NATURAL BRIDGES MONARCH OVERWINTERING GROVE MANAGEMENT PLAN

Natural Bridges State Beach

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1 Background and Purpose

Hundreds of thousands of western monarch butterflies (*Danaus plexippus plexippus*) overwinter in forested groves along the Pacific coastline stretching from Mendocino County, California to Baja California, Mexico. In the past decades this western overwintering population has experienced dramatic declines. A recent study done by Schultz et al. (2017) suggested that 30,000 individuals is the overwintering population threshold necessary to sustain the western migratory monarch population. The 2018 and 2019 overwintering population numbers dipped below this with 28,429 and 29,418 monarchs, respectively (Xerces 2021). The winter of 2020/2021 saw a dramatic crash with only 1,899 monarchs counted across all the sites (Xerces 2021 and 2022), the lowest count since widespread monitoring began in 19976. This represents a 99.9% decrease from the 1980s when millions of monarchs overwintered along the California coast. In December of 2020, the U.S. Fish and Wildlife Service (USFWS) determined that listing of the western monarch butterfly under the Federal Endangered Species Act was "warranted but precluded by other higher priority species." In January of 2021 the USFWS determined that the monarch was "a candidate under the Endangered Species Act; we will review its status annually until a listing decision is made."

The observed declines are likely due to habitat loss and degradation in their overwintering and breeding range, increased pesticide use, and possibly climate change (Pelton et al. 2019) which may be further exacerbated by weather and wildfire events. Protection, restoration, and active management of existing overwintering habitat is considered a critical priority in the attempt to recover western monarch populations (Pelton et al. 2019, Xerces 2018).

Research suggests that monarchs are most vulnerable during the overwintering stage of their life cycle (Pyle and Monroe 2004). While we know little about the species diversity and structure of overwintering groves prior to European contact, the diversity, distribution and abundance of tree groves along the California coast has changed significantly since European settlement. Many remaining overwintering groves are threatened by urban and ex-urban development, fire, and to a lesser extent, agricultural development. Overwintering monarchs require specific microhabitat conditions during diapause, including protection from freezing temperatures, high winds, adequate humidity, dappled sunlight, fresh water, and nectar sources. Grove microclimate conditions change as forests age and as the result of human activities. Thus, adaptive management is necessary to maintain suitable conditions for monarch aggregations at important overwintering sites.

Natural Bridges State Beach (Natural Bridges) is among the most important Western monarch overwintering sites and is also a heavily visited site for viewing monarchs. California State Parks constructed a visitor center, boardwalk and implemented an education program about monarch overwintering and migration. Each year, these facilities and services engage hundreds of thousands of people in monarch ecology and the phenomena of overwintering and migration. This audience includes some 15,000 K-3rd students and teachers, local community members, some of the 13 million greater Bay Area residents, as well as visitors from countries all over the world.

However, like all overwintering sites, Natural Bridges State Beach has experienced severe population declines over the past decade, with data from the winter of 2020/2021 demonstrating

the most dramatic population drop since monarch numbers have been officially monitored. During the 2020 Thanksgiving Counts, Natural Bridges held 550 of the total 1,899 monarchs counted in all of California, representing 33% of the Western population and indicating this site is a critically important overwintering population. This number remained stable for the New Years Count; however, the count for the total Western population fell to 1039, meaning the Natural Bridges monarchs represented 53% of the total overwintering population. The 2021/2022 winter saw an increase in overwintering site counts with the Natural Bridges at 2100 and 1700 at Thanksgiving and New Years respectively. While encouraging, this uptick in population numbers does not reverse the overall declining trend (Pelton et al. 2021).

To help ensure Natural Bridges State Beach continues to provide high quality habitat for the monarch population, with the support of the California Wildlife Conservation Board the California Association of Resource Conservation Districts, the Resource Conservation District of Santa Cruz County, California State Parks (State Parks), and NGO, Groundswell Coastal Ecology (Groundswell) have prepared this overwintering site management plan. This plan will help to better inform, implement, and track management actions that support conservation of monarch butterflies at the Natural Bridges overwintering site. *Any recommended actions taken are voluntary and at the discretion of the land owner.*

This plan was developed based on information collected during site visits by Groundswell staff, Samantha Marcum (Monarch Butterfly/Pollinator Regional Coordinator, USFWS), Nadia Hamey (Forester, Hamey Woods), Tim Hyland (Senior Resource Ecologist, CA State Parks), Martha Nitzberg (Interpreter, CA State Parks), and John Dayton (Independent Biologist). We also consulted previous overwintering plants from Lighthouse Field State Beach (Pelton et al. 2017) and Pismo State Beach (Pelton 2020). This plan approximates a template derived from the Lighthouse Field Mgmt. Plan (Pelton et al. 2017) and the USFWS Coastal Program Monitoring Framework by Marcum et al. 2014 / Prepared by: S. Marcum 10.2019.

2 Legal Status of Monarchs and Their Habitat

2.1.1 Federal

In 2014, the Center for Biological Diversity petitioned the USFWS to list the monarch butterfly as a threatened species under section 4(d) of the Federal Endangered Species Act (Center for Biological Diversity, 2014). The USFWS updated their status assessment on December 15, 2020 (USFWS, 2020), finding listing of the western monarch population was warranted but precluded. The finding stated that the USFWS could not identify Evolutionary Significant Units (ESUs) for monarchs, because, historically when invertebrates, including butterflies, are evaluated, they are evaluated across the entire range. The evaluation was based on the global population which includes monarchs that occur East of the Rocky Mountains and on multiple continents. Hence, the listing was precluded by species of higher priority. Monarchs were ranked at priority level #8 on species list, where they still remain, with the next USFWS determination set for 2024 (USFWS 2022). The USFWS will review/revisit the status of Western monarchs on an annual basis. The extremely low counts for 2021 were not included in the determination despite having been announced by the time the USFWS released their findings.

2.1.2 State

Monarchs are included on the California Department of Fish and Wildlife's Terrestrial and Vernal Pool Invertebrates of Conservation Priority list with a State Ranking of S2S3, Imperiled/Vulnerable (CDFW, 2017). The monarch is also listed as a Species of Greatest Conservation Need on California's State Wildlife Action Plan (CDFW, 2015). The Sacramento Superior Court recently ruled in Almond Alliance of California v. California Department of Fish and Wildlife, Sacramento Superior Court No. 34-2019-80003216 (Nov. 13, 2020) that insects are not protected under the California Endangered Species Act. This applies to Monarchs. However, monarchs are protected under California Fish and Game Code Section (1002) which prohibits the take or possession of wildlife and California Code of Regulations Title 14 Sections 650(a) and (b) which requires a valid Scientific Collection Permit issued by CDFW for "handling monarchs, removing them from the wild, or otherwise taking them for scientific or propagation purposes, including captive rearing." The California Coastal Commission also considers all monarch overwintering sites within the Coastal Zone to be Environmentally Sensitive Habitat Areas (ESHA). However, many Local Coastal Plans do not explicitly list overwintering sites as such, and thus enforcement of ESHA status is inconsistent across overwintering sites. More information can be found in the Legal Status of Monarch Butterflies in California (International Environmental Law Project and Xerces, 2012).

3 Site Description

3.1 Location

The Monarch Butterfly Natural Preserve (Preserve) is located within the 65-acre Natural Bridges State Beach (6.953124° -122.056296) in Santa Cruz, California on the Pacific Ocean at the northern edge of Monterey Bay. The Preserve is 20 acres located in the northeastern corner of Natural Bridges State Beach, bordered by Delaware Avenue to the north, Swanton Blvd. to the east, and Natural Bridges Drive to the west (Figure 1.).

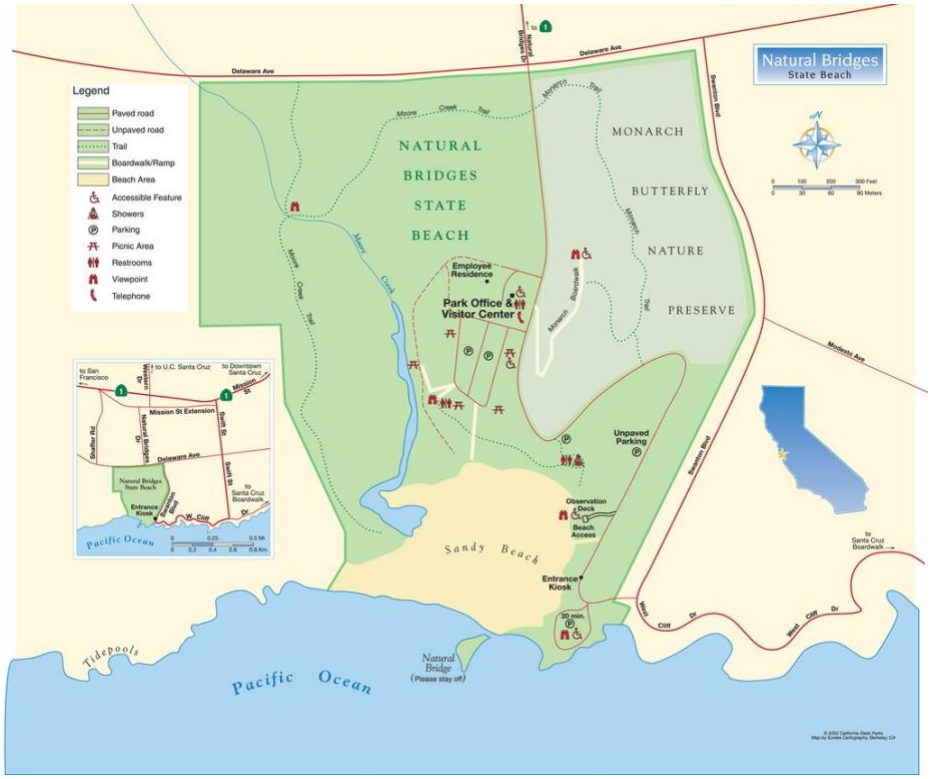

Figure 1. Map of Natural Bridges State Beach. source: Maplets - https://mobilemaplets.com/showplace/8373

3.2 History

The history of Natural Bridges State Beach is described in detail in Hyland (2000). Paraphrasing, this area was first home to Native Americans. The Ohlone were primarily semi- nomadic people who hunted terrestrial game and marine mammals, fished, collected shellfish, plants and widely used fire to manage the flora and fauna. Most of the Ohlone were decimated due to disease, malnourishment and genocide or displaced during California's mission period in the 1700's, which marked a transition from fire as a primary land management tool to grazing and agriculture. In 1874, Richard Harrison Hall acquired what is now Natural Bridges State Beach and used it for pasture. The City of Santa Cruz (City) purchased a right-of-way to what is now Natural Bridges State Beach in 1888. It was likely during this period that eucalyptus (*Eucalyptus globulus)* was first planted at the Park. A dairy remained here until 1906, when it was purchased by Fred Swanton who, unsuccessfully, attempted to develop it. Farming on the terraces and wetlands continued until it was acquired by the State Parks System in 1933 as Swanton Natural Bridges Beach. The Park was reclassified as Natural Bridges State Beach in 1963.

In 1958, Fred Urquhart provided the first written record of monarchs using the eucalyptus at Natural Bridges State Beach as a clustering site. Prior to this, nearby Lighthouse Field was also known to have a large population of overwintering monarchs, however construction and tree removal that occurred sometime between 1940 and 1970, seemed to have impacted the Lighthouse Field population. The monarch population at Natural Bridges State Beach,

subsequently, increased dramatically. In 1984, the Eucalyptus grove was designated a Monarch Butterfly Natural Preserve - the only one in California.

3.3 Land Ownership

Owned by the State of California and managed by the California Department of Parks and Recreation, Natural Bridges State Beach contains the Natural Bridges monarch overwintering grove. The Park is bordered by: the De Anza Mobile Home Park, owned by MHC Property Management, L.P. to the west; Antonelli Pond Preserve, owned by the Land Trust of Santa Cruz County to the northwest; administrative buildings, owned by University of California Santa Cruz to the north; vacant industrial land owned by Red Tree Properties, LP to the northeast; and a mixture of industrial and private residential properties to the east.

3.4 Habitat Description

3.4.1 Soils

Five soils types are found at Natural Bridges State Beach (Hyland 2000) with Bonnydoon loam as the predominant soil type within the Preserve. This soil occurs within Natural Bridges State Beach on 5% to 20% slopes. This soil phase is derived from sandstone, mudstone, or shale. The substratum is weathered sandstone. Bonnydoon soil has moderate permeability and moderate shrink-swell potential. The hazard of erosion is moderate to high.

3.4.2 Dominant Tree/Plant Species

The monarch overwintering grove is centered around the riparian corridor of a north/south-running low gradient unnamed seasonal stream that downcuts through flat topped first coastal terraces (Figure 2.). Historically, these terraces would have supported coastal prairie and coast live oak woodland. The core grove is along the stream and is composed of blue gum (*Eucalyptus globulus*) and river red gum (*Eucalyptus camaldulensis).* Blue gum is the dominant tree on the eastern and western terraces and is an overstory tree along the drainage floodplain. River red gum is a dominant understory tree along the riparian floodplain with larger specimens occurring on the slopes of the western bank adjacent to Natural Bridges Drive. There are few young trees and very limited regeneration of Eucalyptus in the core grove. The area to the northeast of the observation deck has become thin with decreased tree canopy since the early 2000's.

The understory of the core grove is extremely dense, 4-10 foot tall, vegetation dominated by poison oak (*Toxicodendron diversilobum*), Himalayan blackberry (*Rubus armeniacus*) and elmleaf blackberry (*Rubus ulmifolius*). English ivy (*Hedera helix*) is a major component of the core grove, where it climbs to over 100 feet into the overstory canopy. Coffee berry (*Rhamnus californica*), nasturtium (*Tropaeolum majus*) also occur throughout this area. Cape ivy (*Delairea odorata*) is also found throughout the grove. Pacific aster (*Symphyotrichum chilensis*) grows along the intermittent stream.

