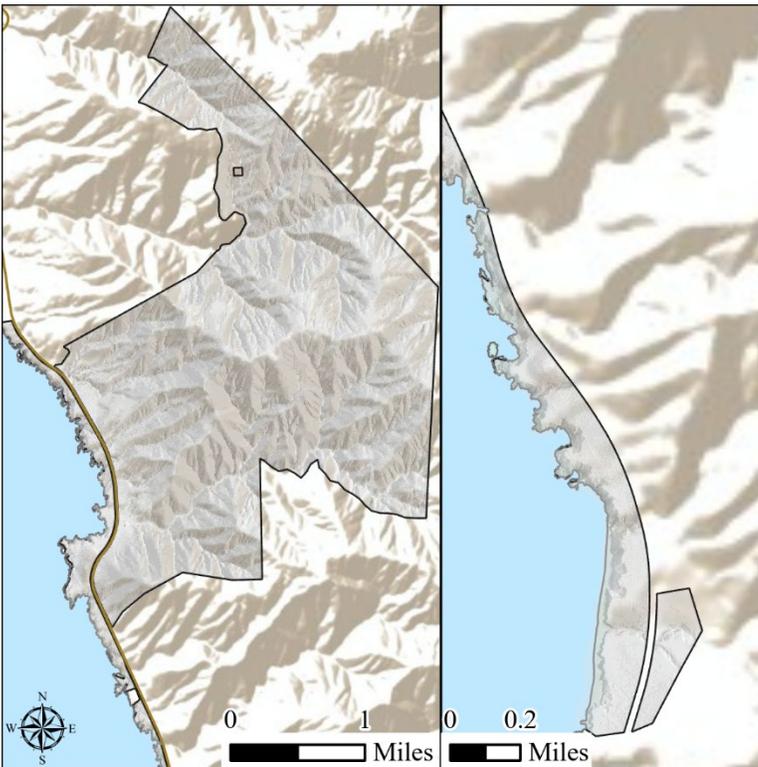
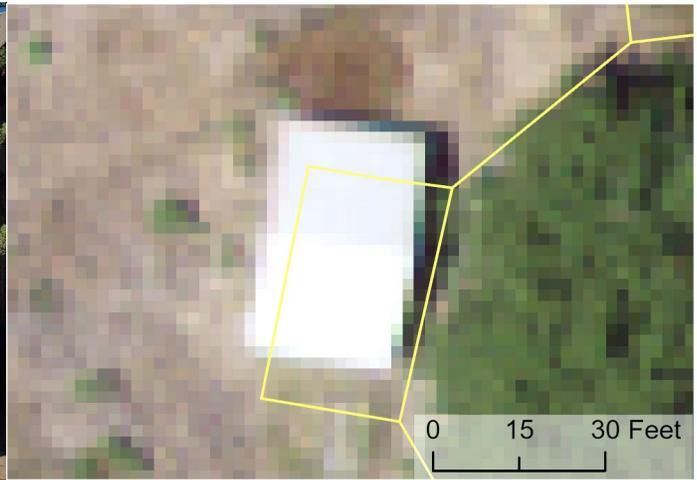
7220 – Unidentified Annual Grasses



DESCRIPTION: One of the most prevalent mapping units present in the study area, annual grassland dominates coverage at high elevations along the Peak Trail and in the northeast section of the park. Annual grassland is also present in smaller stands across the park, notably along the ridges west of the Rocky Ridge trail. We designated stands of annual grass when one or more unknown species of annual grass had greater than 50% relative cover in the herbaceous layer.

State Rarity: N/A **Global Rarity:** N/A

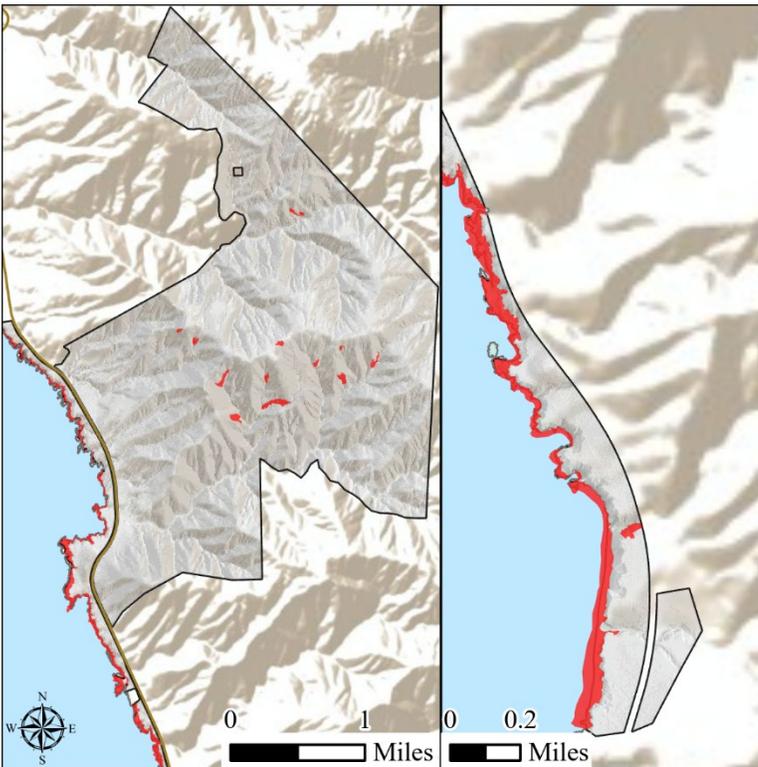
9110 - Built-up & Urban Disturbance



DESCRIPTION: The large structure at the beginning of the Soberanes Canyon trail is the only mapped urban disturbance in the park (other than Highway 1).

State Rarity: N/A Global Rarity: N/A

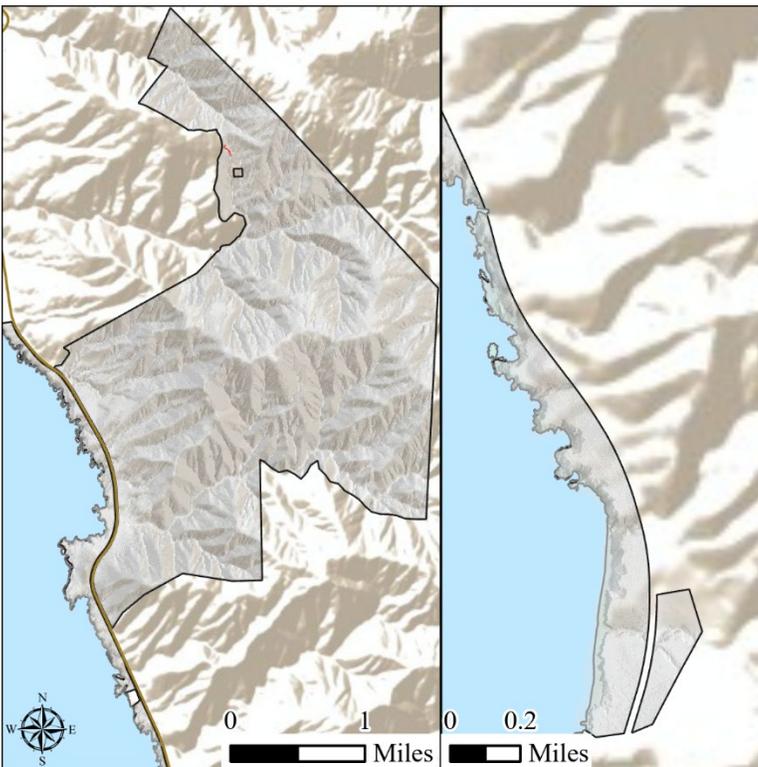
9210 – Cliffs & Rock Outcroppings, Talus & Scree



DESCRIPTION: The most common mapping unit in areas where little vegetation is found. Rock outcroppings are present along the entirety of the park's coastline, while cliffs and talus and scree are found along steep ridges and slopes at the higher elevations in the inland areas of the park.

