

LIGHTHOUSE FIELD MONARCH OVERWINTERING MANAGEMENT PLAN UPDATE

Lighthouse Field State Beach

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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.

Lighthouse Field State Beach (Lighthouse Field), like most overwintering sites, has undergone a severe reduction in its monarch population from the 1990s. In 1997, Lighthouse Field ranked number 3 in California for numbers of overwintering monarchs with 70,000 monarchs counted. Numbers of overwintering monarchs across the western population have declined since the first official record in 1997, yet Lighthouse Field has continued to establish itself as a critical site based on its ranking of number of total monarchs compared to other western sites. Since the initial Lighthouse Field Monitoring Plan was written (Pelton et al. 2017), Thanksgiving Counts numbered: 12,000 in 2017 (ranked 4th); 1802 in 2018 (ranked 2nd), and 3402 in 2019 (ranked 2nd). The winter of 2020/2021 demonstrated the most dramatic population drop since monarch numbers have been officially monitored and Lighthouse Field had only 50 overwintering

butterflies at the time of the Thanksgiving Count. The 2021/22 winter saw an increase in monarch butterflies throughout the overwintering sites with the Lighthouse Field count at 410. While encouraging, this uptick in population numbers does not reverse the overall declining trend (Pelton et al. 2021).

To help ensure Lighthouse Field 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 Update of Actions Completed- Monarch Overwintering Grove Management Plan at Lighthouse Field State Beach. This update will help to better track management actions that support conservation of overwintering monarchs by outlining actions completed since the development of the 2017 *Monarch Butterfly Overwintering Site Management Plan for Lighthouse Field State Beach* (Pelton et al 2017).

This update includes updated management efforts and new information collected during site visits by Groundswell, Samantha Marcum (Monarch Butterfly/Pollinator Regional Coordinator, US Fish and Wildlife Service), Tim Hyland (Senior Resource Ecologist, CA State Parks), and John Dayton (Independent Biologist). This update approximates a template derived by the USFWS Coastal Program Monitoring Framework by Marcum et al. 2014 / Prepared by: S. Marcum 10.2019.

Legal Status of Monarchs and Their Habitat

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 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.

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).

Site Description

Location

Lighthouse Field State Beach (36.953717; -122.027218) is a 38 acres park perched on the headlands at the northern boundary of Monterey Bay and is surrounded by the City of Santa Cruz, California. The overwintering grove consists of a small grove of eucalyptus and cypress trees on the northern edge of the Park bordered by Pelton Avenue on the North and open fields with scattered windbreak trees to the east, south and west (Figure 1).



Figure 1. The Lighthouse Field overwintering grove lies within Lighthouse Field State Beach on the northern edge of Monterey Bay.

History

Refer to the *Monarch Butterfly Overwintering Site Management Plan for Lighthouse Field State Beach* (Pelton et al. 2017).

Land Ownership

Refer to the *Monarch Butterfly Overwintering Site Management Plan for Lighthouse Field State Beach* (Pelton et al. 2017).

Habitat Description

Soils

Refer to the *Monarch Butterfly Overwintering Site Management Plan for Lighthouse Field State Beach* (Pelton et al. 2017).

Dominant Tree/Plant Species

The overwintering grove at Lighthouse Field is a moderately dense stand of overstory blue gum eucalyptus (*Eucalyptus globulus*) and an intermediate canopy of Monterey cypress (*Hesperocyparis macrocarpa*) with scattered openings on a flat coastal terrace. On the periphery of the main grove, red gum eucalyptus (*Eucalyptus camaldulensis*) can also be found.

Understory vegetation in the grove is patchy and predominantly European grasses, poison oak (*Toxicodendron diversilobum*) with iceplant (*Carpobrotus edulis*) on the edges. Some areas of the grove have built up debris from downed tree limbs and leaves and bark strips from the eucalyptus. There is a small amount of blue gum eucalyptus regeneration occurring within the grove. Additionally, Monterey cypress saplings were planted within the grove in 2017/18 (along the northern edge) to help provide a windbreak along Pelton Ave (see “Previous Plan Implementation” for maps and details on plantings).