The West Terrace (Figure 2.) has a southern area dominated by tall mature blue gum and a few planted Monterey cypress (*Hesperocyparis macrocarpa)* that ring the perimeter of park

infrastructure (the visitor center, parking lot, staff residence, bathrooms, butterfly garden, equipment yards and several sheds). The grounds surrounding the facilities are landscaped with a diversity of native and non-native flowering plants intentionally selected to provide early and late season nectar resources. The northern area of the West Terrace contains a swath of Monterey cypress and coast live oak (*Quercus agrifolia*) planted between 1998 and 2006. There are also two clusters, one of mature blue gum and one of Monterey cypress, along Delaware Avenue. Interspersed throughout this area are rememenant patches of coastal prairie with invasive annual grasses, trace components of native plants and encroaching coyote bush (*Baccharis pilularis*) and poison oak.

The East Terrace (Figure 2.) has naturally regenerating and transplanted blue gum interspersed by patches of coastal prairie dominated by invasive annual grasses, native forbs, and encroaching coyote bush. This terrace also contains a short small intermittent tributary with moist wetland habitat that joins the seasonal stream of the core grove to the South. The terrace ridge between these drainages was planted between 1998 and 2006 with now 20-30 ft Monterey cypress to serve as a southern windblock for the grove. Douglas fir (*Pseudotsuga menziesii*), California bay (*Umbellularia californica*), and Monterey pine *(Pinus radiata)* were also planted on the East Terrace. The northern and eastern portions of the East Terrace contain tall mature Monterey pines.

The South East Terrace (Figure 2.) is home to tall, large diameter blue gum which is important for buffering the core grove from south winds. There is little to no blue gum recruitment in this stand.

Perched Dune as well as Strand and Dune habitats are present in the southeast portion of the park (Figure 2.). Parks, in partnership with the California Native Plant Society's Santa Cruz Chapter Habitat Restoration Team, and Groundswell Ecology have worked to increase the acreage and diversity of native flowering plants in these coastal areas since the early 2000's. These efforts have resulted in an extended bloom season of pollinator nectar plants.

Just downstream of the core grove the drainage widens and slows, forming a ephemeral freshwater pond and wetland surrounded by arroyo willow (*Salix lasiolepis*), sand, river red gum, and silver peppermint Eucalyptus *(Eucalyptus tenuiramis)* on the eastern margin of the pond. The pond supports Cattails (*Typha latifolia*), bur rush (*Sparganium eurycarpum*), duckweed (*Lemna sp.*), water fern (*Azolla filiculoides*), willow dock (*Rumex salicifolius*) and other wetland plants. During winter months, the pond fills creating aqueous habitat, saturating soils, and at times, inundating the roots of adjacent overwintering trees. Sandbar willows (*Salix exigua*) appear to have recently expanded in the area where the drainage enters the back of the beach, contributing to altered hydrology of this small drainage.

Moore Creek drains out of nearby Antonelli pond and forms the western border of the Natural Bridges State Beach (Figure 2.). as well as the western border of the City of Santa Cruz. The riparian wetland along Moore Creek has been planted with late blooming nectar plants by Groundswell Ecology.

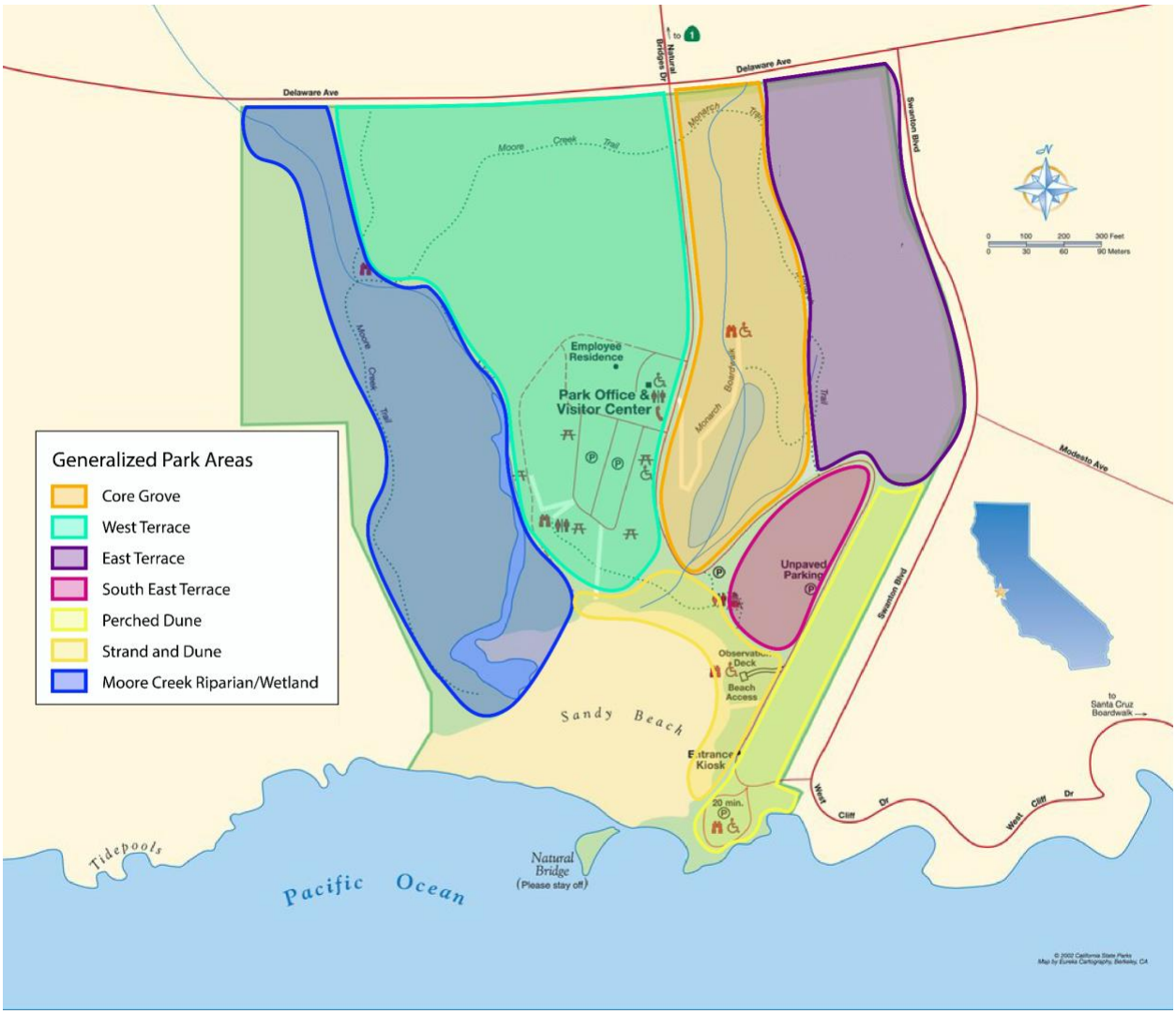

Figure 2. Generalized Map of Park Areas: Core Grove, West Terrace, East Terrace, Southeast Terrace, Perched Dune, Strand and Dune, and Moore Creek Riparian Wetland. Also shown are the access boardwalk, Monarch Trail, other park trails, Moore Creek, unnamed stream watercourse in the Core Grove with its pond and small tributary, as well as Park Roads and Facilities.

3.4.3 Fire

Historically, native peoples undoubtedly practiced cultural burning to steward the Park landscape. Despite largely containing fire-adapted vegetation, the Park has not been managed for fire resilience and little Park acreage has burned in the last century. When the Park was a dairy, vegetation was likely pasture-like under the grazing pressure of the cows. Several small fires have occurred in recent years (Figure 3.). All were set by people and rapidly suppressed due to vigilance in this highly visited urban edge setting and the fact that the closest fire station is less than 5 minutes away. Two fires occurred on the Eastern Terrace in 2016 and July 18, 2018. Two other fires occurred on the Western Terrace in 2018 and 2020. Fires were assumed to have been started by homeless campers, as illegal camping is common inside the Park boundaries. This,

combined with mental health illness and drug addiction, creates a situation where careless actions have started several fires which have threatened the entire grove. State Parks staff discourage campers however the camping pressure is challenging to enforce, often overwhelming understaffed rangers. The later fire on the Eastern Terrace occurred immediately adjacent to recent core overwintering cluster locations. While only burning a limited amount of acreage, this fire scorched important wind shelter blue gum trees, consumed down and dead fuels and resulted in recruitment of blue gum seedlings. Low intensity fire is effective for stimulating blue gum seedlings by providing heat that opens seed pods hanging on the tree.

Figure 3. Location and dates of recorded fires and other features important to monarchs at Natural Bridges State Beach?.

3.5 Current Use and Management

3.5.1 Acting Management Plans

3.5.1.1 California Department of Parks and Recreation

The Park is managed under the State Parks Natural Bridges State Beach General Plan (1992). This plan called for the creation and implementation of the Natural Bridges Ecosystem Management Plan which was authored by Hyland (2000).

Natural Bridges was designated as a State Beach in 1962 under Section 5019.56. of the California Public Resources Code. In 1984 the overwintering eucalyptus grove was designated as

a Natural Preserve under Section 5019.71 of the California Public Resources Code. Natural preserves "consist of distinct areas of outstanding natural or scientific significance established within the boundaries of other state park system units. The purpose of natural preserves shall be to preserve such features as rare or endangered plant and animal species and their supporting ecosystems, representative examples of plant or animal communities existing in California prior to the impact of civilization… Habitat manipulation shall be permitted only in those areas found by scientific analysis to require manipulation to preserve the species or associations that constitute the basis for the establishment of the natural preserve." In 1988, the lower reaches of Moore Creek were designated with the same Natural Preserve status.

The California Parks and Recreation Commission Statement of Policy (2005) also applies to Natural Bridges State Beach. It contains the 2005 Recreation Policy (1.1) that provides for Area Number 4. Preservation of natural and cultural resources. Policies of specific relevance are identified by Hyland (2000) as Policy II.4: Preservation of Vegetative Entities "…to preserve outstanding examples of native California species, and to… perpetuate significant natural plant communities, associations, and examples of rare, endangered endemic, or otherwise sensitive native California plants" and to use local genetic stock for restoration purposes. Policy II.5 Wildlife Management in Units of the State Park System includes "Programs of wildlife management involving the propagation or reduction of animal species may be carried on in the State Park System only where necessary to safeguard the health and safety of State Park System visitors or of the general public, or when the preservation of the wildlife species involved is threatened." Hyland (2000) points out additional relevant Commission Policy including Directives #15 State Recreation Units: protection of resources, #19 Protection of resources, #33 and #34 restoration of native species and removal of exotic plant species, and #35 maintaining the natural faunal habitat wherever possible.

The California Administrative Code, Public Resources Code (Chapter 7, Sections 5812 and 5816) provides for Wetlands protection and preservation.

Other noteworthy policies include the following. A Scientific Collection Permit is required for collecting or handling animals in the Park. Trees at overwintering sites which may be trimmed or removed under State Parks hazardous tree program. Non-native vegetation in the Park is not afforded legal protection, even if invasive vegetation supports overwintering monarchs for a portion of the year.

Natural Bridges State Beach General Plan relevant policies:

- Wetland Management: development and implementation of a management plan for the Moore Creek Wetland.
- Riparian Ecosystem: The integrity of the riparian ecosystem shall be maintained through development and implementation of a vegetation management plan. Control of non-native species shall be an important element of this plan.
- Exotic Plant Species: Exotic species capable of naturalizing shall not be used for landscaping within Natural Bridges State Beach. Management plans to control and eradicate Hottentot fig and jubata grass shall be developed and implemented. An exotic tree removal and replacement program shall be developed and implemented for areas

within the state beach boundary, except eucalyptus trees used as overwintering sites for the monarch butterfly shall be preserved. Native species from local population sources shall be used to replace exotic species.

- Monarch Butterfly Habitat: A "resource management plan shall be developed and implemented to promote the perpetuation of the Monarch butterfly resource within Natural Bridges State Beach."

The Natural Bridges Ecosystem Management Plan (Hyland 2000) contains a more thorough review and policies for management of the Park's ecological assets, including a section on monarchs and overwintering grove management. Parks consulted with Kingston Leong and Dennis Frey between 1990-1991 to identify conditions and management strategies that support the monarch resource.

Relevant objectives from the Natural Bridges Ecosystem Management Plan:

- Enhance monarch butterfly overwintering habitat.
    - *"Management techniques will be employed that will enhance monarch habitat while removing or controlling species with the potential to damage surrounding habitats, or endanger other wildlife within the park."*
    - *Minimize disturbance,,"management activities that have the potential to disturb this population, such as clearing of underbrush, fuel reduction activities, and tree pruning will be restricted to the months from April to September."*
    - *"Management actions will take place over a number of years and in incremental stages"* because large annual fluctuations make it difficult to assess impacts of management actions on monarch populations.
    - Focus on key environmental factors important to monarchs such as those identified by Leong and Frey: *"temperature, solar radiation, wind speed, and humidity. Along with these microclimatic factors, availability of water is required. On-site nectar sources in the fall serve to increase recruitment to the site while winter nectar sources serve to stabilize the population."*
    - *"Management must be undertaken with an eye to the future as well as with some understanding of the past state of this grove."*
    - Specific Actions:
        - Interplanting of Trees
        - Border Tree Plantings
        - Nectar Sources
        - Understory Management
        - Fuel Reduction
        - Lerp Psyllid Control
- Remove invasive exotic species from the park and replace them with native species from local populations.
- Maintain the integrity of the riparian ecosystem within the Park.
    - Address changes in Moore Creek's historic hydrology and sedimentation, undertake exotic species removal, and sensitive species management.
    - Flood Control and Pollution Abatement

3.5.1.2 Local Coastal Plan

Natural Bridges State Beach is in the coastal zone and falls under the purview of the Coastal Act (1972) which requires coastal jurisdictions to have a Local Coastal Program (LCP). The LCP includes a Local Coastal Plan, applicable to lands and resources in the coastal zone. The City's LCP was last updated in 1995 and combined with the General Plan. The LCP affords special protection to environmentally sensitive areas including the Preserve which contains both sensitive monarch habitat and riparian areas. The LCP has had several amendments (City of Santa Cruz Local Coastal Program, 2003). Monarch management is specifically included in the LCP:

4.5.3 Protect monarch butterfly overwintering sites and ensure adequate buffering of these sites from development.

4.5.3.1 Maintain a list and map of monarch sites showing the boundaries of all monarch sites within the City.

4.5.3.2 Require development in the vicinity of designated monarch sites to undergo environmental impact analysis and for development affecting sites prepare a management plan addressing preservation of the habitat that includes criteria such as:

Prohibiting the cutting, thinning, pruning or removal of any tree or shrub (especially nectar plants used by monarchs) except as necessary for safety of homes or persons and requiring replacement of comparable vegetation.

