



Moran Lake Monarch Butterfly Habitat Management Plan Update

prepared with the assistance of

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Table of Contents

1	Introduction	1
2	Background and Purpose	3
2.1	Monarch Butterfly Habitat Listing Status	4
2.1.1	Federal	4
2.1.2	State	4
2.1.3	Regional.....	5
2.2	Consistency with Other County Plans	6
2.3	Community and Stakeholder Engagement	8
3	Site Description	10
3.1	Location	10
3.2	Soils.....	10
3.3	Dominant Tree Community: Eucalyptus Grove.....	13
3.4	Other Vegetation Communities	13
3.5	Current Management.....	13
3.5.1	County Parks Management.....	14
3.5.2	Sanitation District Management.....	14
3.5.3	Sensitive Habitat on Privately Owned Property.....	14
3.6	Overwintering Habitat Zones	14
3.7	Climate Change.....	18
4	Monarch Overwintering Information.....	19
4.1	History of Counts	19
4.2	Monarch Activity History.....	21
4.3	Roosting and Basking Sites	24
4.4	Current Habitat Condition	26
4.4.1	Roosting and Basking Habitat (Sanitation District and County-Owned Land) .	27
4.4.2	North and South Lakeside Habitat (County-Owned Land).....	27
4.4.3	Southeast Grove and 40 Moran Way Habitat (County- and Privately Owned Land)	28
4.5	Nectar Sources	28
4.6	Hazardous Trees	29
4.7	Fire Risk Assessment	29
4.8	Monarch Predators	30
5	Management Plan Actions	31
5.1	Monarch Surveys.....	31
5.2	Monarch Habitat Monitoring	31
5.3	Habitat/Forest Management	32

5.3.1	Tree Planting and Management	35
5.3.2	Hazard Trees	43
5.3.3	Fire Risk Abatement	44
5.3.4	Nectaring Plants	44
5.3.5	Drainage Improvements	46
6	Monitoring Plan.....	51
6.1	Monarch Surveys.....	51
6.2	Habitat Assessments	51
6.3	Monarch Predator Assessments	51
6.4	Annual Report	52
6.5	USFWS Monitoring and Reporting Requirements 2022.....	52
6.6	California Coastal Commission	52
7	Adaptive Management	54
8	References.....	56

Tables

Table 1	MBHMP Consistency with the 2024 General Plan and Local Coastal Program	6
Table 2	Western Monarch Count Statistics for Santa Cruz County Since 1997	20
Table 3	Fall and Winter Monarch Nectar Plants in the Management Area.....	28
Table 4	Tree Species to Plant in Specific Habitat Areas on Figure 5	35
Table 5	Recommended Nectaring Plants	46
Table 6	Summary of Management Actions and associated Protective Measures	48
Table 7	Tree Species Not Well-Suited to the Management Area	54

Figures

Figure 1	Regional Location	11
Figure 2	Monarch Habitat Management Area	12
Figure 3	Moran Lake Sensitive Habitat on Private Land	16
Figure 4	Moran Lake Monarch Butterfly Overwintering Habitat Zones	17
Figure 5	Monarch Butterfly Roost and Windbreak Areas	23
Figure 6	Moran Lake Monarch Butterfly Roosting Site/Core Zone	25
Figure 7	Recommended Overall Management Actions	34

Appendices

Appendix A	Moran Lake Monarch Overwintering Habitat Existing Conditions Report and Associated Appendices (including Wind Study)
Appendix B	Xerces Society Western Monarch Count Protocols and Datasheet
Appendix C	U.S. Fish and Wildlife Service Coastal Program Workplan for the Moran Lake Monarch Butterfly Management Update 2021

Appendix D	Past Studies and Reports Completed for Moran Lake Monarch Butterfly Management Area
Appendix E	2010 Draft Moran Lake Monarch Butterfly Habitat Management Plan
Appendix F	Site Photographs
Appendix G	Xerces Society's Coastal California Plant List
Appendix H	January 2026 Tree Risk Assessment for Moran Lake Park

1 Introduction

Rincon Consultants, Inc. (Rincon) has prepared this report in conjunction with Park Planning staff from the Santa Cruz County Department of Parks, Open Space & Cultural Services (County Parks) as an update to the 2010 Moran Lake Monarch Butterfly Habitat Management Plan (MBHMP). The 2010 MBHMP integrated previous reports and studies regarding monarch butterfly overwintering habitat surrounding Moran Lake in Santa Cruz County, California. This updated MBHMP details the most recent monarch population data, describes current monarch overwintering conditions at Moran Lake, and provides updated monarch habitat management recommendations. This plan includes content that is consistent with the 2022 Monarch Overwintering Grove Management Plan Template. The template was developed for land managers of overwintering sites by the following agencies and organizations: Xerces Society for Invertebrate Conservation,¹ Groundswell Coastal Ecology,² California Department of Parks and Recreation, and the U.S. Fish and Wildlife Service (USFWS).