The main grove is surrounded on three sides by grassland and seasonal wetland areas with sporadic patches of shrubs and trees including Monterey pine (*Pinus radiata*), arroyo willow (*Salix lasiolepis*), nonnative palm (Arecaceae family) and *Prunus sp.* Blue-blossom ceanothus (*Ceanothus thyrsiflorus*) and pink flowering currant (*Ribes sanguineum*) were planted around the perimeter of the grove to provide late winter/early spring nectar as well as insulation from wind (see “Previous Plan Implementation” for maps and details on plantings). The grasslands to the south and west of the grove are dominated by agricultural and pasture weed species, including radish (*Raphanus sativus*), mustard (*Brassica nigra*), european grasses and patches of nonnative ice plant. The wetlands have been planted with late blooming nectar plants planted by Groundswell Ecology (See “Previous Plan Implementation” for maps and details on plantings). To the south of the grove, Monterey cypress saplings have been planted (See “Previous Plan Implementation” for maps and details on plantings) to provide future protection from south winds. The north side of the grove is delineated by Pelton Rd. On the north side of Pelton there is a row of Eucalyptus sp. which provide nectar for butterflies during the winter. There are many other species cultivated winter and early spring flowering plants (*Prunus spp.*,

Malus spp, *Ceanothus* spp., *Salvia* spp., *Lavandula* sp., etc.) in the adjacent suburban landscape that provide nectar resources.

Fire

Refer to the *Monarch Butterfly Overwintering Site Management Plan for Lighthouse Field State Beach* (Pelton et al. 2017).

Current Use and Management

Acting Management Plans

California Department of Parks and Recreation

The California Parks and Recreation Commission Statement of Policy (2005) also applies to Lighthouse Field 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. Nonnative vegetation in the Park is not afforded legal protection, even if invasive vegetation supports overwintering monarchs for a portion of the year.

Local Coastal Plan

Lighthouse Field 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 of Santa Cruz's (City)LCP was last updated in 1995 and combined with the General Plan. The LCP affords special protection to environmentally sensitive areas including the Monarch Butterfly Natural 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 Lighthouse Field State Beach.

Previous Plan Implementation

The *Monarch Butterfly Overwintering Site Management Plan for Lighthouse Field State Beach* (Pelton et al, 2017) prioritized four management objectives. State Parks staff, volunteers, and NGOs have implemented the following actions identified in Pelton et al (2017).

Strategic tree planting and forest management.

Windbreaks

Windbreaks are an important component of the grove. Windbreak trees were planted in two primary areas. Monterey cypress were planted in the north windbreak (Figure 2 and 3) to decrease wind tunnel effect and to help prevent monarchs from being blown onto adjacent Pelton Avenue during winter storm events. Sixteen Monterey cypress trees were planted in this area during the winter of 2017 and the winter of 2018. These plants were watered by hand during their first year of establishment. As of 2022, seven of those trees have survived although these are still quite small in stature (from 1 ft to 3 ft tall) (Figure 3). Pelton et al (2017) suggested that blue gum eucalyptus saplings (possibly sourced from within the site) be transplanted as a quick

growing species to temporarily block this gap while the cypress gain height but this has not yet been done. Another interim solution could be building temporary artificial structures to shelter the grove until infill trees are tall enough to serve as an effective windbreak.



Figure 2. Map of existing windbreak tree zones, proposed windbreak zones from the 2017 Plan and new windbreak trees planted 2017-2022.



Figure 3. View from Pelton Ave. of Monterey cypress saplings planted over 4 years ago as a north windbreak.