Prohibiting pesticide use and keeping all water sources clean.

Allowing construction only during the months when monarchs are not present

Keeping smoke from infiltrating monarch roosting sites.

4.5.3.3 Explore funding for the public acquisition of privately-owned monarch butterfly habitats and place signs and information at City-owned sites.

4.5.3.4 Encourage private landowners and visitors to protect monarch sites by making biological management guidelines available to the public.

The City is currently working on the Public Review Draft of the Santa Cruz Local Coastal Program (2021). This plan includes Figure IIID-2 Sensitive Habitat Areas showing 'Potential Monarch Butterfly Habitat'. The authors communicated to the City that this figure should distinguish between potential and known monarch butterfly habitat. We have recommended that Figure IIID-2 be modified to show 'Monarch Butterfly Overwintering Habitat' including that at Natural Bridges State Beach.

3.5.2 Previous Plan Implementation

State Parks staff, volunteers, and NGOs have implemented some actions identified in Hyland (2000).

I. *Inter-Planting of Trees* Core Grove inter-planting of blue gum and limited numbers of river red gum at the southern end of the drainage to protect against strong storm winds from the south.

II. *Border Tree Plantings* Planting of several native trees and shrub species to reinforce existing windbreaks on the East and Western Terraces of the grove. Over 170 trees and shrubs were planted on the terraces between 1998 and 2006 with most of the planting following the planting plan found in Appendix C (Hyland 2000). To ensure success, a variety of plant species were utilized and subsequently monitored. Monterey Cypress were planted to provide extra height.. Hyland notes that if multiple species establish, they will be thinned to provide the greatest diversity and efficacy of the screen. Thinning of the border plantings has not yet been done and will be addressed in this management plan update.

III. *Nectar Sources* Hyland (2000) noted that the Eucalyptus spp., cape ivy and English ivy provide the most significant winter nectar sources complemented to a lesser extent by native willow, Pacific aster, coyote bush and rough cats ear (*Hypochaeris radicata*). In an attempt to increase native nectar plant abundance, Pacific aster and marsh goldenrod (*Euthamia occidentalis*) were planted in the low areas surrounding the boardwalk. Pacific aster was also planted along the north, and west and edge of the core grove. These plantings have persisted in some areas but have not expanded, perhaps due to limited sunlight and competition from English ivy, poison oak, and blackberry specie.,

Parks has since planted additional nectar plants primarily along Natural Bridges Drive and on the visitor center grounds. This activity is supported by an active Docent Stewardship Program that logs 1000's of volunteer hours annually. In partnership with Groundswell, additional nectar plants were planted on the Dunes and Terraces from 2016-2021.

To support plantings, Parks installed and maintained an irrigation system tied into the visitor center's water system for tree plantings on the West and East Terraces. A functional water line to the East Terrace is still in place and abandoned PVC irrigation pipe remains in portions of the terraces.

IV. *Understory Management* In 2000, European blackberry was the dominant understory and thought to inhibit Eucalyptus recruitment and harbor black rats *(Rattus rattus)*. Hyland's 2000 plan specified blackberry removal and replacement over a period of at least five years. The area was then to be replanted with a mixture of California blackberry *(Rubus ursinus)*, coffee berry *(Rhamnus californica)*, hedge nettle *(Stachys bullata)*, bee plant *(Scrophularia californica)*, marsh goldenrod and California aster. While never completed, the blackberry retreated on its own and the understory is now dominated by poison oak with traces of European blackberry and English ivy. Further understory management is addressed in this plan.

V. *Fuel Reduction* Fuels reduction was conducted in 2001 in the grove. Wood was cut and removed to outside of the grove where it was burned or allowed to decompose. Since, only small amounts of woody debris have been removed. Some of this was piled without ground contact and remains in or around the grove. Substantial amounts of large wood have accumulated, creating an increased fire risk and unhealthy silvicultural state. Additional fuels reduction is warranted and will be addressed in this plan.

VI. *Lerp Psyllid* Psyllaephagus parasitic wasps provided by the University of California Berkeley were released as a bio-control agent and have effectively controlled outbreaks of the river red gum Lerp psyllid *(Glycaspis brimblecombei)*.

Additional actions implemented by John Dayton and State Parks interpreter Martha Nitzberg include:

- Additional planting of nectar plants.
- Removal of invasive species such as poison hemlock *(Conium maculatum)* and Italian Thistle *(Carduus pycnocephalus).*
- Development of the monarch nectar garden.
- Yellow jacket control.

3.5.3 Access

Parks founded a docent program in 1987 and a boardwalk for viewing the butterflies was constructed with support from local nonprofits soon after in 1988. Today, the ADA accessible elevated boardwalk leads from Natural Bridges Drive, near the visitor center and parking area, down through dense understory, along a seasonal freshwater pond and over the unnamed stream. The boardwalk terminates at a viewing platform that was built at the base of the "butterfly tree," a common place to find butterflies sunning at the time the boardwalk was first constructed. Visitors can read the interpretive signs that line the boardwalk and sit or lay on the viewing platform to stare up at the eucalyptus trees in search of clustering, sunning or flying monarchs.

The Monarch Trail (Figure 1.) is a dirt trail leading from the boardwalk along the eastern edge of the pond, which floods the trail after rainfall. The trail then climbs over tree roots and sandstone outcrops up to the East Terrace. The trail continues north along the top of this terrace (a popular area for monarch sunning) and eventually loops back over the unnamed drainage to exit the forest onto Natural Bridges Drive, near the park entrance at Delaware avenue. The portion of this trail next to the pond is in need of improvement, which will be addressed in this plan.

3.5.4 Outreach

Natural Bridges monarchs attract thousands of school children and visitors annually during the overwintering season (Figure 4.). Sakai and Calvert (1991) observed "This is the premier monarch overwinter site for DPR. It is second to the Pismo State Beach in size and has the finest docent and education program of any of the coastal units we visited." State Parks does not keep estimates for the number of visitors to the grove but according to State Parks interpreter, Martha Nitzbergm, from mid-October to mid-February there are: five K-3rd grade school groups per day, five days a week, totalling ~15,000 students; many other weekday environmental science school program visitors; and hundreds of visitors each weekend. Traditionally the park holds the Welcome Back Monarchs Festival in mid-October and the Monarch Migration Festival in mid-February which attracts hundreds of local and out of town visitors.

Figure 4. Visiting school groups on the boardwalk at the core of the monarch grove.

3.6 Climate Change

Climate change is impacting ecosystems at a global scale, including the Natural Bridges overwintering site. Primary climate change impacts that threaten the resilience of this site include the following:

3.6.1 Sea level rise

Sea level rise (SLR) will inundate low lying areas, including coastal lagoons, of the Park with seawater. The City of Santa Cruz Beaches Climate Adaptation Policy Response Strategy Technical Report (Central Coast Wetlands Group and Integral 2020) show that the Natural Bridges Beach back dune will likely be inundated by 2030 with SLR progressing into the unnamed drainage by 2060. SLR will likely increase salinity of this coastal aquifer and adjacent soils. SLR will also exacerbate coastal flooding of low lying areas during periods of high rainfall and runoff where stormwater runoff rates will slow due to higher sea levels as freshwater flows to enter the ocean. This will invariably affect grove trees and visitor serving infrastructure in low lying areas.

3.6.2 Drought

The North American West is experiencing extreme drought. Natural Bridges is dependent on the shallow water aquifer that is derived from a relatively small watershed, meaning that rainfall is the key water source for grove trees and nectar producing shrubs. Declines in precipitation reduces plant productivity, decreases bloom duration, contributes to tree limb loss, weakens trees, increasing susceptibility to disease and pests, and can lead to plant death. Over the past few years we have observed a high rate of limb loss and self-pruning presumably in partial response drying conditions.

3.6.3 Warming Winters

As winters warm, monarchs will spend less time in diapause and have a metabolic need to forage on nectar plants. This will put additional pressure on existing nectar sources. Warm weather also alters flower bloom phenology with plants blooming earlier than previously observed. We observed this during the warm January in the winter of 2021-22 where spring bloomers such as pink flowering currant (*Ribes sanguineum v. glutinosum*) and blue-blossom ceanothus

(*Ceanothus thyrsiflorus*) began blooming in January. While potentially beneficial to monarchs, this early blooming could be offset by a lack of rainfall during drought years. Warmering winters may also reduce the prevalence of morning dew and fog, both of which the monarchs rely on for water. Fog is also an important component of the water budget for many plants including blue gums in Central Coastal California.

3.6.4 Fire

The frequency and severity of fires is increasing in California. This is in part due to reduced precipitation and dry winds of increasing strength. The fire season has also expanded with winter fires becoming more prevalent. Scientists expect this trend to continue. The Natural Bridges grove has already experienced 4 fires in recent years and managers should be prepared to mitigate the risk of catastrophic fire in the grove.

3.6.5 Increased visitor pressure/usage

Coastal areas are recognized as having moderate stable temperatures which makes them popular destinations for residents of inland communities during periods of high temperatures. As the magnitude, frequency and seasonality of high inland temperatures continue to increase, visitorship of coastal areas has grown by several orders of magnitude. There is a need for the park to plan to accommodate increased use while simultaneously protecting natural resources, particularly monarchs.

4 Survey Information for overwintering monarchs

(history of monarch counts at site and estimates by year, Thanksgiving counts cluster locations, predominant winds, areas for monarch sunning, nectaring, water sources, other behaviors including movement throughout the season.) Contact wmtc@xerces.org for copies of overwintering site counts or online at www.westernmonarchcount.org.

4.1 Historical Monarch Counts and Estimates

The first published survey of Natural Bridges was Walt Sakai and Bill Calvert's 1990 statewide survey of monarch overwintering sites (Sakai and Calvert 1991). They observed 20-30,000 monarchs on November 11, 1990 and a maximum of approximately 70,000 butterflies on Jan 4, 5, and 10, 1991. Using mark-release-recapture (MRR) techniques, Dayton and Bell estimated 140,000 monarchs on Jan 4, 1991 (Dayton and Bell, pers. comm. in Sakai and Calvert 1991). Sakai and Calvert noted several monarch overwintering sites further up the Moore Creek drainage in 1990-91 including: the Outlook Apartments located on the west side of Western Avenue; north of Highway 1 there were several thousand butterflies in the eucalyptus trees downhill from the apartments; and Home of Peace Cemetery on Western Drive and Meder Street had as many as a few thousand butterflies.

Thanksgiving counts have been conducted at Natural Bridges annually since 1997 (Table 1. & Figure 5.). The peak count was recorded in 1997, with 120,000 monarchs present (Xerces 2021). The lowest count of only 550 monarchs was recorded during the 2020-21 winter (Thanksgiving Count 2020). This same low number held for the New Years Count (Xerces 2022). Because

monarch populations, like those of many insect species, naturally fluctuate from year-to-year, examining trends over decades provides a more accurate estimate of the population at the site than comparing any two individual years. An average of counts from all sites during the Thanksgiving Count period between 2018-2021 is down 45% from the 2010-2014 average and down 97% from the 1997-2001 average.

Dayton and Nitzberg have observed a mid winter decline in monarch numbers. While this trend has been observed at other overwintering sites (Xerces 2021 and 2022), the magnitude of mid winter declines at Natural Bridges is greater than at other locations. John Dayton hypothesizes that the butterflies are unable to find appropriate mid- winter roosting sites (Dayton pers. comms.). New Years Counts, which began in 2017, demonstrate this phenomenon (Table 1.).

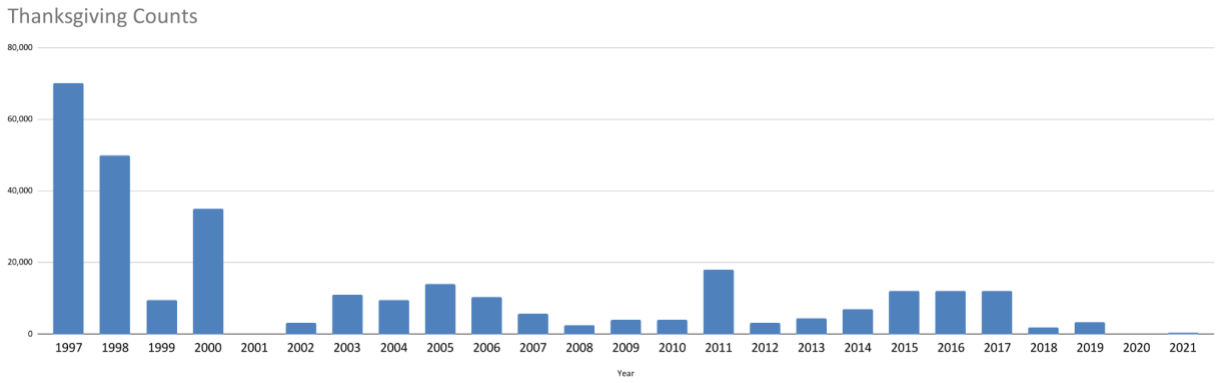

Figure 5. Thanksgiving count data for Natural Bridges 1997 - 2021 (source Xerces 2021).