State Rarity: N/A Global Rarity: N/A

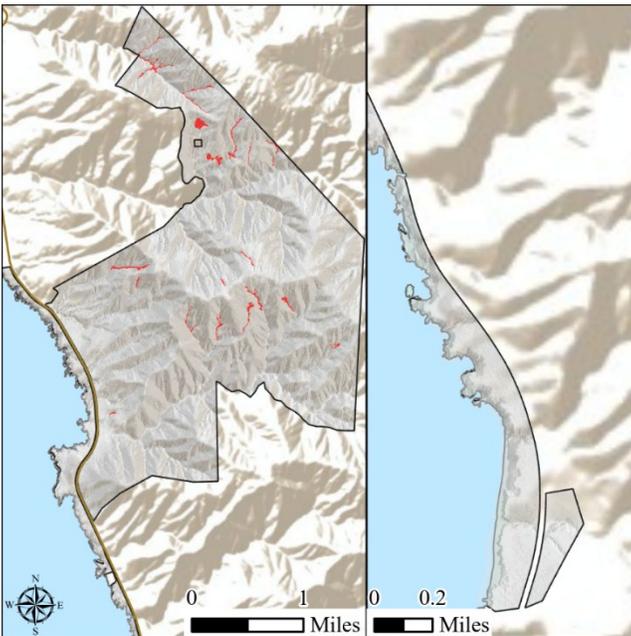
9220 – Undefined Areas of Little or No Vegetation



DESCRIPTION: Since most non-vegetated areas in the park are cliffs or talus and scree, this mapping unit was only observed in one area in the park, an eroded gully below an old road upslope of a riparian area.

State Rarity: N/A Global Rarity: N/A

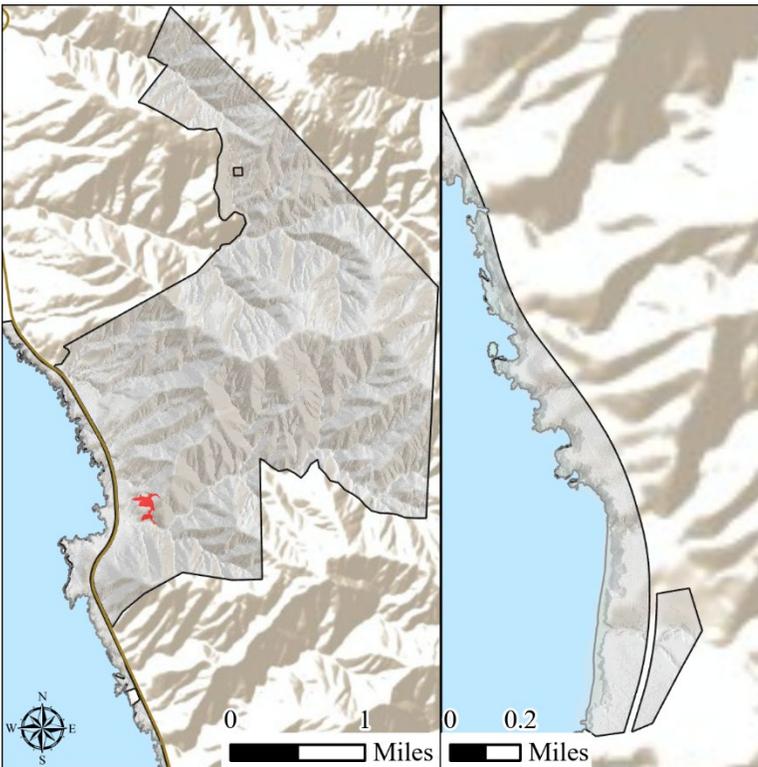
9310 – Ageratina Mapping Unit



DESCRIPTION: *Ageratina adenophora* are widespread across the study area at all elevations, particularly in riparian understories and ravines. Mapped where *A. adenophora* has greater than 50% relative cover, this mapping unit is often present at the highest reaches of ravines, encroaching on the *Salix* stands more common in the riparian lowlands. A large stand of *A. adenophora* also grows along the lower eastern Rocky Ridge trail, where it is codominant with *Baccharis pilularis*.

State Rarity: N/A Global Rarity: N/A

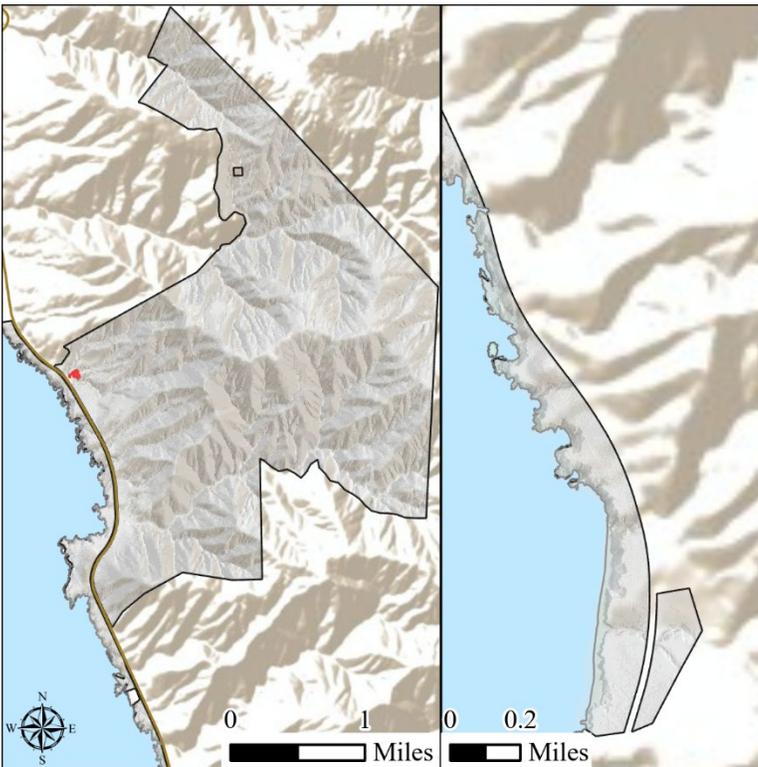
9320 – Prickly Pear Mapping Unit



DESCRIPTION: This mapping unit is assigned where Prickly Pear has greater than 50% cover in the shrub layer. It was only mapped in one location on an arid slope along the Soberanes Canyon trail.