The 2010 MBHMP integrated the Management Plan for the Monarch Habitat at Moran Lake County Park (Joni L. Janecki & Associates 2004), the Management Plan for the Monarch Habitat at the D.A. Porath [Lode Street] Sanitation Facility of the Santa Cruz County Sanitation District (Joni L. Janecki & Associates, Inc. 2006), and portions of the Moran Lake Water Quality Study & Conceptual Restoration Plan prepared for the Santa Cruz County Redevelopment Agency (John Gilchrist & Associates and Fall Creek Engineering 2005). This plan, unlike the 2010 plan, does not address improvements to County Parks' facilities (trails, amenities, etc.) or to the structure of the lake (bank stabilization). A separate project addressing those elements is being developed presently.

Land ownership of the overwintering habitat surrounding Moran Lake is shared between County Parks and the Santa Cruz County Sanitation District (Sanitation District). The overwintering habitat includes the eucalyptus groves within Moran Lake County Park and surrounding the Sanitation District's D.A. Porath Sanitation Facility. Under the terms of a memorandum of understanding between the Sanitation District and County Parks that was approved by the Board of Supervisors on September 30, 2025, County Parks is responsible for managing the entirety of the monarch habitat.

County Parks was awarded a grant from the USFWS Coastal Program for Central California Coast. The USFWS agreement contains two objectives for County Parks to meet:

- Objective 1 – Create an updated site assessment and set of management recommendations, based on monitoring of the overwintering monarch site, to be referenced and considered in a future Monarch Butterfly Habitat Management Plan
- Objective 2 – With stakeholder and community input, prepare an updated Monarch Butterfly Habitat Management Plan for Moran Lake County Park, prepare environmental review document in accordance with the California Environmental Quality Act, and present

¹ The Xerces Society for Invertebrate Conservation is an international nonprofit organization that protects the natural world through the conservation of invertebrates and their habitats. As a science-based organization, they both conduct their own research and rely upon the most up-to-date information to guide their conservation work. Key program areas include pollinator conservation, endangered species conservation, and reducing pesticide use and impacts (Xerces 2023a).

² Groundswell Coastal Ecology is a 501(c)(3) dedicated to building healthy coastal ecosystems through education and community-based ecological restoration and research. The organization partners with land managers, agencies, stakeholder groups, and the public to identify, prioritize, plan, and implement projects that enhance biodiversity and the long-term health of coastal habitats (Groundswell Coastal Ecology 2023).

to the County Board of Supervisors for review and adoption, allowing subsequent objectives to be completed.

To meet these objectives, County Parks contracted a qualified entomologist specializing in migratory monarchs to assess the site, complete an updated report, and provide a set of recommendations for monarch habitat management at Moran Lake County Park. Entomologist Dr. Stu Weiss's findings and recommendations are presented in the 2022 Moran Lake Monarch Butterfly Habitat Existing Conditions Report (Appendix A). Recommendations were modified in 2024 based on additional available information and written as an addendum to the Moran Lake Monarch Butterfly Overwintering Habitat Existing Conditions Report prepared in 2022. Data and management recommendations from the 2024 Addendum have been incorporated into this plan, and are in Appendix A. Recommendations were further modified in 2025 based on a wind study conducted by Althouse and Meade and Dr. Stu Weiss. Data and management recommendations from the 2025 wind study have been incorporated into this plan, and are included as a 2025 Addendum to the Moran Lake Monarch Butterfly Overwintering Habitat Existing Conditions Report in Appendix A.

County Parks orchestrated stakeholder and community input over a three-year period that was used to complete this Monarch Butterfly Habitat Management Plan for Moran Lake County Park. In addition, County Parks has contracted with consultants to prepare an environmental document in accordance with the California Environmental Quality Act. The final Habitat Management Plan and environmental document will be presented to the County Board of Supervisors for review and adoption, which would facilitate completion of the USFWS grant objectives.

2 Background and Purpose

Available reports regarding the origin of the blue gum eucalyptus forest that provides the monarch butterfly overwintering habitat include the 1980 Environmental Baseline Study for the Moran Lake Enhancement Plan Santa Cruz, California, and the 2005 Santa Cruz County Redevelopment Agency's Moran Lake Water Quality Study & Conceptual Restoration Plan, and the 2010 Moran Lake Monarch Butterfly Habitat Management Report (MBHMP). The consensus is that the blue gum eucalyptus growing around Moran Lake were likely planted as windbreak trees in the late 1800's or early 1900's. An analysis of aerial photos showed that the trees were well-established by 1929. Two adjacent woodlots were planted north of the lake. The main eucalyptus grove is likely the remains of one of the woodlots and now surrounds the Sanitation District's D.A. Porath Sanitation Facility, which was constructed in 1953.