Table 1. Thanksgiving and New Years Count data for Natural Bridges, Lighthouse Field and Davenport (source Xerces 2021 & 2022).

Year	Natural Bridges TC	Natural Bridges NYC	Lighthouse Field TC	Lighthouse Field NYC	Davenport TC	Davenport NYC
1997	120,000		70,000			
1998	60,000		50,000			
1999	15,000		9,500		>=100*	
2000	20,000		35,000			
2001	3,000					
2002	6,000		3,200			
2003	5,700		11,000			
2004	9,600		9,600			
2005	3,900		14,000			
2006	7,300		10,300			
2007	2,700		5,700			
2008	3,500		2,607			
2009	1,300		4,000			
2010	2,300		4,000			
2011	3,000		18,100			
2012	500		3,200			
2013	4,600		4,500			
2014	3,400		7,000			
2015	8,000		12,000			
2016	3,500	3	12,000	10,214	2,417	
2017	9,000	0	12,000	13,533	2,876	
2018	1,120	765	1,802	1933	694	
2019	1,997	25	3,402	2600	167	57
2020	550	550	50	13	0	1
2021	2,100	1700	410	637	985	215

TC = Thanksgiving Count, NYC = New Years Count**

* Observations on 17 Nov by Dayton detected min # of 100

** New Years Count included in Thanksgiving Count Year

4.2 Cluster locations

When roosting, monarchs form both aggregations and clusters. We define clusters as aggregations that remain in the same location for weeks with adjacent monarchs positioned with overlapping wings. Aggregations are less dense and more ephemeral, often only lasting for a few days. Monarchs may aggregate and cluster at different sites within the grove depending on the

time of day, time of year and weather. Records of locations where monarchs roost in the grove help identify important microsites within the grove. The mid-winter roosts reflect core clusters in late December/early January, a critical time during the overwintering period. These locations are highly important areas (Dayton pers. comms). Midwinter roost sites, as well as other cluster and aggregation sites, from the 1980s to present (Nitzberg pers comms) are shown in Figure 6. It is important to note that aggregations are dynamic thus mapping their locations represent a snapshot in time (Dayton pers. comms).

The areas to the east of the observation deck were important mid-winter roosting sites during the 1980s and 1990s. Starting in the early 2000s, a time with decreased tree and canopy cover, the clusters began moving southward (Nitzberg pers. comms.), a pattern that has continued into recent times. During the 1980s, 1990s and early 2000s the small central tree to the north of the observation deck, the “butterfly tree”, was an important late season mating and sunning aggregation site during warm conditions, when monarchs are actively flying (Dayton pers. comms.). In recent years, the primary butterfly clusters have been located south of the observation deck, just north of the split in the boardwalk/interpretive trail, and also adjacent to the pond, sometimes near the water's edge. In 2020-21, the 550 overwintering monarchs, 25% of the documented overwintering western population, frequently roosted in a silver peppermint Eucalyptus two meters from the pond water's edge.

The pond has flooded more frequently in recent years, with water extending further into the grove (see Reducing Monarch Mortality in Section IV.). Dayton (pers. comms.) observed butterflies avoid roosting over open water during flooding events, presumably due to the hazard posed by being dislodged by high winds and falling into the water. While this site is viable during good weather; precipitation, flooding and wind exposure make this a poor clustering location during inclement weather.

A section of the Moore Creek riparian corridor between Highway One and Antonelli Pond is an important autumnal site where monarchs stage prior to moving to overwintering sites (Dayton pers. comms. Figure 7.).

Figure 6. Historic monarch cluster and aggregation locations; monarch sunning locations and water sources. Water sources include the intermittent unnamed creek through the main grove, the wet area past the east terrace and the seasonal pond in the grove.

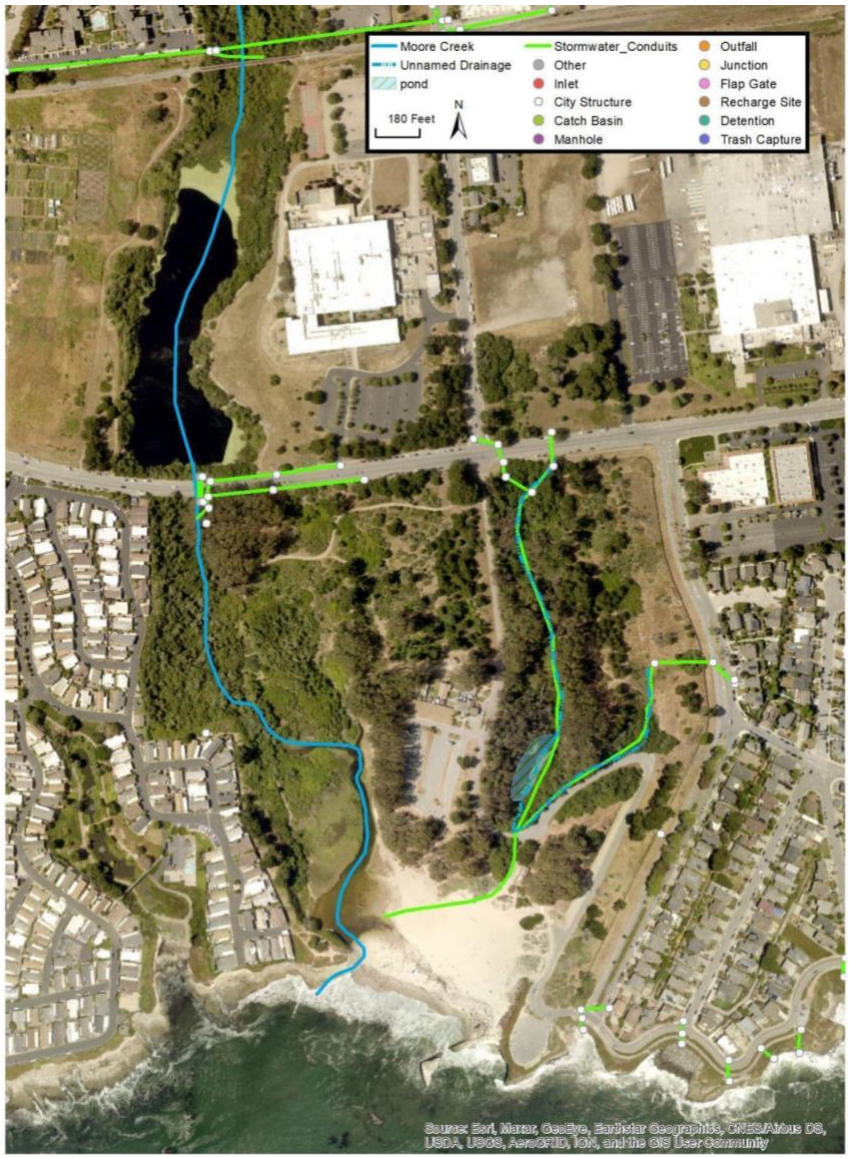

Figure 7. Moore Creek riparian corridor includes Antonelli pond (body of water in upper left of map). Also shown is stormwater drainage surrounding the overwintering grove.

4.3 Roosting Habitat Trends

Sakai and Calver (1991) observed "that there has been some discussion among monarch biologists that the grove is becoming too dense and that the site is becoming too shaded and cold for the butterflies. In recent years, Dayton (pers comms.) has observed that monarchs are unable to find appropriate roost limbs in mid-late December and typically disperse before January. While reasons for this are unclear, both Hyland (pers comms) and Dayton have noted an increase in light infiltration into the grove over time, which may be associated with wind fall, tree senescence, increased self-pruning, or leaf canopy thinning. Increased recruitment of grove trees could help mitigate this change over time.

4.4 Tree Recruitment

Very few Eucalyptus are recruiting in the main grove, likely due to the dense understory combined with dense canopy. Recruitment is occurring on the East Terrace following fires that occured in 2018. This is consistent with observations of blue gum recruitment at Lighthouse Field following fuels reduction and chipping operations. This suggests that natural processes such as fire and/or chipping can promote recruitment and could be applied to the Natural Bridges grove in select areas.

4.5 Wind

Natural Bridges State Beach is located on the northern coast of the Monterey Bay where winds play a dominant role in environmental forcing and are a key variable that groves buffer against. The general wind pattern phenology is:

- Fall - relatively calm winds with occasional strong northerlies or southerlies.
- Winter - strong southern winds occur when low-pressure fronts move onshore followed by northwest winds as the fronts move inland, cold north winds can blow down off of the Santa Cruz Mountains.
- Spring - strong northwest upwelling winds. Both the south and northwest winds can gust above 45 knots. The south winds often precede rain and lower temperatures, which can knock roosting monarchs to the ground.

Once grounded, monarchs require a period of dry and warm weather to be able to regain access to the roost. At Natural Bridges, the deep narrow riparian north-south running riparian corridor offers considerable protection from prevailing winds, while allowing for the penetration of sunlight into the grove (Hyland 2000).

Parks has taken measures to maintain the buffering capacity of the core grove. Windbreaks were planted to the east and west of the grove in the early 2000s (Figure 8.). There were several different species of trees planted including some that are incongruent with Parks policy, including western red cedar (Thuja plicata) and possibly, English oak (Quercus robur). The later may be volunteers disperse by native animals such as California scrub jays (*Aphelocoma californica*)

The west plantings are especially critical for sending northwest winds up and over the grove. Fires on the eastern side of the grove appear to have facilitated natural Eucalyptus regeneration. The canopy is now increasing in this area and planted cypress are coming of size to bolster this southeastern windbreak. Maintaining trees on the west and east side of the parking area may help buffer the pond area from northern and south eastern winds, however the mouth of the small drainage and pond continue to allow southern winds to penetrate to the grove core. Strong wind events often result in multiple limb falls year round.

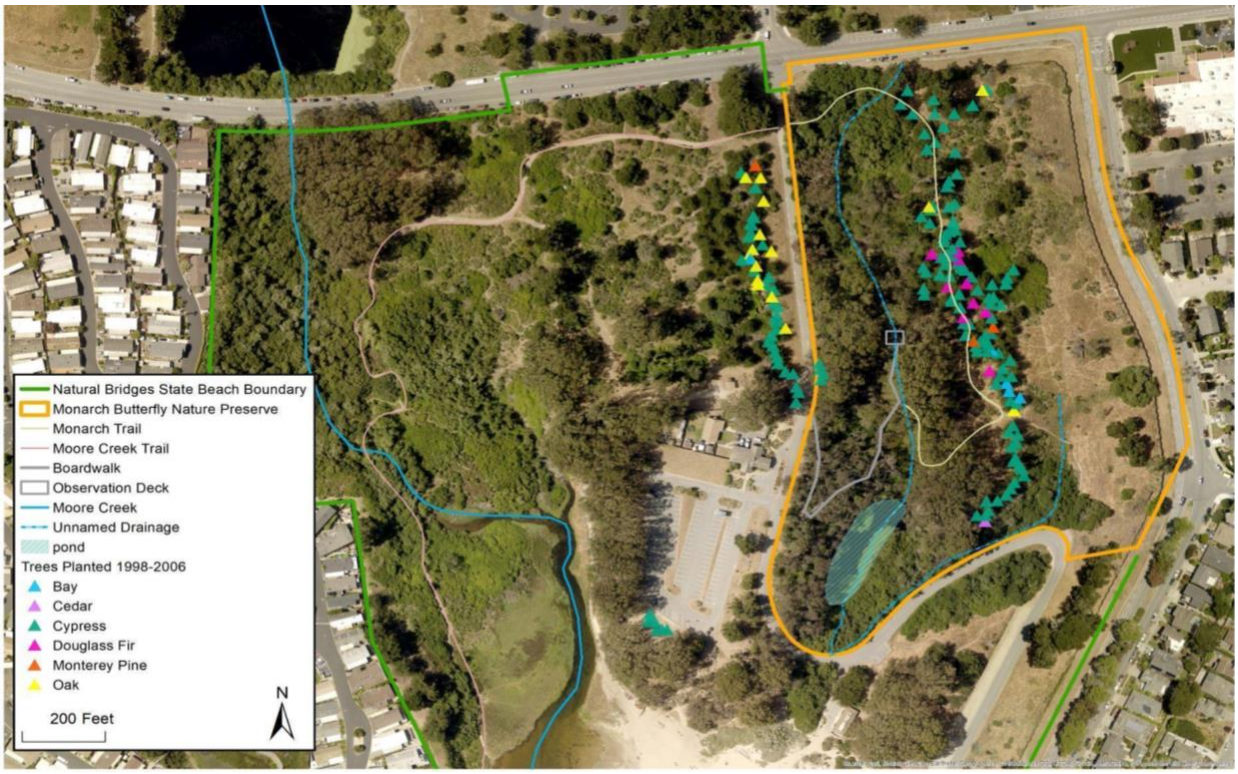

Figure 8. Map of windbreak plantings at Natural Bridges State Beach.

4.6 Sunning

Monarchs frequently sun on the lower blum gum and Monterey cypress branches and coyote bush on the East Terrace (Figure 6.). Parks has managed this as an open area that offers clear and protected sunning space with elements of coastal prairie and now encroaching coyote bush. Monarchs also can also be found sunning within the grove in locations where sunlight streams up the south facing canyon.

4.7 Nectaring

On warm days, monarchs have traditionally nectared in sunlit areas within the core grove, West, and East Terraces. Late blooming fall nectar species include river red gum, coyote bush, marsh baccharis (*Baccharis glutinosa*), Pacific aster (Sy*mphyotrichum chilense*), Western flat-topped goldenrod (Euthamia occidentalis), California goldenrod (*Solidago velutina*), goldenbush (*Ericameria ericoides*), and gumplant (Grindelia stricta). Highly important winter flowering nectar sources are the blue gum eucalyptus, which has annual variation in flowering intensity (~November - March), English ivy and Cape ivy. Early spring nectar sources include a host of native species such as arroyo willow, wild lilac (*Ceanothus thyrsiflorus*), red flowering currant (*Ribes sanguineum*), and others. Introduced wild radish (*Raphanus sativus*) and wild mustard (*Brassica nigr*a) are also available but are primarily offsite on private lands to the North. Monarchs have also been observed nectaring in the nectar garden on pincushion (*Scabiosa spp*). Figure 9. shows a map of nectar plantings. A list of nectar species planted is in Appendix I.