State Rarity: N/A **Global Rarity:** N/A

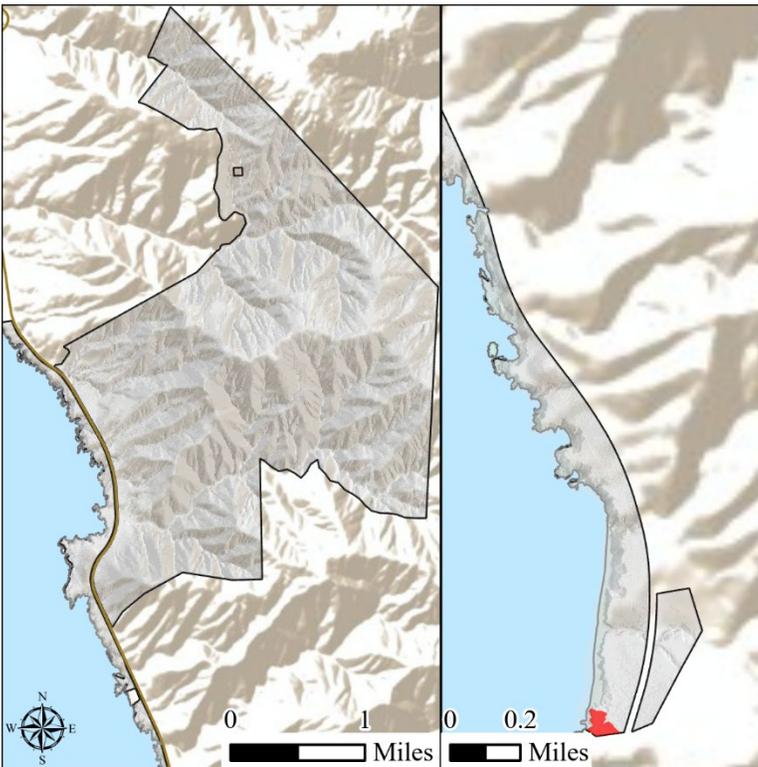
9330 – Pride of Madeira



DESCRIPTION: Designated where *Echium candicans* has greater than 50% relative cover in the herbaceous layer, one stand of *E. candicans* was mapped in northwestern section of the park east of Highway 1, where it grows between several *Salix* stands.

State Rarity: N/A Global Rarity: N/A

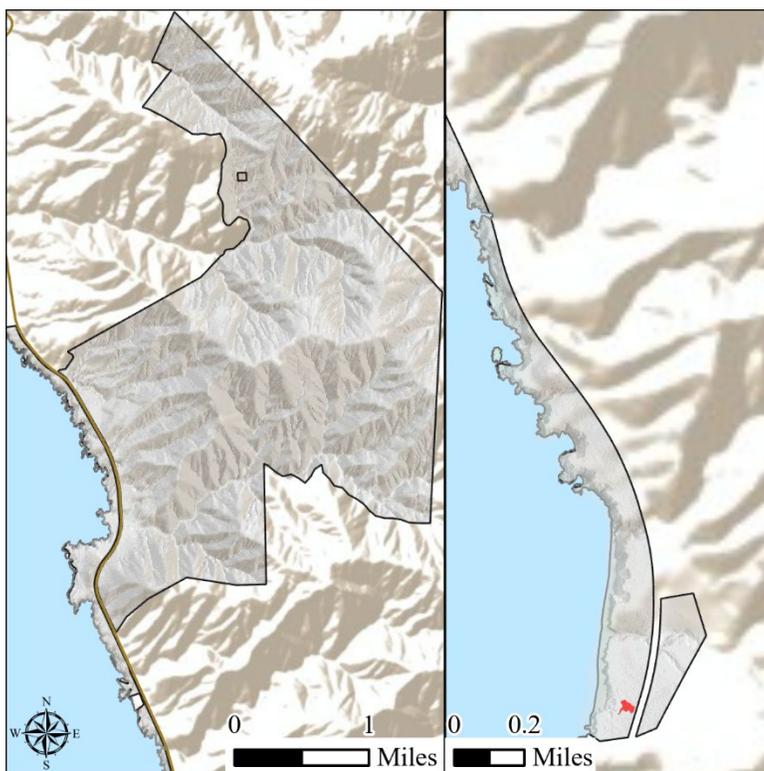
9410 – Chaparral Curreant Mapping Unit



DESCRIPTION: Present only at the southernmost point of the study area, this mapping unit is assigned where *Ribes malvaceum* has greater than 50% relative cover in the shrub layer.

State Rarity: N/A Global Rarity: N/A

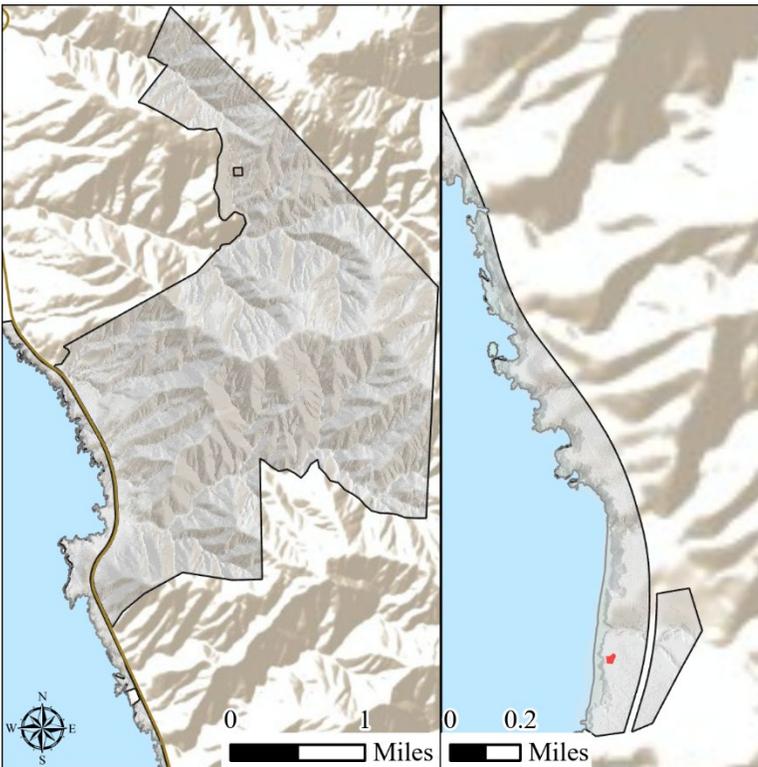
9420 – Little Sur Manzanita Mapping Unit



DESCRIPTION: Mapped where *Arctostaphylos edmundsii* has greater than 50% cover in the shrub layer, we documented only one occurrence of this mapping unit in the pre-existing CNDDDB polygons in the far south of the park.

State Rarity: N/A Global Rarity: N/A

9430 – Wood Mint Mapping Unit



DESCRIPTION: Mapped where *Stachys bullata* has greater than 50% relative cover at the herbaceous layer, this mapping unit is present in one location along the coast in the far south of the study area.

State Rarity: N/A Global Rarity: N/A

Appendix C. Working Guide to Plant Species, Alliances, and other Mapping Units

We developed a working guide to plant species, alliances, and mapping units in order to ensure consistent training and application of classification rules. The guide was primarily for internal use, but it also constitutes a useful record of our procedures and a useful starting point for future work. It is reproduced below.

Membership rules were adapted from the Manual of California Vegetation Online. Plant species information was sourced largely from Calscape, Calflora, and Cal-IPC.

* Indicates mapping units for which we created the membership rules.