Windbreak tree plantings were expanded in the southwest and eastern portions of the site to increase wind protection. Monterey cypress and coffeeberry (*Frangula californica*) were planted here (Figure 2, Figures 4-6). Between 2017-2019, 59 trees and 4 windbreak shrubs were planted in concentric rings to create redundant windbreaks outside of the main cluster area. This was done to slow down winds off the ocean that during storm events blow monarchs out of their cluster. Trees were watered during the first years of establishment and monitored for disease. Only one of the shrubs survived, likely due water limitation, competition from native grasses, and/or gophers. Thirty-nine of the trees survived and are growing at a rate of 2-3 feet per year. Eight additional trees were planted in 2021/2022 in gaps where previous plantings did not survive.



Figure 4. Map of windbreak trees and nectar plantings at Lighthouse Field State Beach.



Figure 5. Volunteers help plant Monterey cypress trees to provide additional windbreaks



Figure 6. Monterey cypress planted in 2018 form concentric rings of the southwest windbreak.

Remove woody debris

State Parks employees cut and removed fallen trunks and large branches from the understory of the main grove area on August 13, 2020. This effort was done to reduce fuels, encourage eucalyptus recruitment, prevent insect pests such as eucalyptus long horned borer from building up in the forest debris, and to prevent accumulation of material that would encourage nest building by small rodents which may be monarch predators (Ruiz 2018). This material was chipped on-site and spread on adjacent footpaths where it helps retain soil moisture for grove trees and reduces mud pools following localized flooding from winter rains.



Figure 7. Map of fuels reduction areas and photo of work at Lighthouse Field State Beach.

Reducing monarch mortality

Predation

Evaluate species involved in large predation events and develop a predator mitigation plan. Predation has continued to be monitored at Lighthouse Field after the large predation event that occurred during the winter of 2016/17. During this winter, of the 12,000 monarchs counted at the site, 650 (5.4%) were found dead at or nearby the overwintering grove (Pelton et al 2017). In the winter of 2017/18, the mortality of the 13,533 butterflies overwintering at Lighthouse Field was 12.6%, of which 49% (based on the collection and examination of dead monarchs) was attributed to yellowjackets (*Vespula* spp) (Ruiz 2018). One large yellow jacket nest, located about 20 meters to the southwest of the grove was estimated to have thousands of residents (John Dayton pers. comms). The yellow jackets were documented attacking monarch butterflies while roosting, as well as scavenging downed monarchs after a storm (Figure 8). This large nest was exterminated by dry ice in January 2018. Since that time, Groundswell staff have installed hanging yellow jacket traps and eradicated nests in late summer/fall (2018-2021). Nests adjacent to the grove were destroyed at night using the non-toxic dry ice technique, which suffocates hive inhabitants (Figure 9). The number of dead monarchs encountered in the grove following these actions has been significantly reduced.



Figure 8. A monarch being attacked and eaten by yellowjackets.

Figure 9. Groundswell staff using dry ice to eradicate a yellow jacket nest on the edge of the Lighthouse Field overwintering grove in 2021.

Waste management

Yellow jacket abundance is associated with the availability of food resources. Improper waste management provides these resources. Originally developed to reduce food subsidies to corvid predators in forested ecosystems, the Parks Crumb Clean Campaign represents an effective 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. Signage could solicit crowd sourced observations of yellow jacket nests to facilitate removal. To date, improvement of trash management has not been initiated at this site; no new trash receptacles have been installed. However, there have been some efforts to increase awareness of human commensal predator attraction through public engagement on social media including videos of yellowjackets attacking monarchs and requests for the public to submit Google pins of nest locations.

Remove predator habitat

Removal of woody debris and large brush piles to reduce available habitat for rodents was done August 13, 2020. Woody debris removal should be evaluated on an annual basis and performed if necessary.