Figure 9. Map of nectar planting and restoration at Natural Bridges State Beach.

4.8 Water Sources

Overwintering monarchs require consistent access to water in the form of pooled water or dew. There are multiple water sources for monarchs at Natural Bridges including the pond (both margins and center), waters in the unnamed drainage, dew in meadows on the East and West Terraces, and potentially, Moore Creek. Availability of these sources are subject to patterns in precipitation, relative humidity, and dew point and will likely be of increasing importance under climate change scenarios which signal a drying climate in Central California.

4.9 Natural Bridges as a Site Complex

Unpublished marked capture and recapture research in Santa Cruz County indicates that overwintering monarchs move within and between overwintering sites throughout the season (Dayton pers. comms). It is hypothesized that most inter-site movement is between nearby sites (1-5 miles apart) (Pelton 2020). Tagged monarchs have been observed moving between Natural Bridges State Beach and other nearby sites such as Lighthouse Field State Beach (<2 miles). In some years, the mid-winter exodus from Natural Bridges is accompanied by increases in butterfly numbers in the Lighthouse Field New Years monarch counts (Table 1). Despite this, Dayton does not consider sites to be part of a site complex, and while inter-site exchange occurs

and sites are not entirely independent of each other, each site remains separate and unique. Additional research would help to determine the percentage of the overwinter populations that move between regional overwintering sites.

5 Management Plan Actions

The management plan actions aim to synthesize multidecadal local cross disciplinary knowledge of partners and literature to create a clear vision and roadmap for implementation of actions that will protect and enhance monarch habitat at Natural Bridges.

Management actions are broken into the following categories: Forest and Tree Management; Reducing Monarch Mortality; Nectar Sources and Milkweed; and Public Engagement. Each section will outline the threats to maintaining and/or increasing the monarch population and offer potential solutions.

5.1 Forest Management

The forest management actions suggested in this plan will address the site-specific threats of fuel loading/fire hazard, lack of regeneration, and lack of roosting habitat. The primary goals of forest management actions are to:

- Prevent catastrophic fire in the grove through fuels reduction and other management actions.
- Maintain and restore suitable microclimate with appropriate wind protection and solar radiation.
- Maintain a varied vertical structure for roosting, aggregations and sunning monarchs.
- Optimize tree health to prevent outbreaks of disease and pests.
- Promote regeneration of wind block, roosting, and aggregation trees in and surrounding the grove.
- Support transitioning to native tree species, where appropriate.

5.1.1 General Forestry Guidelines

5.1.1.1 Fuel loading

The absence of fire, combined with infrequent fuels management, has resulted in heavy fuel loading throughout the park but of particular concern in the core grove. The understory consists of suspended dead and downed limbs and trunks interlayered with bark strips and debris from the overstory eucalyptus. Live components include poison oak, blackberry and English ivy that rise above a thick layer of debris. The combined understory reaches heights of over 10 feet. It is unclear if this understory is beneficial to monarchs. The suspended dead and downed limbs may provide benefits of thermal insulation and wind protection, however, the thick understory also reduces circulation promoting fungal tree pathogens that can kill grove trees, increases the risk of canopy fires, provides habitat for invasive rodents such as black rats which have been implicated in predation on monarchs (Ruiz 2018), and reduces the biodiversity of understory flowering plants.

The grove is susceptible to fire with substantial ladder fuels and, under the right conditions, could lead to a catastrophic crown fire that kills grove trees and, if during the overwintering season, kills roosting monarchs. While this latter scenario is unlikely under historic weather conditions, the frequency, intensity and seasons of extreme fire weather has increased in recent years with winter fires becoming more prevalent in Central California. One factor that helps mitigate this risk is the potential for rapid fire suppression response is high owing to the fact that the Santa Cruz City Fire Department Station on Younglove Avenue is 1.5 miles away and a fire hydrant is located ~150 meters from the core grove which supports rapid hose deployment and high volumes of water. This said, rapid response is subject to the instantaneous demand for EMS services for the entire community, which have historically been overextended during extreme fire conditions.

An assessment of the core grove was conducted by Nadia Hamey (2021) of Hamey Woods. In this assessment the following were documented as existing conditions that would contribute to catastrophic loss of this overwintering site:

- Heavy fuel loading has created a high fire risk.
- Reducing fuel loading in strategic locations and ladder fuels around significant trees will reduce the fire hazard.
- Fine ladder materials present are associated with high wildfire rate of spread.
- Large woody debris pose a reduced fire hazard because they maintain soil moisture and are consumed very slowly.
- Putting dead and downed branches in ground contact will increase fuel moisture and decomposition rate.
- Hazard Tree Guidance (public safety first, should be assessed annually). No notable hazard trees were identified, but the risk tolerance ultimately depends on a combined risk threshold of public safety and monarch habitat. Note that Cal/OSHA definitions of hazard trees need to be considered.

We identified five treatment sites in the Core Grove that need fuels reduction which can also stimulate seedling recruitment (Figure 10.).

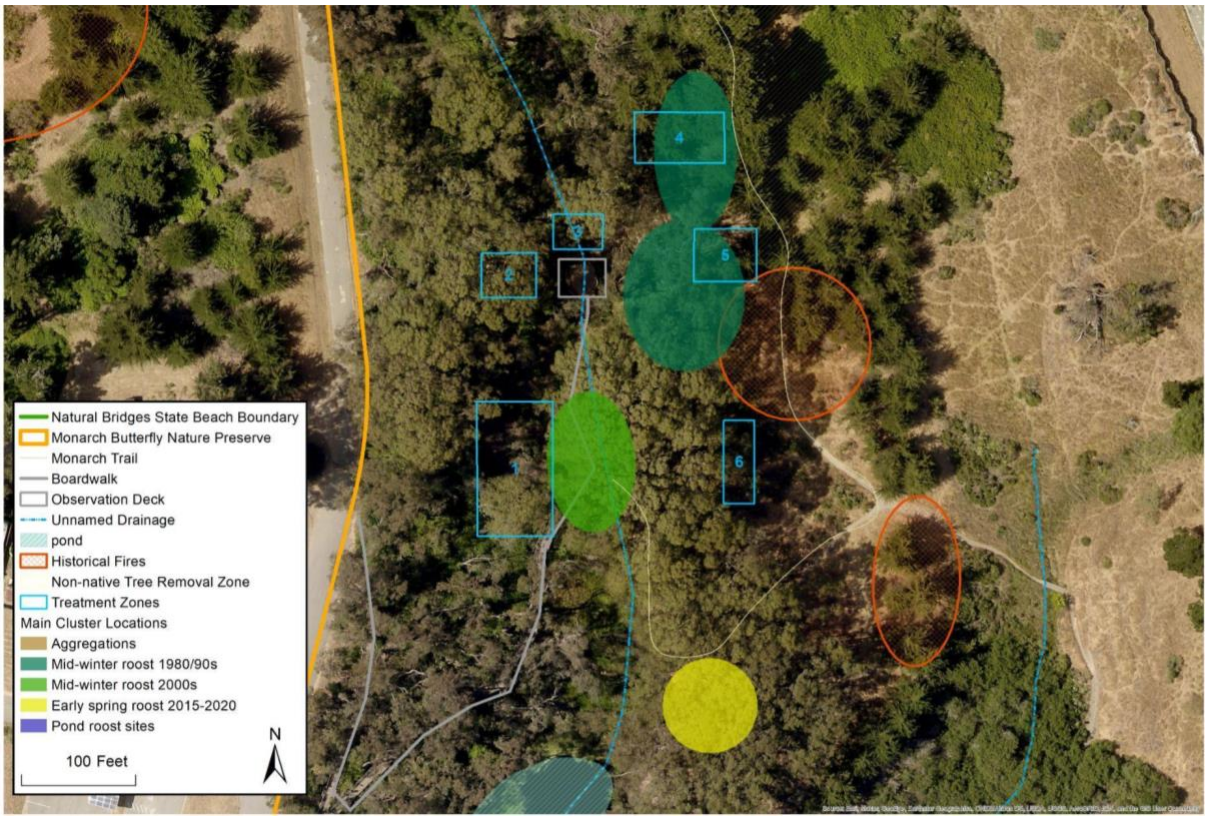

Figure 10. Fuels treatment zones in the core grove.

To address above mentioned conditions, recommendations were made for individual treatment zones within the core grove, which include:

1. Open area to the west of the elevated boardwalk. High coverage of poison oak and slash, no trees in this area.
2. Flat area directly west of the observation deck. Currently receives heavy browsing by deer. Reduce fuels and promote recruitment.
3. Flat area directly north of the observation deck around the base of "butterfly tree." Reduce fuels and promote recruitment.
4. On the talus hillside east of the boardwalk. Reduce fuels and promote recruitment.
5. Eucalyptus grove edge. Downed Eucalyptus limbs, reduce fuels and promote recruitment.
6. On the talus hillside east of the start of the Monarch Trail. Reduce fuels and promote recruitment.

5.1.1.2 Fuels reduction

There are multiple methods to reduce fuels and stimulate recruitment. Any treatment will need to occur between April and October when the monarchs are absent. Treatments should be accompanied with follow up monitoring to assess recruitment of seedlings and unwanted invasive weeds. Treatments should be regularly scheduled with re-entry intervals based on follow up monitoring. The suggested interval is approximately 5 years.

5.1.1.2.1 Mechanical Mastication

A small excavator or skid steer with a mulching head could be used to mulch understory fuels. Mulch would remain onsite and need hand raking to scatter to a depth of 3 inches. Equipment could access the area from West via Natural Bridges Drive. The access path should be oriented diagonally to the slope and away from monarch clustering sites in a manner that does not create a pathway for northwest winds to enter the grove.

5.1.1.2.2 Hand Crew Mastication

Hand crews with chainsaws could cut and put downed fuels in contract with the ground. Larger materials could be removed and chipped on-site. The chipper would need to be located on Natural Bridges Drive. Chips could be redistributed to their source footprint to a depth of 2 inches, or moved to support restoration activities in other locations. Leaving chips onsite can help retain soil moisture. We observed blue gum seedlings recruiting to recently mulched areas at the nearby Lighthouse Field Overwintering Site. The exact mechanism for this recruitment is unclear and may be due to seed rain on mulched areas or associated with the chipping procedure which may open pods, releasing seeds into the chips.

The fuels at Natural Bridges have a large poison oak component which makes it difficult to move cut fuels large distances to the chipper and creates a mulch that is hazardous to workers susceptible to poison oak. The California Conservation Corps (CCC) have expressed concern about having their crews brush areas with high poison oak content. Another option for hand crews is to stage materials for pile burns. Piles burning specifications are detailed under prescribed fire.

5.1.1.2.3 Browsing

Browsing with goats may help to reduce fuel loading and create advantageous soil disturbance as goat hooves create bare areas required for recruitment of blue gum seedlings. Deer are prevalent in the core grove, and they consistently graze the blackberry in Zones 2 and 3. This treatment would require prescribing parameters such as fenced browsing areas, duration and the number of animals. These variables could be optimized based on observation. This method could help reduce that amount of poison oak but will not remove dead and downed material. Goats may also climb and hoove trees to reach live blue gum forage and could potentially introduce new weeds.

5.1.1.2.4 Burning

Two primary forms of burning could reduce fuels: pile burning and broadcast burning.

5.1.1.2.4.1 Pile Burning

Pile burns are an effective low risk, time intensive treatment for reducing fuels and receiving some of the benefits of fire on the landscape. Pile burning reduces the effort in moving fuels to stationary chippers. Pile burns can be extinguished to leave a varying amount of charcoal that can remain as a ground mulch. Piles can also be located under overhanging Eucalyptus limbs with seed pods. The heat from the burn will open the pods resulting in seed rain that will

facilitate recruitment. Pile burns would need to occur outside of the overwintering season when monarchs are not present. If covered, piles could overwinter for spring burning in April.

Specifications for pile burns:

- Secure burn permits as necessary.
- Partners may include: CA State Parks, the Central Coast Burn Association/AMLT/City of Santa Cruz
- Research possibility of using CADPR fire funds
- Size: variable depending on location.
- Ignitions would occur when surrounding fuels were unavailable to reduce risk.
- Timing of Spring cut and immediate burn, Spring/Summer/Fall cut and fall burn, Spring/Summer/Fall cut and overwinter for Spring burn.
- Maintain adequate spacing from live trees to reduce tree kill, stump sprouting and coppicing/undesirable tree structure.
- Flag and avoid existing saplings during treatment.
- Recognize the outreach opportunity for good fire with messaging such as “Use of fire to enhance monarch butterfly overwintering groves”. Include outreach signage on burn piles.

5.1.1.3 Regeneration/Recruitment

Blue gum, the primary grove trees, are fire adapted and benefit from fire or fire like processes. We have observed blue gum regeneration following previous site fires. Fuel treatment areas could be accompanied by adding pre-treated blue gum seeds following treatments. Note the red river gum is fire intolerant (Dexter 1978) but seeds could still be added following treatments.

5.1.1.3.1 Manual Soil Scarification

Soil scarification could be performed as follow up treatment after fuels control in select areas where germination is desired. This would involve manual removal of surface soil organic matter and raking of the bare soils. Bare soils treatments will require monitoring and follow up treatments to ensure invasive weeds do not establish following the disturbance.

5.1.1.4 English Ivy

English ivy extensively covers some blum gum trees and may compromise tree health. Potential solutions include partial removal of ivy down to 50% to 75% of the tree height. Efforts should attempt to leave ivy flowers as they are important winter monarch nectar sources. Ivy removal would be determined on a case-by-case basis.

5.1.1.5 Fuels Reduction Outside Grove

Fuels have accumulated in areas outside of the Core Grove including in the 20-30 year old cypress windbreaks. A fire in this area could quickly spread to the core grove. Potential treatments could include limbing lower cypress to a height of no more than 3 feet at a time.