California Bay Laurel

Umbellularia californica

Umbellularia californica Forest & Woodland Alliance (1110)



Tree Shape: Upright, rounded, 6–80 ft tall, 3–30 ft wide

Leaves: Oblong, smooth-edged

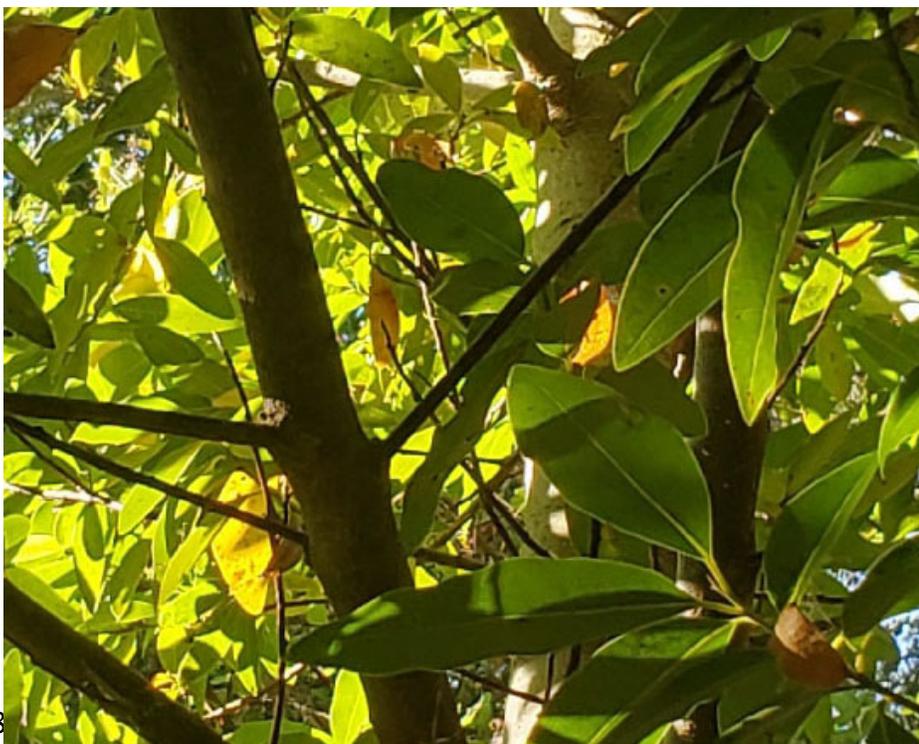
Flowers: Yellow, cream, white, green

Fruit: Round green berry, lightly spotted with yellow and purple

Other Features: Leaves have a peppery aroma

Membership Rules:

Umbellularia californica usually > 50% relative cover in the overstory as a tree or tall shrub; when with *Alnus rhombifolia* or *Quercus wislizeni*, > 30% relative cover (Klein et al. 2007).



Coast Live Oak

Quercus agrifolia

Quercus agrifolia Forest & Woodland Alliance (1120)



Tree Shape: Rounded, many-branched trunk; 25–82 ft tall, 15–35 ft wide

Leaves: Dark green, oval, often convex, 2–7cm long, 1–4cm broad; spiny-toothed leaf margin with sharp thistly fibers

Flowers: Yellow, cream, green

Fruit: Slender, reddish brown acorn 2–3.5cm long, 1–1.5cm broad

Other Features: Variable in form, trunk is often contorted and gnarled

Membership Rules:

Quercus agrifolia > 50% relative cover in the tree canopy; if *Umbellularia californica* trees present, then < 33% relative cover in the tree canopy (Keeler–Wolf et al. 2003a, Evens and San. 2004, Keeler–Wolf and Evens 2006).

Monterey Pine

Pinus radiata

Pinus muricata – *Pinus radiata* Forest & Woodland Alliance (1210)



Tree Shape: Upright, pyramidal, rounded, upright columnar; 49.2–196.9 ft tall, 15–30 ft wide

Leaves: Needles, bright green, in clusters of three, slender, 8–15 cm long and with a blunt tip

Flowers: Yellow, brown, cream

Cones: Cones are 7–17 cm (2.8–6.7 in) long, brown, egg-shaped, and usually set asymmetrically on a branch, attached at an oblique angle.

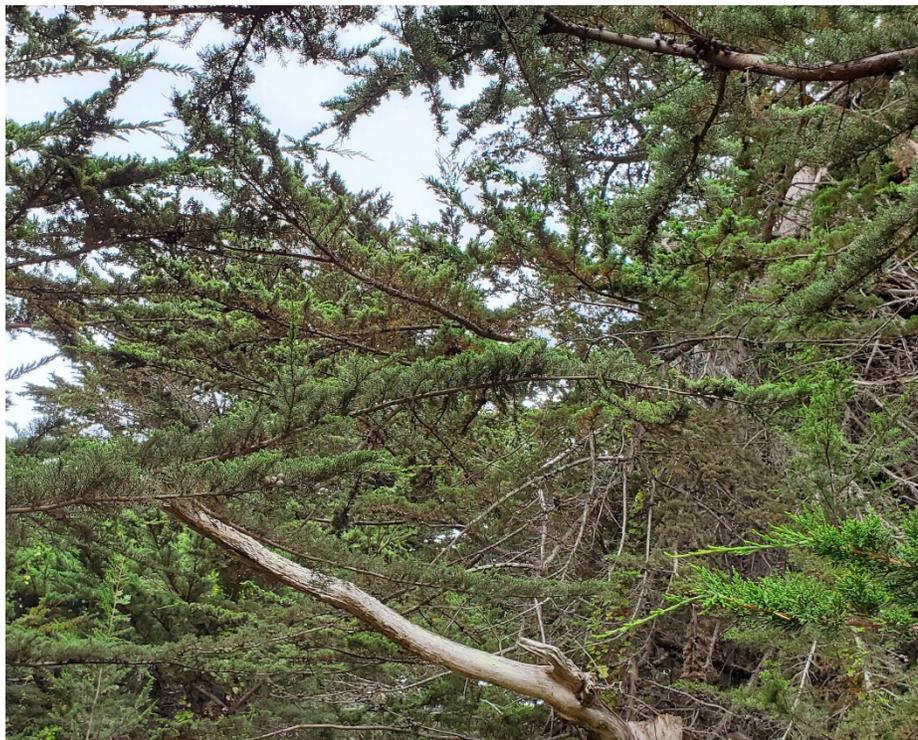
Membership Rules:

Pinus muricata has 30–60% relative cover in the tree layer with *Notholithocarpus densiflorus* in the overstory or regenerating tree layers; *Hesperocyparis pigmaea* not significant in cover (CDFW 2018).

Monterey Cypress

Hesperocyparis macrocarpa

* *Hesperocyparis macrocarpa* – *Pinus radiata* Semi-Natural Alliance (1220)



Tree Shape: Up to 25 m; crown generally broadly spreading, especially on exposed headlands; fairly sparse, often composed of few major limbs from near ground; more upright in sheltered locations

Leaves: Scale-like, 2–5 mm long, and produced on rounded (not flattened) shoots

Fruit: Seed cones are globose to oblong, 20–40 mm long, with 6–14 scales, green at first, maturing brown. The pollen cones are 3–5 mm long.