Native nectar resource availability

Nectar plants

Additional native fall, winter, and early spring (October-March) blooming flowers should be planted at the site. Groundswell engaged school groups and community members in planting additional appropriate native winter and early spring blooming flowers in sunlit areas close to the grove during winters 2019-2022 (Figure 4, Figure 10). Late blooming fall nectar species that have been planted include marsh baccharis (*Baccharis glutinosa*), Pacific aster (*Symphyotrichum chilense*), Western flat-topped goldenrod (*Euthamia occidentalis*), California goldenrod (*Solidago velutina*), goldenbush (*Ericameria ericoides*), and gumplant (*Grindelia stricta*). Early spring nectar sources include a host of native species such as arroyo willow, blue blossom ceanothus (*Ceanothus thyrsiflorus*), pink flowering currant (*Ribes sanguineum*), and others. The plantings have included both upland and riparian species, which are attractive to monarchs and other native pollinators. Perennial forb and shrub plantings have been accelerated by transplanting rhizomatous species collected from nearby sources. Additional planting areas in Lighthouse Field (such as those close to Steamer Supply) are part of Groundswell's Living Shoreline restoration work. A list of species planted is in Appendix I.



Figure 10. Volunteers planting native nectar species January 2022 in the field west of the main grove.

Native nectar species survival and nectaring.

Survival estimates of native nectar plants were not completed for herbaceous species due to time and resource limitations. Shrubs survivorship was 12% for red flowering currant and 60% for blue blossom ceanothus (Figure 4). The low survivorship of the currant is likely due to site suitability and limited subsurface late summer water.

Monitoring monarch utilization and preference of native nectar plants was not performed due to low monarch population numbers at Lighthouse Field. We have incidental observations of monarch's nectaring on pacific aster, blueblossom ceanothus, seaside daisy and arroyo willow at the site.

Access and public engagement

Expand fencing

Additional symbolic fencing around the grove and adjacent meadows should be installed.

Additional signage

Signage that discourages the release of captive-reared monarch butterflies was installed around the perimeter of the site in Fall 2021. Additional interpretive signage could be developed to better convey actions taking place at this overwintering grove and actions that visitors can take at their homes to support monarch conservation.



Figure 11. Signs developed by Parks, CARCD and Groundswell to discourage release of captive reared monarchs at Lighthouse Field.

Docent program

The Grove would benefit from an extension of the Natural Bridges docent program. During the winter of 2017, California State Parks docents were onsite to provide interpretation services to the public. There is opportunity for interpreters to provide additional services especially on the weekends from November - February.

Neighborhood outreach

Numerous neighborhood community planting events have been held at Lighthouse Field since Pelton et al 2017. Outreach for these events occurred through Groundswell's Instagram and Facebook pages and was shared via partners such as the California State Parks Foundation, California Native Plant Society, the Santa Cruz Longboard Union., and the Resource Conservation District of Santa Cruz County. In the five winters, 2017/18 - 2021/22, over 4,000 nectar plants and shrubs were planted throughout Lighthouse Field during community and school planting events.

Groundswell frequently worked with neighboring Gateway School science and outdoor life lab classes during the winters of 2017 and 2018. Students participated in pollinator visitation studies, monarch walking transect counts (making notes of monarch activity-flying/nectaring/mating/sunning), helped take measurements when qualified personnel captured and tagged monarchs for research purposes (see Monarch Alert <http://monarchalert.calpoly.edu/> for details) and planted nectar shrubs throughout Lighthouse Field. Additionally, during the 2020/21 winter in which most schools were doing online learning, numerous school "pods" assisted with nectar planting.

Access

Refer to the *Monarch Butterfly Overwintering Site Management Plan for Lighthouse Field State Beach* (Pelton et al. 2017).

Climate Change

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

Sea level rise

The Lighthouse Field Grove is buffered from sea level rise due to its distance from the shoreline (~500') and elevation (~33'). Coastal erosion will likely impact adjacent nectaring habitat at some point in the distant future. The City of Santa Cruz's West Cliff Adaptation and Management Plan has explored the possibility of migrating West Cliff Drive inland in response to coastal erosion. This stands to impact monarchs and future planning efforts need to include measures that will protect the Grove from future developments.