Actions would be then monitored/documented to safeguard for unwanted responses such as wind throw.

5.1.1.6 Trees

5.1.1.6.1 Tree Planting

The focus of tree management at groves with overwintering monarchs should be to maintain or restore suitable microclimatic conditions with the most important factors to consider are wind protection and solar radiation (Leong 1990, 1991 in Pelton, 2020). Grove structure should be managed to act as a "thermal blanket and a rain umbrella" where canopy cover minimizes heat loss during the night, provides both sun and shade, and protects from excessive winds and storms that typically come from the southeast.

Monarchs do not persist at sites with high wind speeds (Leong 1990, 1991). Mid-story roosting sites are crucial for wind protection of the roosting monarchs. Varied vertical structure is important and monarchs utilize multiple heights for roosting, presumably in search of microclimate conditions that shift as the weather changes. See Protecting California's Butterfly Groves: Management guidelines for monarch butterfly overwintering habitat (Xerces Society 2017) for more information about managing groves for overwintering monarchs.

The following tree management recommendations were developed under the goals and policies of California State Parks. It should be acknowledged that these goals and policies are intended to create optimal habitat for monarchs, as well as support the multi-use mission of California Department of Parks and Recreation. It should be noted that the planting recommendations in this plan were developed under the following constraints:

- State Parks does not currently support planting of eucalyptus species outside of its existing footprint.
- State Parks has a Public Works Plan (PWP) currently in development. The Natural Bridges Management Plan and the PWP are intended to identify the most effective plan for their purposes while taking the other plan into consideration.
- Tree planting recommendations were confined to areas owned by State Parks.
- All actions taken under this plan should comply with applicable local, state, and federal regulations.

5.1.1.6.2 Tree Planting in the Grove

Rather than planting new trees, natural regeneration is recommended within the grove through fuels reduction practices.

5.1.1.6.3 Outside of the Grove

The existing Parks management plan has a mandate to manage for native plant biodiversity. Furthermore, monarchs have been shown to prefer natives over introduced species for roosting (Griffiths and Viablanca, 2015). Hence, management actions should prioritize native tree species when appropriate. Native oak woodland can help protect the grove from wind while supporting

Parks' biodiversity mandate. Coast live oaks can be released from competition by removing some Monterey cypress in the west terrace windbreak. Shreve oak (*Quercus parvula v. shreevii*) can be used for future plantings, as this oak grows taller than coast live oak.

5.1.1.6.4 Tree Removal

Non-native trees that are not specifically beneficial to monarchs should be removed. These include Western red cedar and English oak.

5.1.1.6.5 Tree and Plant Sourcing

The Monterey cypress were sourced from a mix of unknown nursery stock and naturalized plants transplanted from Ano Nuevo State Park. The Monterey cypress of unknown nursery stock has a dense uniform branching pattern that may create weak limbs as trees age. Other plant and tree species were sourced from regional nurseries. Nectar plants planted by Groundswell were grown from locally collected stock or wild stock transplanted from Wilder Ranch State Park. Future propagation should be limited to onsite regeneration or local transplanting complemented by phytosanitary testing to avoid vectoring of diseased plant stock.

5.1.1.6.6 Hazard Tree Guidance

While Parks assess all their facilities every year for tree hazards, the overwintering site should be assessed yearly to identify trees that pose threats to public safety or structures; these trees should be the first priority for trimming/removal. Any trimming or removal actions proposed for trees monarchs are known to cluster on or trees immediately adjacent to cluster trees should be carefully considered for benefits/risks. If management action is deemed necessary, a certified arborist and monarch butterfly overwintering expert should consult on appropriate actions. Human safety should take precedence over public access. Fencing and signage may be useful to restrict public use of the area in the case of an emergency.

5.1.1.6.7 Tree Management Timeline

See Table 2.

5.2 General Land Management

5.2.1 Invasive Species Management

The Park is home to many species of invasive plants and animals that negatively impact biodiversity.

5.2.1.1 Plants

Invasive plant species found at Natural Bridges that have potential to or are adversely impacting the natural plant communities are listed in Table 3. These species can outcompete native plants and negatively impact the biodiversity of native pollinators. These species should be controlled to the extent possible and monitored. Control can include hand methods, which involve

volunteers and engage people in parks land stewardship. Control methods should include annual reentry and be accompanied by annual monitoring that includes mapping.

Some invasive plant species such as blue gum, English ivy, and Cape ivy are beneficial to monarchs because they provide structural habitat and winter nectar resources. These plants should be managed to maintain their extent in the core grove and prevent expansion into adjacent sensitive habitats including the Moore Creek Natural Preserve, coastal prairie, scrub, bluff, and dune habitats. Management of English ivy within the grove is addressed above.

Table 3. Invasive plant species of concern that occur at Natural Bridges State Park (updated from Hyland 2000).

Common Name	**Scientific Name**	**CalEPPC List**	**CDFA List**
wild mustard	*Brassica nigra*	nl	nl
rip-gut brome	*Bromus diandrus*	Red Alert	nl
iceplant	*Carpobrotus edulis*	List A-1	nl
poison hemlock	*Conium maculatum*	List B	nl
jubata grass	*Cortaderia jubata*	List A-1	nl
Cape ivy	*Delairea odorata*	List A-1	nl
blue gum	*Eucalyptus globulus*	List A-1	nl
tall fescue	*Festuca arundinacea*	List B	nl
English ivy	*Hedera helix*	List A-1	nl
velvet grass	*Holcus Lanatus*	List B	nl
Bermuda buttercup	*Oxalis pes-caprae*	nl	nl
wild radish	*Raphanus sativa*	nl	nl
Himalaya berry	*Rubus discolor*	List A-1	nl

5.2.1.2 Animals

Existing invasive animals classified as predators are addressed in the Predators section below.

Commercial drops of the invasive European honey bee (*Apis mellifera*) have become common in northern coastal Santa Cruz County during the winter months. European honeybees are highly competitive pollinators that likely outcompete species including monarchs for nectar. Commercial beekeepers have been observed to specifically target winter flowering eucalyptus groves with drops of hundreds of commercial hives (Henry pers. obs.)(Figure 11), often unbeknownst to the landowners whose property they are on. In the spring of 2022 over two hundred hives were dropped less than ½ miles from the Core Grove with additional hives at further distances. Assuming there are an average of 50,000 bees per hive this represents 10 million competitors being added to the system. Parks is working to exclude hive drops from their

leases in areas adjacent to monarch overwintering sites. Groundswell will work with adjacent landowners and governments to discourage this practice and create a policy for establishing buffers.

Figure 11. Commercial European honey bee (*Apis mellifera*) hive drop adjacent to the Core Grove (Bill Henry, Groundswell).

5.2.1.3 Early detection and rapid response

Early detection and rapid response (EDRR) is an important component of invasive species management. Detection is the process of observing and documenting an invasive species. Park staff should report observations of new introduced species to Environmental Scientists at the California State Parks Santa Cruz District Office. Resource managers will confirm species identification, assess the threat, develop and implement an appropriate plan.

5.2.2 Flooding

A seasonal freshwater wetland forms where the unnamed drainage widens and slows at the south end of the main grove, near Natural Bridges Drive. The pond develops during winter months following rainfall events, flooding up to the edge of the boardwalk and trail during heavy rains. This can inundate and saturate soil and the roots of adjacent overwintering trees. The system occasionally flushes and the creek mouth opens with waters turning northward at the beach to

confluence with the Moore Creek estuary. During large swells and king tides, ocean waters can wash up the creek mouth to the bathroom facility at the lowest part of Natural Bridges Drive. This small watershed may meet the technical criteria of a bar-built estuary. The area of open water and soil saturation of the Pond has increased over time (Nitzberg and Dayton pers. comms.) and poses threats to roosting monarchs that, if dislodged from overhanging roosts, may fall into the water.

Increases in the size and duration of the pond and associated saturated soils have resulted in the toppling of eucalyptus on the pond margins and threatens important silver peppermint Eucalyptus roost trees on the eastern margin. These trees have historically held early season monarch aggregations. Dayton (pers comms) has suggested that the pond dynamics affect the roost because the monarchs prefer not to roost over water perhaps owing to the risk of being blown into the water during inclement weather events.

Potential factors that can influence drainage patterns include:

- Increased ponding due to decreases in precipitation frequency and magnitude of flushing events that breach the drainage mouth.
- Reduced percolation and draining through sandy soils due to accumulation of silt and oily sediment pollution from stormwater from the upper watershed including Delaware Avenue (Figure 7.).
- Development in the upper watershed resulting in decreased permeability and shallow aquifer recharge leading to increased runoff during moderate, non-scouring, rain events.
- Sedimentation of the culvert under Natural Bridges Drive.
- Sand stabilization by sandbar willow roots in the coastal strand/backdune. Note that historical photos show the beach and dune system extended 100m or so further seaward, however the historical structure of the back dune/strand area remains unclear.

Potential solutions include:

- removing the sandbar willow that entraps sand and blocks the watercourse exit
- installing a check dam or water control structure downstream of the pond to control the extent of the inundated area by regulating pond height
- reducing sedimentation and oil pollution from the upper watershed, which includes pollution from vehicle encampments on Delaware Avenue
- increasing percolation and slowing flow during moderate rain events using techniques such as bioswales and check dams in the upper watershed.

Any fixes to the mouth of the watershed should take sea level rise into consideration. Longer term fixes could involve elevating the low point of Natural Bridges Drive and relocating the adjacent bathroom to a less flood prone elevation.

5.2.3 Water Sources

If the pond is dry and dew is not present during the winter, managers might consider creating a monarch drinking station.

5.3 Reducing Monarch Mortality

5.3.1 Predators

A diversity of predators has targeted both individual and clustering monarchs over the years.

- Introduced Eastern gray squirrels (*Sciurus carolinensis*) predate upon and disturb the clusters. Local eradication of Eastern gray squirrels is possible with vigilant trapping. Eastern gray squirrels are a local pest and the authors have observed community members trap them in urban areas and relocate them to rural areas or parks. Signage explaining the problems with relocation of pest animals could help discourage this practice.

- Rodents including black rats (*Rattus rattus*), dusky-footed woodrat (*Neotoma fuscipes*) and deer mice (*Peromyscus maniculatus*) occur at Natural Bridges but there are no recent observations of monarch predation by the species. However, rodent caches of up to hundreds of monarchs have been found at the Lighthouse Field overwintering site, suggesting they predate on monarchs (Ruiz 2018). Managing fuels will help control forest floor woody structures frequently utilized by rodents. Crumb clean practices at local food establishments will further help control rodents in the Grove.

- Western yellow jackets (*Vespula pensylvanica)* are known monarch predators (Ruiz 2018) and have been observed molesting and preying on individual and clustering monarchs. Park and Groundswell staff have installed hanging yellow jacket traps and eradicated nests in late summer/fall. Yellow jacket abundance is tied to the availability of food resources associated with poor waste management. Originally developed to reduce food subsidies to corvid predators in forested ecosystems, the Parks Crumb Clean Campaign is a great outreach tool for minimizing subsidies that lead to hyperabundance of predators including yellow jackets. This program should be extended to monarch groves with interpretive signage, upgraded waste receptacles and appropriately scaled waste removal schedules. Signage could also solicit crowd sourced observations of yellow jacket nests for subsequent eradication.

- Avian predators also impact monarchs. Steller's jay (*Cyanocitta stelleri*) prey on monarchs and in 2019/20 they disturbed butterflies during the day by landing on clusters and causing a cascade of falling monarchs (Nitzberg pers comms.). Steller’s jays were not observed frequenting the grove or molesting monarchs in 2020/21. Other corvids such as American crow (*Corvus brachyrhynchos*), known to molest monarchs, are not common at Natural Bridges. Presence of these corvids is likely reduced by a resident nesting pair of great horned owls (*Bubo virginianus*) that have successfully fledged chicks in the core grove for past four nesting seasons.

  Chestnut-backed chickadees (*Poecile rufescens*) are also present and have been observed preying on monarchs (Dayton pers comms.). However these observations are infrequent and likely of minor impact to the monarchs.

5.4 Environmental Contaminants and Pollution

5.4.1 Water quality

Water quality is impacted by pollutants from street runoff that enter the storm drain system which feeds the unnamed drainage at the core of the Grove. There are dozens of vehicles with long-term residents on streets adjacent to the grove. Activities associated with inhabitants include dumping of chemicals from vehicle repairs and sanitary waste on adjacent street surfaces which drain to the grove. These activities are prohibited in City limits and enforcement defers to the City of Santa Cruz's Illicit Discharge Detection and Elimination Program under the City's Storm Water Management and Discharge Control Ordinance. (Ord. 96-1101, § 1) and the Storm Water and Urban Runoff Pollution Control Ordinance (Ord. 2003-21 § 2 (part), 2003). The City's Large Vehicle Ordinance (City of Santa Cruz General Code Ordinance No. 2021-20) may also be relevant to reducing point source pollution. This runoff should be treated through a bioswale before entering the grove. There may be some pretreatment in the small, engineered wetland at the northeast corner of Delaware Avenue and Natural Bridges Drive. Further inquiry with the City's Department of Public Works is warranted.

5.4.2 Pesticides

The Grove lies near the urban agriculture interface with active conventional agriculture operations on private and publicly owned land. These economically important conventional agriculture fields lie within a half mile of the grove. Monarchs that overwinter at the Grove likely utilize this stretch of coast in the fall and spring migration and may be exposed to unknown types of pesticides. This topic warrants further research into the crops, types of pesticides used in these systems, their half-life, and the timing of application

5.5 Nectar Sources and Milkweed

5.5.1 Increasing Appropriate Nectar Sources

Monarchs rely on nectar sources during overwintering to maintain lipid levels needed for spring migration (Tuskes and Brower 1978). At Natural Bridges, Eucalyptus spp. English ivy, and cape ivy provide late winter nectar resources within the cluster area. It is likely that monarchs are not currently nectar-limited at this site. However, increasing the diversity of flowering plants that bloom when the monarchs are present enhances biodiversity and the overall resilience of the site. Therefore, late fall and early spring-blooming (October-March) nectar resources could still be beneficial to monarchs and other native pollinators.