Membership Rules:

Hesperocyparis macrocarpa > 50% coverage in the tree layer

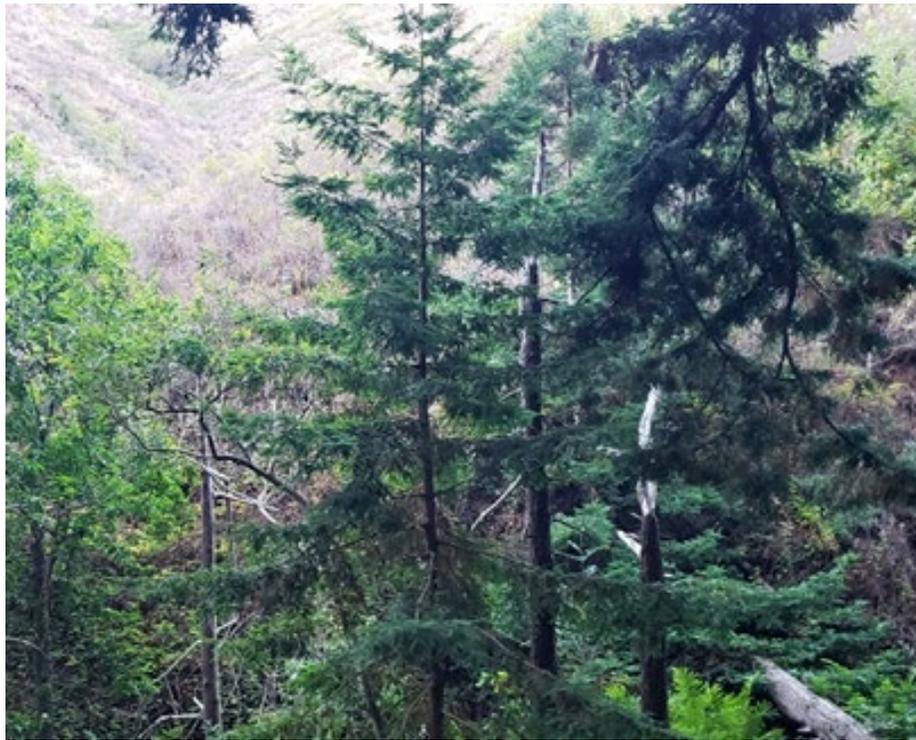
OR

Pinus radiata > 25% coverage in the tree layer.

Coast Redwood

Sequoia sempervirens

Sequoia sempervirens Forest & Woodland Alliance (2110)



Tree Shape: Upright columnar
60–380 ft tall, 45 ft wide

Leaves: Needles 0.5–0.75 in with sharp edges, shaped like a double-edged sword, and are on a flat plane

Flowers: Yellow, cream

Fruit: Cones: 1 in long, hard and woody, made of thick, wrinkled scales

Other Features: Bark is reddish-brown, thick rough and deeply furrowed (2 ft thick)

Membership Rules:

Sequoia sempervirens > 50% relative cover in the tree canopy, or > 30% relative cover with other conifers such as *Pseudotsuga menziesii* or with a lower tier of hardwood trees such as *Notholithocarpus densiflorus* (Keeler-Wolf et al. 2003a, Evens and Kentner 2006).

Eucalyptus globulus

Eucalyptus spp. – *Ailanthus altissima* – *Robinia pseudoacacia*
Woodland Semi-Natural Alliance (2210)



Tree Shape: Upright columnar, straight; 150–180 ft

Leaves: waxy blue, sickle-shaped; hang vertically

Fruit: sessile, sub-spherical to hemispherical

Other Features: Bark is usually rough, grayish or brownish at tree base, peeling off above in long strips

Membership Rules:

Eucalyptus species > 80% relative cover in the tree layer (cf. Evens and San 2005, Klein and Evens 2005, Keeler-Wolf and Evens 2006).

Pacific madrone

Arbutus menziesii

Arbutus menziesii Forest Alliance (2310)



Tree Shape: Rounded, upright columnar; 15–100 ft tall, 5–25 ft wide

Leaves: Thick, oval, 7–15 cm long and 4–8 cm broad, and arranged spirally; glossy dark green above and a lighter, more grayish green beneath, with an entire margin. Leaves brown during fall and detach from the branches.

Flowers: Small bell-like flowers; white, red

Fruit: In autumn, red berries

Other Features: Orange–red bark that peels away on the mature wood, leaving a greenish, silvery appearance that has a satin sheen and smoothness

Membership Rules:

Arbutus menziesii > 50% relative cover in tree canopy (Evens and Kentner 2006).

Willows (Arroyo, Goodding's, Red, and Sitka Willows)

Salix lasiolepis / *gooddingii* / *laevigata* / *sitchensis*

*Willow Mapping Unit (3110)



Tree Shape: Upright, rounded;
7–50 ft tall

Leaves: Light–green to medium green and deciduous, shiny green on top, dull whitish green underneath

Flowers: Catkin: White, cream, yellow, green, red

Fruit: Two–valved capsule

Other Features: Bark is ridged and grayish, though it sometimes turns reddish with age. Its form is variable, but it will often grow from multiple winding trunks,

Membership Rules:

Salix spp. > 50% relative cover in the tree canopy

Western Sycamore

Platanus racemosa

Platanus racemosa – *Quercus agrifolia* Woodland Alliance (3210)



Tree Shape: Upright columnar, rounded, 20–115 ft tall, 50 ft wide

Leaves: ~10 in

Flowers: Yellow, cream, orange, brown

Other Features: leaves have a peppery aroma

Membership Rules:

Platanus racemosa > 30% relative cover in tree canopy; *Quercus agrifolia*, *Salix spp.*, or *Populus fremontii* may be co-dominant. (Evens and San 2005, Klein and Evens 2005, Keeler-Wolf and Evens 2006, Stillwater Sciences and URS 2007).

Chamise

Adenostoma fasciculatum

Adenostoma fasciculatum Shrubland Alliance (4110)



Shrub Shape: Upright and rounded, 2–10 ft tall, 5 ft wide

Leaves: 4–10 mm long and 1 mm broad with a pointed tip, and sprout in clusters from the branches

Flowers: White tubular flowers at the end of branches, rusty brown when dried

Other Features: Leaves are shiny with flammable oils

Membership Rules:

Adenostoma fasciculatum > 50% relative cover in the shrub canopy (cf. Keeler–Wolf et al. 1998b), but *Salvia apiana* less than 30%



Eastwood Manzanita

Arctostaphylos glandulosa

Arctostaphylos glandulosa Shrubland Alliance (4210)



(Refer to Manzanita Book PDF for more info)

Take photos of: base of the plant, twigs, leaves and flowers (ALSO take a sample with you)

Shrub Shape: Rounded, 3–12 ft tall, 8 ft wide

Leaves: Variable depending on subspecies, generally oval and bright green

Flowers: Pink, white, pitcher shaped

Other Features: Bristly, sometimes hairy, secreting sticky oils

Membership Rules:

Arctostaphylos glandulosa > 60% relative cover in the shrub canopy (Gordon and White 1994, Borchert et al. 2004, Klein and Evens 2005, Keeler-Wolf and Evens 2006).

OR

Both *Adenostoma fasciculatum* and *Arctostaphylos glandulosa* each have between 30% and 60% relative cover (Gordon and White 1994, Borchert et al. 2004, Evens and San 2005, Klein and Evens 2005, Keeler-Wolf and Evens 2006).