Drought

The North American West is experiencing extreme drought. Rainfall is the key water source for grove trees and nectar producing shrubs. The Grove is dependent on the shallow water aquifer of a relatively small watershed. The watershed has extensive impermeable surfaces which reduces the amount of rainfall that enters the aquifer. Irrigation from adjacent suburban homes likely contributes to this aquifer. Reduced rainfall and city-imposed water usage restrictions in response to the drought has decreased the amount of water available to the Grove. 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, self-pruning, and disease, presumably in partial response drying conditions.

Warming Winters

As winters warm, monarchs will spend less time in diapause and have increased metabolic demands to forage on nectar plants, underscoring the importance of existing nectar sources. Warm weather also alters flower bloom phenology with plants blooming earlier than previously observed. We observed this in the warm January in the winter of 2021-22 where spring bloomers such as pink flowering currant (*Ribes sanguineum*) and blue blossom ceanothus (*Ceanothus thyrsiflorus*) began blooming in December. While potentially beneficial to monarchs, this early blooming may eventually be negatively impacted by drought. Warming 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.

Fire

The frequency and severity of fires is increasing in California. Reduced precipitation, decreased relative humidity, and stronger drier winds are associated with this trend. The duration of the fire season has also expanded, with winter fires becoming increasingly common. Scientists expect this trend to continue, and managers should be prepared to mitigate the risk of catastrophic fire in the grove by reducing fuels and outreach to reduce sources of ignition.

Increased 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. Visitorship of coastal areas has grown by several orders of magnitude in recent years. There is a need for the park to plan to accommodate increased use while simultaneously protecting monarchs and the resources they depend on.

Survey Information for Overwintering Monarchs

Historical Monarch Counts and Estimates

Refer to the *Monarch Butterfly Overwintering Site Management Plan for Lighthouse Field State Beach* (Pelton et al. 2017) for background information with most recent count data shown in Figure 12 and Table 1 below.