Late and early blooming nectar plants should be planted in sunlit areas close to the grove and should be implemented in multi-year phases with monitoring to ensure good establishment and to avoid creating a gap in nectar availability during the planting/disturbance year. The plantings should include both upland and riparian species, which are attractive to monarchs and other native pollinators. Low growing species should be planted to discourage illegal camping at the site.

A list of native, commercially available appropriate monarch-friendly native plants is available in Appendix I. A mix of species should be selected to ensure overlapping bloom times to cover

the entire overwintering season. Establishment of perennial forbs and shrubs can be accelerated by transplanting rhizomatous species. Plants should be sourced from nurseries which do not use systemic neonicotinoid insecticides which have been shown to harm monarchs (Krischik et al. 2015; Pecenka and Lundgren 2015) or other insecticides which have pollinator or mammalian toxicity. Ideally, management to maintain the plantings will rely on alternatives to pesticides to control weeds and pests. If planted in the late fall or early winter of a year with abundant rainfall over the entire winter season, plantings may become established by the spring and not require additional irrigation. Otherwise, plantings will likely require irrigation every 10 - 14 days during the dry season to become established.

Priority nectar planting areas include sites that support early and late blooming native nectar plants such as meadows and wetlands respectively. Sites include the Moore Creek riparian corridor, the small unnamed drainage to the east of the pond, the catchment pond on the northside of Delaware Avenue which feeds the unnamed creek that runs through the grove, the back dune and low bluffs, the visitor center parking area medians and borders, and the perched dune habitat to the east of the entrance kiosk off Swanton Blvd.

5.5.2 Milkweed Guidance

(Remove milkweed from in and around overwintering sites if it was planted/does not naturally occur there; most important to remove all non-native milkweeds, such as tropical milkweed {Asclepias curassavica})

"Nonnative, evergreen milkweed—particularly *Asclepias curassavica* –has been shown to increase the rate of Ophryocystis elektroscirrha (OE), an obligate, protozoan parasite, in winter-breeding monarchs in California (Satterfield et al. 2016) and may disrupt the natural reproductive diapause monarchs enter during the fall. Thus, evergreen milkweed and OE can have negative impacts on monarch health and have been linked to lower migration success in the Eastern monarch population (Altizer et al. 2015). In coastal California, even California-native milkweed species (e.g., A. fascicularis) planted close to the coast can be problematic because the mild climate may prevent or delay these species from going dormant, which causes parasite build-up and natural cycle disruption like that seen with nonnative milkweed. According to the best available records, native species of milkweed did not historically grow along most parts of the Central California coast, including the Santa Cruz area" (Pelton et al. 2016 in Pelton 2020). Davis (2022) found that evidence that monarchs reared on Tropical milkweed in Central California do not appear to be large enough to be migrants. The evidence against planting tropical milkweeds near overwintering sites is compelling and managers should avoid planting them near overwintering sites. We have previously encountered and have removed milkweed illegally planted by individuals at Lighthouse Field. Managers should keep an eye out for similar plantings at other overwintering sites.

For these reasons and Parks management guidelines for introducing non-native plants, it is not recommended to plant milkweed, nonnative or native, close to overwintering sites on the Central California coast outside of its historic range, generally within 5 miles of the Pacific Ocean (Figure 12). In the past Natural Bridges State Parks interpreters have grown and raised monarchs on nonnative milkweed adjacent to the core overwintering grove. To protect overwintering monarchs, interpreters modified this practice in 2020 to the protocol/practice of accepting

captive reared monarchs from the public. These butterflies are now reared in cages where they remain isolated from wild butterflies. This protocol safe-guards monarchs preventing captive reared monarchs from being released and isolating potentially infected monarchs from wild monarchs. Outreach activities related to growing milkweed should discourage planting any milkweed close to overwintering sites (Figure 12). Individuals are encouraged to plant native milkweed in gardens, schools, etc. over 5 miles away from the coast. Removal of nearby stands of nonnative milkweed species is also recommended.

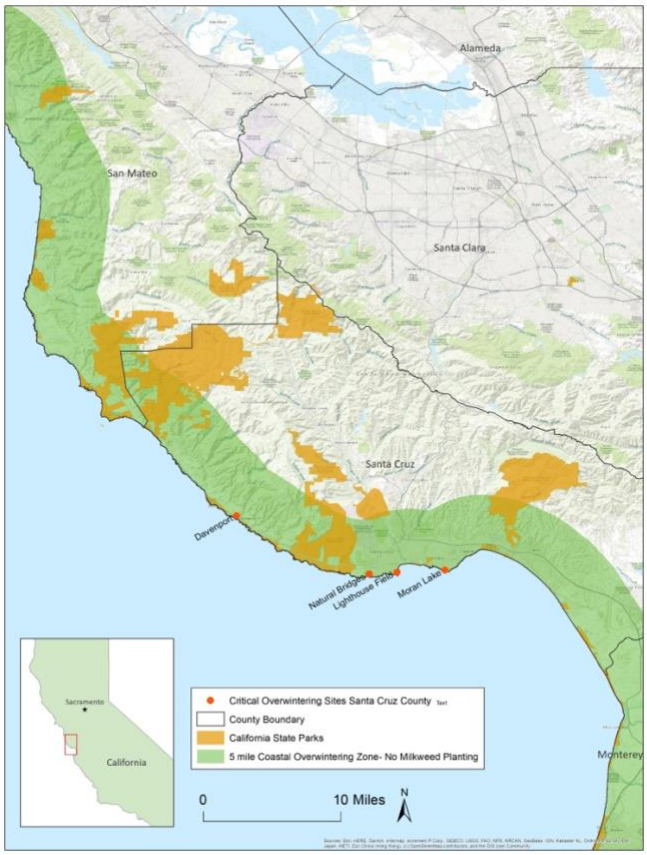

Figure 12. Map showing 5-mile buffer zone from coast where milkweed planting should be discouraged.

5.6 Public Engagement, Access/Trails, and Facilities/Infrastructure

5.6.1 Public Engagement

There is a robust public engagement program run out of the Visitor Center by a dedicated staff Natural Bridges Docents. Programming includes teaching K-12 students, interpretative walks for adults and children, internship stewardship activities, and public events such as Welcome Back the Monarchs and Migration Festivals which are very well attended. This site received large volumes of traffic and the visitor center would benefit from updates to facilities that will allow staff to better offer interpretive services to guests. Larger storage facilities and better supplies would be helpful for supporting stewardship activities that help enhance grove biodiversity.

5.6.2 Access/Trails

The elevated boardwalk was built in the early 80s and has degraded to the point of becoming unstable in some areas and needs repair or rebuilding. Following a tree fall upstream of the observation deck, the seasonal creek has rerouted to meander under the boardwalk downstream of the observation deck. The creek could be evaluated for routing to its original bed outside the boardwalk footprint.

The Monarch Trail is a dirt path that loops southward from the boardwalk, doubles back as it climbs the east terrace, running through the upper terrace where monarchs sun and northward into forested areas before crossing the unnamed drainage and returning to Natural Bridges Drive. Immediately south after branching from the boardwalk, the trail needs maintenance and improvements to prevent people from entering the pond, and to reduce erosion, minimize foot damage to grove trees, and discourage visitors from cutting through the lower sections of the overwintering grove.

These upgrades could include:

- Lower trail - install a low rock retaining wall or logs on the pond edge.
- Upper trail - Curve the trail at higher point and align 17% grad that minimizes root disturbance.
- Discourage shortcutting - install natural log barriers or erect split rail fence along the upper side of the trail.
- Northern section that crosses unnamed creek - stabilized bank.

5.6.3 Facilities/Infrastructure

Updates to the facilities and parking lots should follow green building principles, such as reducing runoff and incorporating native pollinator friendly landscaping. These elements, along with other practices that increase overwintering grove resiliency, should be included in planning for infrastructure improvements including the upcoming ADA redevelopment of the parking area adjacent to the visitor center. Interpretive signage of green building practices that can benefit native pollinators should be included in planning efforts to maximize outreach that provides the public with working models that visitors can implement on their own properties. The visitor center is also in need of better storage facilities and tools that support site stewardship programs.

6 Success Criteria & Monitoring Plan

6.1 Baseline Assessment

Refer to Appendix II. for the Habitat Assessment Form.

6.2 Management Actions Summary

Table 2. Management Actions Summary. Outline of management Problems, Goals, Objectives, Success Criteria, Monitoring Questions, Monitoring Methodologies, and Tools to be used.

Category	Problem Statement	Goal (achievable outcome)	Objective (shorter term measurable action)	Success Criteria	Monitoring Questions	Monitoring Type	Monitoring Method	Equipment	Year Start	Interval (yrs)
Forest Management	***Catastrophic fire is a threat to the Grove.*** ***Grove trees require silvicultural stewardship to optimize tree health to prevent outbreaks of disease and pests.***	Reduce 1 and 10 hour fuels in the Grove, with a focus on ladder fuels that can lead to canopy fire.	Develop fuels treatment plan.	Plan created.	Was plan created?	Pre-project	N/A	N/A	2022	5
			Strategically treat fuels in the Grove by removing dead ladder fuels under 3 feet.	Treat a rotating 20% of the Grove annually.	Were fuels reduced in the Grove?	Implementation	Fuels survey with photo plots.	Camera and transect.	2022	1
		Reduce and remove dead and downed wood that harbor pests and promote fungal pathogens.	Remove new large, downed material.	Remove 10% of new dead downed material annually.		Implementation				
	The Grove is dynamic with senescence, recruitment and limb loss, but must also provide monarchs with stable suitable microclimates (wind protection, thermal properties, solar radiation, circulation, etc.). ***The Grove has poor natural regeneration and needs a greater diversity in age and height class structure of wind block, roosting, and aggregation trees in and surrounding the Grove.***	Promote appropriate micro climates in the Grove through strategic tree recruitment. Establish a diversified age structure of Grove trees that will allow for senescence and replacement. Increase structural heterogeneity in the Grove by facilitating strategic tree recruitment.	Assess existing age classes.	Map of gaps in age class.	Was map created?	Pre-project	N/A	N/A	2022	10
			Develop geographically explicit recruitment plan.	Creation of recruitment plan.	Was plan created and suggested actions implemented?	Pre-project	N/A	N/A	2022	5
			Trial different techniques for recruiting Grove trees. Prep recruitment sites (e.g. remove fuels and soil prep).	Establish and monitor 12 new recruitment sites. Monitor previously established sites.	Did activities lead to seedling recruitment? Where did seedlings recruit to? Where are the gaps?	Effectiveness	Recruitment survey with photo plots.	Camera and transect tape.	2022	
			Scale recruitment activities.	Recruit seedlings to 100% of the identified locations.	What is the most efficient method for recruitment? Does recruitment require	Effectiveness			2024	5
	Hazard trees threaten human safety and other trees in the Grove.	Ensure safety of the public and/or important living Grove trees by removing hazard Grove trees and/or limbs.	Evaluate hazard trees in the Grove.	Implement evaluation schedule and program.	Do hazardous tree exist?	Pre-project	Forester survey and georeference any hazardous trees.	Camera.	2022	2
			Remove hazard trees that are of concern.	No hazard trees in Grove.		Implementation				
	The State Parks Management Plans support native trees while the Grove has many non-native tree species, some of which are beneficial to monarchs.	Support native trees where they can provide structural function to the overwintering site that are comparable to non-native trees.	Identify and manage for native trees which support beneficial conditions for monarchs in the Grove.	Map of important native trees.	Was map created?	Pre-project	N/A	N/A	2022	5
			Remove non-native trees that impact the health and development of important native trees.	# of native trees enhanced.	Were native trees that support Grove function enhanced?	Quantitative	Survey, evaluate, and georeference important and new native trees.	GIS software and camera.	2022	
			Identify locations and plant native trees in locations where they can enhance Grove conditions.	# of native trees planted.	Were native trees that support Grove function planted?	Quantitative			2023	

Table 2. Management Actions Summary. Outline of management Problems, Goals, Objectives, Success Criteria, Monitoring Questions, Monitoring Methodologies, and Tools to be used (cont.).

Category	Problem Statement	Goal (achievable outcome)	Objective (shorter term measurable action)	Success Criteria	Monitoring Questions	Monitoring Type	Monitoring Method	Equipment	Year Start	Interval (yrs)
General Land Management	***Invasive plants species form valuable monarch habitat but also negatively impact biodiversity of native flora and fauna.***	Have a functional monarch Grove while minimizing and limiting the spread of invasive species.	Develop and implement an invasive species management plan.	Plan created.	Was plan created and were suggested actions implemented?	Pre-project	N/A	N/A	2023	5
		Minimize the number and distribution of invasive species that have negatively impacts on monarchs or are not providing substantial benefits to monarchs.	Maintain invasive species control programs.	Control of invasive species.	What species were controlled? What are priority species? What resources are needed for successful control?	Effectiveness	CA State Parks invasive species management protocols.	Phone, camera, Calflora Observer.	2022	1
			Establish and implement program for early detection and rapid response (EDRR) to new invasive species.	EDRR surveys using CA State Parks invasive species management protocols.	Where new invasives detected? What is needed to control these species?	Pre-project	EDRR surveys.	Phone, camera, Calflora Observer.	2022	1
	An increase in flooding and pond duration is killing Grove trees and impacting monarch roosting habitat.	Remove impediments to pond drainage and find solutions that will prevent flooding in the Grove.	Excavate back dune to improve drainage so flooding does not impact monarchs.	Pond does not flood.	Does pond still flood?	Implementation	Monitor pond levels.	Camera.	2022/23	1
			Clean clogged culvert.	Culvert cleaned.		Implementation				
		Evaluate the risk of sea level rise to the Grove and identify and implement solutions that will protect the Grove.	Create living shorelines and retreat plan for the Grove.	Plan created.	Was plan created and suggested actions implemented?	Pre-project	N/A	N/A	2022/23	5
		Increase percolation in upper watershed of unnamed creek to reduce surface flow.	Complete geospatial watershed analysis to identify opportunities for slowing runoff and increasing percolation.	Analysis created.	Were analyses created and suggested actions implemented?	Pre-project	N/A	N/A	2022/23	5
	Water availability is becoming less predictable during drying winters.	Provide supplemental water to monarchs if the pond is dry and dew is not present during the winter (monarch drinking station).	Create monarch drinking station.	Monarch drinking station created.	Was station created? Do monarch use station?	Validation	Observations during dry weather site visits.	Camera.	2022/23	1

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Table 2. Management Actions Summary. Outline of management Problems, Goals, Objectives, Success Criteria, Monitoring Questions, Monitoring Methodologies, and Tools to be used (cont.)