California Sagebrush

Artemisia californica

Artemisia californica - (*Salvia leucophylla*) Shrubland Alliance
(5110)



Shrub Shape: Rounded; height varies significantly between 1–8 ft.

Leaves: Gray/green pinnately divided, hairy leaves; 1–10 cm long.

Flowers: Inconspicuous, whitish or greenish flower heads which hang along the stem.

Fruit: Small, dry seed typical of a plant in the sunflower family.

Other Features: Fragrant

Membership Rules:

Artemisia californica > 3 times cover of *Baccharis pilularis* and other shrub species (Keeler-Wolf et al. 2003a).

Artemisia californica > 60% relative cover in the shrub canopy (Gordon and White 1994, Borchert et al. 2004).

Sticky Monkey Flower

Diplacus aurantiacus (previously *Mimulus aurantiacus*)

Diplacus aurantiacus Shrubland Alliance (5120)



Forb Shape: Mounding, spreading; 3.9–5ft tall, 5 ft wide

Leaves: Deep green, sticky leaves 3–7cm long and up to 1cm wide

Flowers: Light orange (common) and shades of white to red; flower stems grow vertically

Other Features: Sticky leaves

Membership Rules:

Diplacus aurantiacus > 50% relative cover in the shrub canopy; if equal or less cover than *Artemisia californica* or *Adenostoma fasciculatum*, see those alliances (Keeler–Wolf and Evens 2006).

Deerweed

Acmispon glaber (previously *Lotus scoparius*)

Lotus scoparius Shrubland Alliance (5130)



Forb Type: Perennial Herb

Forb Shape: Fountain

1.6 – 3 ft tall, 3 ft wide

Leaves: small, pinnate leaves with 3–6 leaflets

Flowers: Yellow to reddish yellow; small with clusters of 2–7 flowers in the upper leaf axils

Fruit: Curved pod with two seeds

Other Features: Green stem, flowers in the winter, spring and summer

Membership Rules:

Lotus scoparius > 50% relative cover in the shrub canopy (Evens and San 2005, Keeler-Wolf and Evens 2006, Klein and Evens 2005).

Black Sage

Salvia mellifera

Salvia mellifera Shrubland Alliance (5140)



Shrub Shape: Mounding; 3–6 ft tall, 10 ft wide

Leaves: 1–3 in dark green leaves, textured somewhat like a fingerprint pattern. Upper surface of leaf is somewhat smooth, with a hairy lower surface

Flowers: 0.5–1.5 in wide clusters. Colors vary from white, pale blue, lavender, or (rarely) pale rose.

Other Features: Very aromatic

Membership Rules:

Salvia mellifera > 50% relative cover, or > 30% relative cover when *Rhus integrifolia* or *Opuntia littoralis* is present (Rodriguez et al. 2019).



Sydney golden wattle, Acacia

Acacia longifolia

**Acacia spp.* – *Grevillea spp.* – *Leptospermum laevigatum*
[pending] (5150)



Shrub Shape: Upright, variable, up to 8 m

Leaves: Leathery and strap-like, finger-wide and long, with parallel veins and have a conspicuous basal gland with no resinous margins

Flowers: Yellow and arranged in short spikes in leaf axils

Fruit: Long pods

Membership Rules:

Acacia spp. > 50% relative cover in the shrub layer

Lizard Tail, Seaside Woolly Sunflower

Eriophyllum staechadifolium

Eriophyllum staechadifolium – *Erigeron glaucus* – *Eriogonum latifolium* Herbaceous Alliance (6110)



Forb Shape: 2–5ft tall, 5ft wide

Leaves: Green–gray leaves are oval to lance–shaped and have rolled–under edges

Flowers: Yellow, both ray and disk florets

Membership Rules:

Erigeron glaucus, *Eriophyllum staechadifolium*, *Fragaria chiloensis*, and/or *Eriogonum latifolium* > 50% relative cover in the herbaceous layer, while shrubs may be present at low cover (Buck–Diaz et al. 2020).

Eriogonum parvifolium > 50% relative cover in the herbaceous layer (WRA 2017).

Seaside Fleabane (beach aster/seaside daisy)

Erigeron glaucus

Eriophyllum staechadifolium – *Erigeron glaucus* – *Eriogonum latifolium* Herbaceous Alliance (6110)



Forb Shape: Spreading, 0.16–1 ft tall, 2 ft wide

Leaves: Hairy to hairless depending on environment

Flowers: Lavender, yellow

Membership Rules:

Erigeron glaucus, *Eriophyllum staechadifolium*, *Fragaria chiloensis*, and/or *Eriogonum latifolium* > 50% relative cover in the herbaceous layer, while shrubs may be present at low cover (Buck–Diaz et al. 2020).

Coast Buckwheat

Eriogonum parvifolium

Eriophyllum staechadifolium – *Erigeron glaucus* – *Eriogonum latifolium* Herbaceous Alliance (6110)



Forb Shape: Mounding, may be quite small or sprawl to a maximum height of 70 cm.

Leaves: Pale white–green, oval, woolly, and sometimes waxy and are mostly basal, can partially extend up the erect stem if there is one.

Flowers: Cream, pink, white; at the end of each branch, blooms from summer into fall

Membership Rules:

Erigeron glaucus, *Eriophyllum staechadifolium*, *Fragaria chiloensis*, and/or *Eriogonum latifolium* > 50% relative cover in the herbaceous layer, while shrubs may be present at low cover (Buck–Diaz et al. 2020).

Note that *Eriogonum parvifolium* stands are classified here, even though the *E. parvifolium* name does not appear in the name of the alliance (See Membership Rules in MCV Online for *Eriophyllum staechadifolium* – *Erigeron glaucus* – *Eriogonum latifolium* Herbaceous Alliance).

Silver Beach Lupine/ Dune Bush Lupine

Lupinus chamissonis

Lupinus chamissonis – *Ericameria ericoides* Shrubland Alliance
(6120)



Shrub Shape: Mounding

Leaves: Each palmate leaf is made up of 5–9 leaflets, ~ 2.5 cm long. The herbage is coated in silvery hairs.

Flowers: Whorls of flowers each about one to 1.5 cm long. Each flower is light purple to blue with a yellow spot on its banner.

Fruit: Hairy legume pod 2.5–3.5 cm

Membership Rules:

Lupinus chamissonis and/or *Ericameria ericoides* are conspicuous (Keeler–Wolf et al. 2003a).

Mock Heather Scrub

Ericameria ericoides

Lupinus chamissonis – *Ericameria ericoides* Shrubland Alliance
(6120)



Shrub Shape: Mounding; 2–3.5 ft tall, 3–4 ft wide

Leaves: Comb-like fans of small cylindrical leaves up to 1 cm long.

Flowers: Clusters of small golden yellow flower heads, each with several disc florets and a few ray florets.

Fruit: ~4 mm, cylindrical

Leaves: Each palmate leaf is made up of 5–9 leaflets, ~ 2.5 centimeters long. The herbage is coated in silvery hairs.

Flowers: Whorls of flowers each about one to 1.5 cm long. Each flower is light purple to blue with a yellow spot on its banner.

Fruit: Hairy legume pod 2.5 to 3.5 cm

Membership Rules:

Lupinus chamissonis and/or *Ericameria ericoides* are conspicuous (Keeler-Wolf et al. 2003a).