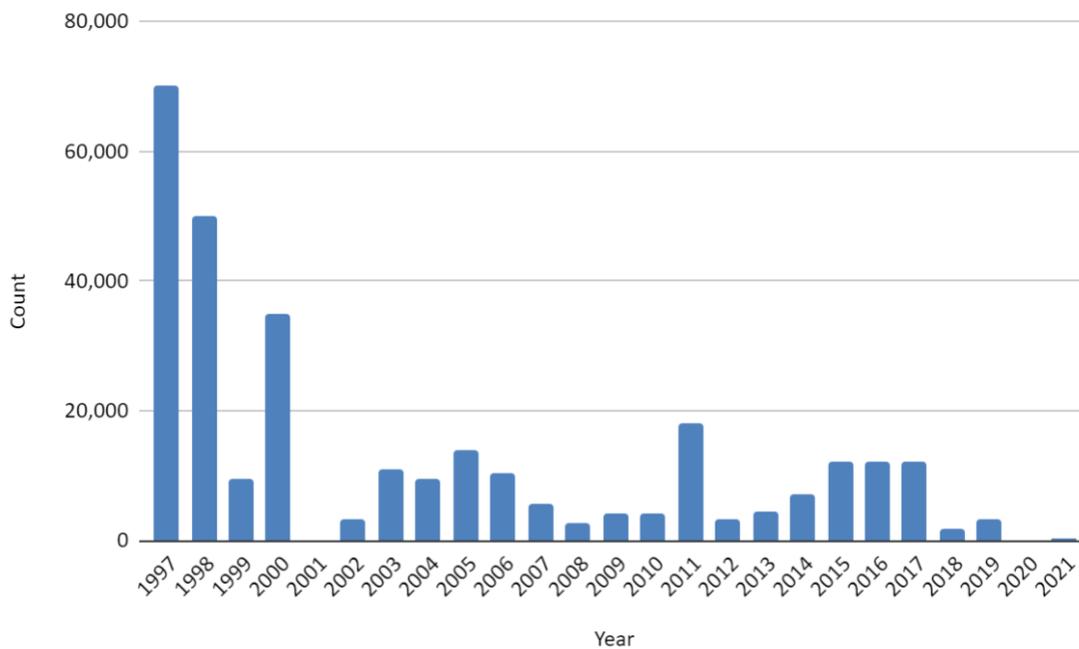


Figure 12. Thanksgiving count data for Lighthouse Field 1997 - 2021 (source Xerces 2021).

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

Cluster locations

See the *Monarch Butterfly Overwintering Site Management Plan for Lighthouse Field State Beach* (Pelton et al. 2017) with updated map below (Figure 13).



Figure 13. Existing early flowering nectar zones, sunning areas and cluster locations at Lighthouse Field.

Roosting Habitat Trends

Refer to the *Monarch Butterfly Overwintering Site Management Plan for Lighthouse Field State Beach* (Pelton et al. 2017).

Tree Recruitment

The authors have observed blue gum recruitment on the East border of the Grove in response to fuels reduction and chipping activities. Recruitment was likely facilitated by removal of duff and/or the chipper mechanically opening eucalyptus seed pods.

Wind

Lighthouse Field 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 for grove buffering capacity. The general wind pattern phenology is:

- Fall - relatively calm winds with occasional strong northerlies or southerlies

- Winter - strong southern winds that can gust to over 50 knots occur when low-pressure fronts move onshore followed by northwest winds as the fronts move inland. South winds often precede rain and/or lower temperatures, which can knock roosting monarchs to the ground. Cold north winds can blow down off the Santa Cruz Mountains and are associated with cold, sometimes freezing temperatures in the grove.
- Spring - strong northwest upwelling winds. Northwest winds can gust in excess of 45 knots.

Once grounded by wind and/or rain, monarchs require a period of dry and warm weather to be able to regain access to the roost. At Lighthouse Field, senescing trees has led to gaps through which wind can penetrate the grove (Pelton et al. 2017). As explained in the *Strategic Tree Planting and Forest Management* section above, measures have been taken to maintain the buffering capacity of the core grove (Figure 2 &4). However, these will take many years to grow into effective windbreaks, especially those trees growing in the shade within the northern part of the grove.

Sunning

Refer to the *Monarch Butterfly Overwintering Site Management Plan for Lighthouse Field State Beach* (Pelton et al. 2017) with updated sunning zones shown in Figure 13.

Nectaring

Refer to the *Monarch Butterfly Overwintering Site Management Plan for Lighthouse Field State Beach* (Pelton et al. 2017) as well as the section *Increasing Native Nectar Resource Availability* above with maps of updated native nectar planting areas (Figure 4) and the updated map of nectaring zones (Figure 13).

Water Sources

Refer to the *Monarch Butterfly Overwintering Site Management Plan for Lighthouse Field State Beach* (Pelton et al. 2017).

Lighthouse Field 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 Lighthouse Field and other nearby sites such as Natural Bridges State Beach (<2 miles). In some years a 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 (pers. comms.) does not consider sites to be part of a site complex, and while intersite 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.

Management Recommendations

The following management recommendations include existing practices that should be continued and new actions that can be implemented.

Previous Management Actions:

- Monitor and manage yellow jacket population
- Design and implement crumb clean campaign
- Remove debris and large brush piles to reduce pest populations and predator habitat.
- Perform fuels reduction every 3-5 years.
- Continue to mulch around the grove trees and on paths to enhance soil moisture retention and protect shallow roots.
- Install symbolic fencing around the grove and adjacent meadows.
- Design and install interpretive signage about monarch conservation and how people can best help in their everyday lives.