Category	Problem Statement	Goal (achievable outcome)	Objective (shorter term measurable action)	Success Criteria	Monitoring Questions	Monitoring Type	Monitoring Method	Equipment	Year Start	Interval (yrs)
Reducing Monarch Mortality	***Monarch mortality occurs during overwintering period.***	Reduce monarch mortality at overwintering sites.	Monitor monarch mortality.	Quantify the # of monarch mortalities. Identify solutions.	How many monarchs died at the overwintering site and what were the causes of death.	Quantitative	Monarch mortality area searches. (note submit dead monarchs to researchers).	Collection permits, glassine bags, freezer, notebook.	2022	1
	Predators and hyperabundant species threaten monarchs.	Control predators that are a threat to overwintering monarchs.	Control known predators for the time period of June - January	Control yellow jacket population.	Were yellow jacket control measures implemented? How many nests were eradicated? Where were nests located? How many traps were deployed?	Effectiveness	Log actions.	Non-toxic eradication equipment. Traps. Camera and GIS software.	2022	1
		Identify and manage for other species that predate on or disturb monarchs.	Log observations of other monarch predation or disturbance. Control species that predate on or disturb monarchs.	Completed log of predator interactions. Implement control measures on all species of concern.	What, if any, impacts were observed? What species were observed predating or disturbing monarchs?	Qualitative	Log book. Crowd-sourced observations.	Phone, camera, log book.	2022	1
					Was the impact of Eastern gray squirrels on monarchs assessed?	Qualitative	Count Eastern gray squirrels in the Park.		2022	1
					If significant threat, were Eastern gray squirrels removed from the Park?	Implementation	Depredation log book.	Non-toxic eradication equipment.	2022	1
		Design and Implement Crumb Clean Campaign at the Park.	Post crumb clean signage at Grove and by picnic tables. Develop and provide outreach materials to visitors at the kiosk. Evaluate waste container security and check for adequate size and maintenance schedule.	Signage is posted. Fewer yellow jackets are observed. Produce outreach materials. Waste containers are appropriately sized and maintained.	Is signage posted? Were fewer yellow jackets present? Were outreach materials made and distributed? Were there modifications to waste containers?	Implementation	Log book of observations of outreach and waste management notes. Yellow jackets, see above.	Log book.	2022	1
		Quantify the extent and threat of hosted commercial European honey bee hive drops. Create policy to protect monarchs, if warranted.	Map bee hive drops and estimate bee abundance in the region.	Map of hive drops with hive and land ownership.	How many, ownership, land owner, where, and when are hives dropped?	Quantitative	Hive surveys.	Camera, GPS, iNaturalist.	2022	1
			Determine if bees impact monarchs.	Research summary on potential impacts of drops created.	Do hosted commercial honey bee hives impact monarchs? Are hosted commercial honey bee hives dropped within a distance where they can impact Grove nectar resources?	Qualitative	Hive and bee surveys before/after drops.	Camera, GPS, tally whacker.	2022/23	
			Work with regional landowners, the Countyand City to create and implement policy for commercial European honey bee hive registration and drop exclusion areas near overwintering grove.	Policy created with partners. Enforce policy (if warranted)	Was policy created and implemented? Where?	Pre-project, Implementation	Log and map enforcement.	Phone, camera.	2023	1

Table 2. Management Actions Summary. Outline of management Problems, Goals, Objectives, Success Criteria, Monitoring Questions, Monitoring Methodologies, and Tools to be used (cont.)

Category	Problem Statement	Goal (achievable outcome)	Objective (shorter term measurable action)	Success Criteria	Monitoring Questions	Monitoring Type	Monitoring Method	Equipment	Year Start	Interval (yrs)
Environmental Contaminants and Pollution	***Water pollution impacts the Grove health.***	Reduce point source pollution through outreach and enforcement of pollution laws.	Map extent of watershed and identify pollution sources. Signage with reporting number on adjacent streets. Increased public safety patrols on adjacent streets to enforce.	Improved water quality in un-named creek during first flush.	Did water qualtiy improve in un-named creek?	Quantitative	Water testing in creek and adjacent gutters during first flush.	Water testing kit and GIS software.	2022	1
		Increase biofiltration of stormwater runoff into the Grove including Natural Bridges Dr, Delaware Ave, Swanton Blvd., and the visitor center parking lot.	Create bioswale implementation plan for the un-named creek watershed including adjacent streets. Reduce hardening in the upper watershed.	Creation of plan. Installation of bioswales.	Were bioswales installed? What % of total potential bioswales were installed?	Pre-project, Implementation	Geospatial surveys.	GIS software.	2023	1
	Insecticides negatively impact monarchs.	Research pesticide types and applications in adjacent agricultural lands to better understand potential impacts on monarchs and take action to reduce threats, if warranted.	Summary of pesticides used on adjacent lands and potential impacts to monarchs. Map of usage and land ownership/management with contacts.	Creation of summary document with map.	Are pesticides that harm monarchs utilized adajacent to the Grove? If so, at what distance? Are voluntary or regulatory actions warranted?	Pre-project	Query of Santa Cruz Agricultural Commissioner's database.	Geospatial software.	2022	1
Nectar Sources and Milkweed	***Early and later blooming nectar sources can be impacted by drought and changing landscape conditions.***	Increase the abundance and diversity of native early and late blooming nectar sources in the surrounding landscape.	Create planting plan for planting in surrounding landscape. Implement plan recommendations to increase nectar sources.	Identification of species, methodologies, and locations for implementation. Implement X % of plan recommendations to Increase of early and later flowering nectar plants in surrounding areas..	What are best techniques? Were species lists developed? Was a map developed? Was outreach to inform public performed? Were corridors implemented?	Pre-project, Implementation	Creation of best practices report and outreach materials. Mapping of corridors.	Geospatial software.	2023	1
		Support continuity of early and late nectar resources along monarch migration and movement corridors.	Create plan for planting of appropriate locations for nectar resources in regional corridors. Implement plan recommendations to increase nectar sources.	Identification of species, methodologies, and locations for corridor implementation. Implement X% of plan recommendations to Increase in monarch nectar corridors.		Pre-project, Implementation				
	Milkweed should be planted in appropriate locations following best management protocols.	Remove milkweed in the Park and adajcent areas.	Identify sites for milkweed removal.	Identify sites and remove X% of milkweed from Park and adjacent areas.	Were removal sites detected? Was milkweed removed?	Pre-project, Implementation	Log book and mapping.	Geospatial software.	2022	1
		Encourage best management practices for planting milkweed in the region.	Disseminate information for best practices of milkweed. Create regional map for milkweed planting with key ares of importance. Distribute native milkweed in area.	Creation of map. Create and disseminate BMP guidance materals. Distribute and promote milkweed plants in nurseries.	Where are appropriate areas to plant milkweed? How many plants and were have people planted milkweed regionally?	Pre-project, Implementation	Geospatial database. Data solicitation from the public.	Geospatial software.	2023	1

Table 2. Management Actions Summary. Outline of management Problems, Goals, Objectives, Success Criteria, Monitoring Questions, Monitoring Methodologies, and Tools to be used (cont.)

Category	Problem Statement	Goal (achievable outcome)	Objective (shorter term measurable action)	Success Criteria	Monitoring Questions	Monitoring Type	Monitoring Method	Equipment	Year Start	Interval (yrs)
Public Engagement	***The Natural Bridges facilities for public engagement are outdated and/or in disrepair.***	Upgrade facilities to better support interpretation, stewardship, and the overall visitor experience.	Access Parks facilities. Identify priority needs. Create plan to implement. Implement.	Need assessment with list of priority needs created. Plan for implementation of needs created. Implement X% of the high priority needs identified in the plan.	Were needs identified? Was implementation schedule created? Are plans and permits ready? Were upgrades built?	Pre-project, Implementation	Log book and project tracking.	Logbook.	2023	5
			Redesign and rebuild the Grove access way.	Access way rebuilt.	Was access way rebuilt? How is trail performing?	Implementation, Qualitative	Log book.	Log book.	2024	-
			Create and implement trail plan. Design and build the section of the Monarch Trail along the pond edge.	Access way rebuilt.	Was trail rebuild? How is trail performing?	Implementation, Qualitative	Log book.	Log book.	2023	-
Research	***We lack knowledge in the distribution and utilization of autumnal and vernal monarch habitat.***	Increase undestanding of autumnal and vernal habitat by monarchs.	Determine areas to be surveyed. Perform surveys. Summarize data and recommnedations.	Quantification of autumnal and vernal habitat utilization.	What areas nearby the Grove are important habitat during the autumn and spring migration?	Pre-project, Implementation	Direct observation.	GIS software, camera, binoculars.	2022	1
Monarchs (Validation of Response)	***We need monitoring of monarchs for effective management.***	Conduct biannual counts Thanksgiving and New Years counts.	Ensure Thanksgiving and New Years counts happen.	Count data.	How many monarchs overwinter? What is their micro site selection?	Implementation	Survey.	Tally whacker and camera.	2022	1
		Evaluate if plantings are providing useful nectar resources.	Monitor native plantings to assess monarch visitation.	Observe and quantify splant species visited by nectaring monarchs at different seasons.	What plants are most frequently visited during the various seasons? Learn is plantings are beneficial to monarchs.	Qualitative	Observation based survey.	Taly whacker, flowering plants.	20223	-
		Crowd source local observations of monarchs along the Santa Cruz North Coast utilizing existing applications.	Utilize Western Monarch Watch or iNaturalist to document regional monarch distirbution during beginning and end of migration period.	100 people participated in looking for monarchs at this time.	How many and where are the monarches moving through?	Quantitative	Observation based crowd-sources data.	Phone with camera.	2022	1

6.2.1 Problem Statement/Restoration or Management Hypothesis

See Table 2.

6.2.2 Project Goals and Objectives

See Table 2.

6.2.3 Success Criteria

See Table 2.

6.2.4 Monitoring Questions

See Table 2.

6.2.5 Monitoring Types to be Used

See Table 2 for monitoring types used (those checked below all apply). These are appropriate to answer questions posed, assist in tracking progress of goals and objectives via success criteria, and relate back to the problem statement and hypothesis.

_X_ Pre-project *(Baseline Assessment)*
_X_ Implementation *(Was project installed or conducted as planned?)*
_X_ Effectiveness *(Did habitat conditions change at site over anticipated timeframe?)*
_X_ Qualitative *(e.g., veg photos)*
_X_ Quantitative *(e.g., veg cover plots)*
_X_ Validation (*Did monarchs respond to changed habitat conditions as a result of the project?)*

6.2.6 Monitoring Methods

Methodology, timeframe for monitoring and equipment.

See Table 2.

6.2.7 Post-monitoring Evaluation

To be completed after implementation of actions.

6.2.8 Results to be shared with the following entities

Share results with CA Overwintering Group, landowners/managers, USFWS, CDFWS

6.2.9 Adaptive Steps to be Taken Upon Results

Adaptive steps taken following evaluation of management actions will be different for each specific management action. Potential adaptive steps should be included in post-monitoring.

6.3 Notes and Recommendations for Future Projects

See Table 2.

7 Timeline for Plan Actions: Adaptive Management & Monitoring

See Table 2.

7.1 Adaptive Management

This plan was developed based on the best available information for the past and present state of the overwintering grove. New or different threats and opportunities will emerge as site conditions and management tools change (e.g., tree falls, hazard trees removed, wildfire, etc.). As research into monarch requirements and management techniques for overwintering habitat continues, this plan should be updated with the latest advances in science and restoration practices. Future management should continue to assess management priorities and be adaptive to these changing parameters.

8 Appendices

8.1 Appendix I. Nectar plant list.

Common Name	Scientific Name
bee plant	*Scrophularia californica*
Blue eyed grass	*Sisyrinchium bellum*
blueblossom ceanothus	*Ceanothus thyrsiflorus*
California fuschia	*Epilobium canum*
California goldenbush	*Ericameria ericoides*
California goldenrod	*Solidago velutina ssp. californica*
California hedge nettle	*Stachys bullata*
California poppy	*Eschscholzia californica var. maritima*
ceanothus Anchor Bay	*Ceanothus gloriosus 'Anchor Bay'*
checker mallow	*Sidalcea malviflora*
coast buckwheat	*Eriogonum latifolium*
coast tarweed	*Madia sativa*

coastal sagewort	*Artemisia pycnocephala*
common cow parsnip	*Heracleum maximum*
common yarrow	*Achillea millefolium*
coyote bush	*Baccharis pilularis*
creeping wild rye	*Elymus triticoides*
gumplant	*Grindelia stricta var. platyphylla*
Harford's sedge	*Carex harfordii*
horkelia	*Horkelia californica*
Pacific aster	*Symphyotrichum chilense*
Pink flowering currant	*Ribes sanguineum var. sanguineum*
sea plantain	*Plantago maritima*
seaside daisy	*Erigeron glaucus*
self heal	*Prunella vulgaris var. lanceolata*
sticky monkey flower	*Diplacus aurantiacus*
thrift seapink	*Armeria maritima*
Western flat topped goldenrod	*Euthamia occidentalis*

8.2 Appendix II. Habitat Assessment Form

Habitat Assessment Form

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