Coyote Brush

Baccharis pilularis

Baccharis pilularis Shrubland Alliance (6130)



Shrub Shape: Mounding, generally 1–3 meters in height. It is smooth and generally sticky. 1.5–10 ft tall, 12 ft wide

Leaves: 8–55 mm long with three principal veins, scalloped, oval-shaped to wedge-shaped

Flowers: White or yellow, rayless flowers that bloom in early winter

Fruit: Dense feathery tufts

Membership Rules:

Baccharis pilularis > 50% absolute cover in the shrub layer (Borchert et al. 2004).



California Coffeeberry

Frangula californica

Frangula californica – *Rhododendron occidentale* – *Salix breweri*

Shrubland Alliance (6140)



Shrub Shape: Mounding, rounded, spreading. 6–15 ft tall 5–15 ft wide

Leaves: Dark green w/ reddish tint, 1–3 in long, with a curl under at the edges

Flowers: Inconspicuous greenish–white with five petals; produced in clusters of 5–60

Fruit: Berries 10–15 mm in diameter, which turn red, then purple and finally black

Other Features: Reddish branches

Membership Rules:

Frangula californica has > 50% relative cover in the shrub canopy and > 8% absolute cover (Evens and San 2004).



Ice Plant Mats

Carpobrotus spp.

Mesembryanthemum spp. – *Carpobrotus spp.* Semi-Natural Alliance (6150)



Herb Shape: Mat or shrub (depends on species)

Leaves: Thick, three sided leaves can be anywhere between green, red and purple in color

Flowers: Pink, yellow, white

Fruit: Greenish purplish fruit that resembles a fig.

Membership Rules:

Carpobrotus edulis, *Mesembryanthemum crystallinum*, or other ice plant strongly dominant (> 80% relative cover) close to the coast

(cf. Keeler-Wolf et al. 2003a, Evens and San 2005, HDR 2014b, Rodriguez et al. 2017, Verdone and Evens 2010).

Yellow Bush (Tree) Lupine

Lupinus arboreus

Lupinus arboreus Shrubland Alliance and Semi-Natural Alliance
(6160)



Shrub Shape: 4–6 ft

Leaves: Palmately compound leaves with 5–12 leaflets per leaf. Leaflets 2–6 cm long and may be sparsely covered with silky hairs.

Flowers: Yellow to lavender, but are typically yellow along the Central Coast.

Fruit: Legumes (seed pods typical of plants in the pea family).

Membership Rules:

Lupinus arboreus > 50% relative cover in the shrub canopy (Keeler-Wolf et al. 2003a)

Carmel ceanothus

Ceanothus thyrsiflorus var. *griseus*

Ceanothus thyrsiflorus Shrubland Alliance (6170)



Shrub Shape: Mounding, spreading, upright columnar, weeping; 2–30 ft tall, 2–40 ft wide

Leaves: Evergreen, bright green to dark green. Distinguishable from *C. thyrsiflorus* var. *thyrsiflorus* by its softly hairy twigs and leaves which typically curl along their margins.

Flowers: Tiny flowers, each about 0.5 cm wide. The flowers may be white or tinted strongly with blue or lavender

Fruit: 0.25 – 0.5 in long and have 3 distinct horns near the top without crests or ridges

Other Features: Contain a significant amount of woody material

Membership Rules:

Ceanothus thyrsiflorus > 35% relative cover in the shrub canopy (Keeler–Wolf, et al. 2003a).

Poison oak

Toxicodendron diversilobum

Toxicodendron diversilobum Shrubland Alliance (6210)



Shrub Shape: Mounding, rounded, upright columnar, weeping 1.6–13 ft tall, 13 ft wide

Leaves: Usually divided into three leaflets, 3.5–10 cm long, with scalloped, toothed, or lobed edges. Leaves are glossy, and depending on the season can be bronze, bright green, yellow–green to reddish, bright red, orange, or pink.

Flowers: Small, white flowers

Fruit: Small tan berries

Other Features: Leafless vines can sometimes be identified by black marks made by dried sap

Membership Rules:

Toxicodendron diversilobum > 50% relative cover in the shrub canopy (Evens et al. 2004, Keeler–Wolf and Evens 2006, Rodriguez et al. 2017, Sproul et al. 2011).

Toxicodendron diversilobum > 50% relative cover in the shrub canopy, or > 30% relative cover with *Artemisia californica* > 30% relative cover (Buck–Diaz and Evens 2015) layer (Buck–Diaz et al. 2012)

Berry Alliance (Western Thimbleberry/ Salmon Berry / Pacific Blackberry)

Rubus (paviflorus/spectabilis/ursinus)

Rubus (parviflorus, spectabilis, ursinus) Shrubland Alliance (6220)



Shrub Shape: Upright, spreading, mounding

Leaves: Leaf margins are toothed and are trifoliate

Flowers: White, purple, yellow

Fruit: Red in color

Other Features: Thorny vines

Membership Rules:

Rubus spectabilis > 50% relative cover in shrub canopy (Keeler-Wolf et al. 2003a).

Blue Wildrye

Elymus glaucus

Bromus carinatus – *Elymus glaucus* Herbaceous Alliance (6230)



Grass Shape: Upright; 1–5 ft tall, 1 ft wide; small, narrow tufts of several erect stems

Leaves: Flat leaves each up to 1 cm wide at the base and rapidly narrowing to a point

Flower: Narrow, pointed flower cluster many centimeters long made up of a few spikelets at tip of stem

Membership Rules:

Bromus carinatus, *Elymus glaucus*, or *Pteridium aquilinum* > 30% relative cover in the herbaceous layer (Klein et al. 2015).

Small-fruited bulrush marsh, Panicked Bulrush

Scirpus microcarpus

Scirpus microcarpus Herbaceous Alliance (6310)



Grass Shape: Upright; 2.8–5.5 ft tall

Leaves: Green, deciduous

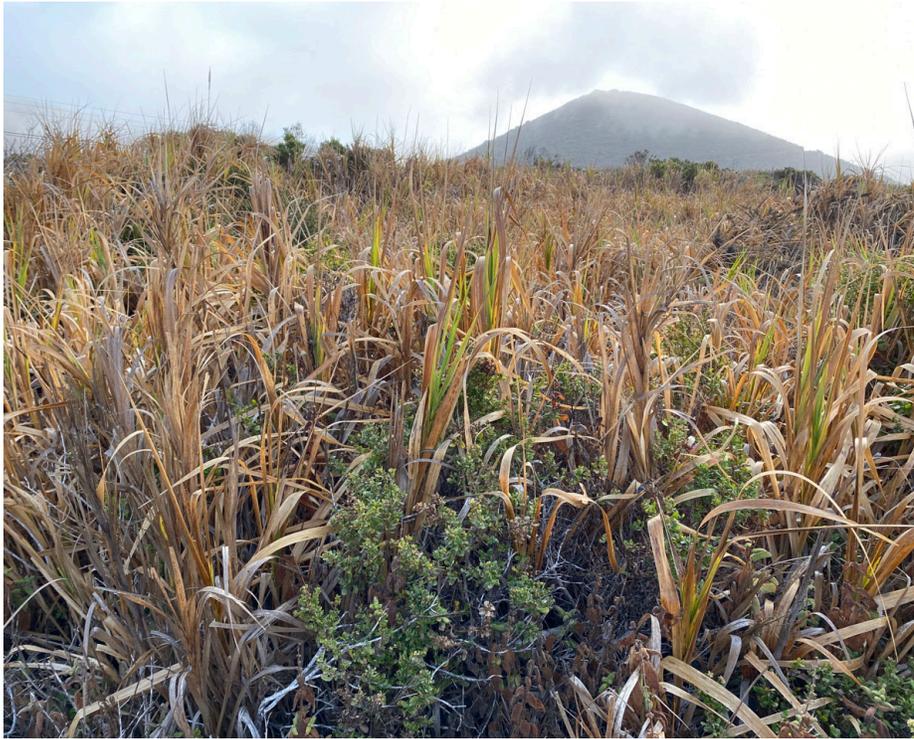
Flower: White

Membership Rules:

Scirpus microcarpus >30% relative cover (VegCAMP 2020).