New Management Actions:

- Assess solutions for rapid enhancement of the north windbreak including artificial means.
- Design and implement a docent program with Natural Bridges State Beach
- Drought - assess solutions to address the effects of declines in precipitation which is impacting the health, growth and phenology of trees and nectar plants.
- Warming winters - assess solutions to combat reduced morning dew and fog
- Fire - mitigate the risk of catastrophic fire in the grove through fuels management and interpretation.
- Increase visitorship - Develop a plan to accommodate increased visitor pressure while simultaneously protecting monarchs and other natural resources.

Next Steps

Implementation of the above recommendations and those in the 2017 plan will help support overwintering monarchs at the Lighthouse Field Grove. Consolidating this information into a document that is adopted into the Lighthouse House Field State Beach Management Plan will provide a binding framework for enhancement and facilitate funding of future projects. These actions should be ranked in order of priority. Actions should have an adaptive approach where outcomes are evaluated and methodologies are adjusted to maximize effectiveness.

Appendices

Appendix I. Planting List

Common Name	Scientific Name	Location
bee plant	<i>Scrophularia californica</i>	LHF & SS
Blue eyed grass	<i>Sisyrinchium bellum</i>	SS
blue wildrye	<i>Elymus glaucus</i>	SS
blueblossom ceonothus	<i>Ceanothus thyrsiflorus</i>	LHF
California buttercup	<i>Ranunculus californicus</i>	SS
California fuschia	<i>Epilobium canum</i>	LHF & SS
California poppy	<i>Eschscholzia californica var. maritima</i>	SS
California rose	<i>Rosa californica</i>	LHF
California sagebrush	<i>Artemisia californica</i>	SS
checker mallow	<i>Sidalcea malviflora</i>	SS
coast buckwheat	<i>Eriogonum latifolium</i>	LHF
coast dudleya	<i>Dudleya caespitosa</i>	SS
coast tarweed	<i>Madia sativa</i>	LHF & SS
coffeeberry	<i>Frangula californica</i>	LHF
common cowparsnip	<i>Heracleum maximum</i>	LHF
common yarrow	<i>Achillea millefolium</i>	LHF & SS
creeping wild rye	<i>Elymus triticoides</i>	SS
Douglas iris	<i>Iris douglasiana</i>	SS
gumplant	<i>Grindelia stricta var. platyphyla</i>	LHF & SS
Harford's sedge	<i>Carex harfordii</i>	LHF & SS
horkelia	<i>Horkelia californica</i>	LHF & SS
lizard tail	<i>Eriophyllum staechadifolium</i>	SS
Monterey Cypress	<i>Cupressus macrocarpa</i>	LHF
Pacific aster	<i>Symphotrichum chilense</i>	LHF & SS
pink flowering currant	<i>Ribes sanguineum</i>	LHF
prunella	<i>Prunella vulgaris var. lanceolata</i>	LHF & SS
purple needlegrass	<i>Stipa pulchra</i>	SS
salt marsh baccharis	<i>Baccharis glutinosa</i>	LHF
seaside daisy	<i>Erigeron glaucus</i>	LHF & SS

self heal	<i>Prunella vulgaris var. lanceolata</i>	LHF
sneezeweed	<i>Helenium puberulum</i>	LHF
sticky monkey flower	<i>Diplacus aurantiacus</i>	LHF & SS
thrift seapink	<i>Armeria maritima</i>	SS
tufted hairgrass	<i>Dechampsia cespitosa</i>	SS
Western flat topped goldenrod	<i>Euthamia occidentalis</i>	LHF
yerba buena	<i>Clinopodium douglasii</i>	SS
* LHF = planted at and around Lighthouse Field for monarchs and other pollinators		
* SS = planted at and around Steamer Supply as part of the Living Shoreline Project		

Appendix II. Habitat Assessment Form

[Habitat Assessment Form.](#)

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