Arundo donax

Phragmites australis – *Arundo donax* Herbaceous Semi-Natural Alliance (6410)



Cane Shape: 20–33 ft tall, 2–3 cm in diameter stem

Leaves: Alternate, sword-like, green leaves 30–60 cm long, 2–6 cm wide

Flower: Upright, feathery plumes, 40–60 cm long

Membership Rules:

Phragmites australis \geq 2% absolute cover (Thomas et al. 2004) and \geq 50% relative cover in the herbaceous layer (Keeler-Wolf and Vaghti 2000, Evens et al. 2014).

Phragmites australis \geq 30% absolute cover in the herbaceous layer (Hickson and Keeler-Wolf 2007).

Arundo donax $>$ 60% relative cover in the herbaceous and shrub layers (Evens and San 2005, Sproul et al. 2011, Buck-Diaz et al. 2012).

Purple Needlegrass

Nassella pulchra

Nassella spp. – *Melica spp.* Herbaceous Alliance (7110)



Grass Shape: Fountain; 3.3 ft tall, 1.5 ft wide

Flowers: Open, nodding flower clusters; up to 60 cm long; cream, green, purple, red

Membership Rules:

Melica californica and/or *Nassella pulchra* > 30% relative cover in the herbaceous layer. Other species including *Achnatherum lemmonii*, *Avena spp.*, *Bromus spp.*, *Hemizonia congesta*, *Lolium perenne*, *Plantago erecta*, and/or *P. lanceolata* may intermix as dominant, co-dominant or characteristic taxa in associations of this alliance (Klein et al. 2015).

Melica torreyana > 30% relative cover in the herbaceous layer and is commonly associated with serpentinite soils (Buck and Evens 2010).

Black Mustard

Brassica nigra

Brassica nigra – *Centaurea (solstitialis, melitensis)* Herbaceous
Semi-Natural Alliance s (7210)



Forb Shape: Annual forb, 2–8 ft tall

Leaves: Alternate leaves; 2–10 in long, 1–6 in wide.

Flowers: Yellow, narrow racemes 6–24 in when mature

Membership Rules:

Brassica nigra, *Raphanus sativus*, *Carduus pycnocephalus*, *Centaurea solstitialis*, or another non-native forb > 50% relative cover in the herbaceous layer, often in old or active agriculture lands (Buck-Diaz et al. 2020)

Wild radish

Raphanus sativus

Brassica nigra – *Centaurea (solstitialis, melitensis)* Herbaceous
Semi-Natural Alliance (7210)



Forb Shape: Annual forb; ~4 ft tall

Leaves: Grow in a basal rosette, can be prickly with small hairs; 2–3 ft long

Flowers: Small pink, white, or lavender

Membership Rules:

Brassica nigra, *Raphanus sativus*, *Carduus pycnocephalus*, *Centaurea solstitialis*, or another non-native forb > 50% relative cover in the herbaceous layer, often in old or active agriculture lands (Buck-Diaz et al. 2020)

Sticky Eupatorium, Sticky Ageratina

Ageratina adenophora

**Ageratina* Mapping Unit



Shrub Shape: Upright; 3–5 ft tall

Leaves: Opposite; blade deltoid–ovate, serrate, purple below, glandular–puberulent esp. below, leaf blade generally 2–4 in long

Flowers: 10–60 per head, cylindric, corollas white, pink tinged

Fruit: 5 angled, usually 5 ribbed, pappus 5–40

Membership Rules:

Ageratina adenophora > 50% relative cover



Prickly Pear

Opuntia spp.

*Prickly Pear Mapping Unit (9320)



Succulent Shape: Segmented;
~1 m tall, densely clumped

Leaves: Flat, paddle-shaped,
covered in spines

Flowers: Yellow or red

Membership Rules:

Opuntia spp. > 50% relative
cover in the herbaceous layer

Pride of Madeira

Echium candicans

*Pride of Madeira Mapping Unit (9330)



Shrub Shape: Mounding, 5–6 ft tall, 6–10 ft wide

Leaves: Silvery–green hairy leaves arranged in rosettes

Flowers: Cone–shaped blue clusters

Membership Rules:

Echium candicans > 50% relative cover

Chaparral Currant

Ribes malvaceum

*Chaparral Currant Mapping Unit (9410)



Shrub Shape: Spreading, 5–8 ft tall, 5 ft wide

Leaves: Blades are 20–50 mm, densely hairy and double toothed

Flowers: Bright pink, purple

Fruit: Purple berries

Membership Rules:

Ribes malvaceum > 50% relative cover in the shrub layer

Little Sur Manzanita

Arctostaphylos edmundsii

*Little Sur Manzanita Mapping Unit (9420)



Shrub Shape: Prostrate, mounding. 0.5–1 ft tall, 3–5 ft wide

Flower: White, pink

Membership Rules:

Arctostaphylos edmundsii

> 50% relative cover in the shrub layer

California Hedgenettle

Stachys bullata

*Wood Mint Mapping Unit (9430)



Forb Shape: Upright, ~80cm tall

Leaves: Glandular, 18 cm long, opposite pairs along stem

Flower: Slightly fragrant, purple

Membership Rules:

Stachys bullata > 50% relative cover in the herbaceous layer

Appendix D: Invasive Species Survey from Vantage Points

To map highly visible invasive species in areas that are difficult to reach on foot, we took photos from vantage points. The intent was to develop a system for converting this information into georeferenced polygons by:

1. Hiking to vantage points
2. Recording the vantage point location with a GPS unit
3. Systematically scanning the visible terrain using binoculars and/or spotting scopes
4. Taking photos and marking weed locations on the photos
5. Recording the angular bearing and angular elevation of the weed locations relative to the vantage point
6. Rendering the same photos in Google Earth and tracing polygons to match the photo-marked locations
7. Exporting the polygons from Google Earth into ArcGIS
8. Using a viewshed analysis in ArcGIS to record which areas were scanned from the vantage point, and which areas could not be seen
9. Prioritizing future vantage points based on the cumulative map of areas never seen
10. Repeating these steps several times

In the time available, we completed steps 1, 2, and 4 at several vantage points. Some of the resulting photos appear in the following figures.



Figure 10. *Ageratina adenophora* visible from a vantage point.



Figure 11. Cape ivy visible from a vantage point.



Figure 12. Prickly pear visible from a vantage point.



Figure 13. Prickly pear visible from a vantage point.



Figure 14. *Cortaderia* visible from a vantage point.