The 1980 Environmental Baseline Study (Study) was prepared for the first phase of the Moran Lake Enhancement Plan. The Study notes that surveys were conducted that year for water quality in relation to biological abundance and diversity. Biological inventories included vegetation, birds, aquatic invertebrates (benthic and planktonic), fish and mammals. The stated intent of the Study was for the baseline information to be used for comparison, with post-restoration monitoring at Moran Lake. No known monitoring reports are available at the time of the drafting of this document. The Study notes that Moran Lake supported an extremely impoverished fauna of estuarine organisms at that time. No data regarding monarch butterflies is provided.

The Redevelopment Agency's Restoration Plan discusses Moran Lake historically as a pocket beach heavily influenced by seasonal tides that was filled with soil and materials in the early 1960s when Wood's Lagoon was expanded and converted into the Santa Cruz Yacht Harbor. The 2005 Plan describes the area being colonized primarily by non-native plants at that time, including by the dominant trees of blue gums (*Eucalyptus globulus*) and Monterey cypress (*Cupressus macrocarpa*).

In 1997, the Xerces Society, a volunteer citizen scientist group, began recording monarch butterfly overwintering counts in the State. In 1997, the organization recorded approximately 70,000 overwintering monarchs at the Moran Lake site. In 2016, the Xerces Society listed the Moran Lake site as one of the top 10 highest priority overwintering sites in the region. The western population of monarch butterflies has fluctuated greatly in recent years. An annual count of monarchs at Moran Lake in 2020 recorded just 50 overwintering monarchs; 7,050 were recorded in 2023 (Xerces Society 2023b).

In 2010, Moran Lake County Park's MBHMP was prepared to include the most recent monarch population use and habitat information and provide County Parks with an updated, comprehensive, and certified monarch management plan. The MBHMP provided goals and management recommendations for all monarch overwintering habitat surrounding Moran Lake. Since that time, County Parks has struggled with the funding to implement such a plan, and thus, management actions were constrained.

Over the past decade much of the monarch overwintering habitat at Moran Lake, comprised of eucalyptus groves, has been altered by drought. The long-term drought has negatively affected monarch overwintering habitat along the California coast as it has at the Moran Lake site. The drought, plus permitted and non-permitted tree removals, non-holistic tree maintenance, and poorly draining soil resulting in multiple tree failures of windbreak trees are contributing to the declining habitat.

The purpose of this updated MBHMP is to describe the current habitat conditions on-site and provide updated management recommendations based on current monarch overwintering observations and existing habitat conditions that will aid in the restoration, preservation, and future enhancement of monarch overwintering habitat at Moran Lake.

2.1 Monarch Butterfly Habitat Listing Status

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 (ESA; Center for Biological Diversity 2014). The USFWS updated their status assessment on December 15, 2020 (USFWS 2020), finding that listing of the western monarch population was warranted but precluded. The finding stated that the USFWS could not identify Evolutionary Significant Units (ESU) for monarchs, because, as defined in the ESA, when invertebrates, including butterflies, are evaluated, they are evaluated across the entire range. The evaluation was based on the global population that includes monarchs that occur east of the Rocky Mountains and on multiple continents. Monarchs were ranked at priority level #8 on the species list (USFWS 2022). Monarchs were proposed for listing as Threatened under the ESA by the USFWS on December 12, 2024. In addition, the USFWS proposed the Moran Lake habitat area as one of the five designated critical habitat areas in Santa Cruz County. A final decision by the USFWS is expected in early 2026.

2.1.2 State

Monarchs are included on the California Department of Fish and Wildlife (CDFW) 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 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 (CESA). On May 31, 2022, an appellate court ruled that the CESA does in fact cover terrestrial invertebrates, thereby reversing the previous ruling (Sacramento Superior Court No. 34-2019-80003216CUWMGDS). Currently, monarchs are not listed under the CESA, though there is potential for the overwintering population to be listed in the future, based on the May 2022 ruling. Monarchs do have protection 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 Act (CCA) defines Environmentally Sensitive Habitat Areas (ESHA) as "any area in which plant or animal life or their habitats are either rare or especially valuable because of their nature or role in an ecosystem and which could be easily disturbed or degraded by human activities and developments." Wetlands, including the estuarine habitat in and near Moran Lake, are protected under Section 30233 of the Coastal Act. Additionally, marine resources, including the marine habitat that occurs in the southwestern portion of the Project Area, below the high tide line of the Pacific Ocean, are protected under Section 30230 of the Coastal Act. The Santa Cruz County Local Coastal Program (LCP) Implementation Plan (IP) (County Code/IP Section 16.32.040) definition of sensitive habitat includes unique plant habitats, rare and endangered plant and animal habitats,

wetlands, coastal streams, rocky points, sea cliffs, intertidal areas, and kelp beds. Therefore, according to the Santa Cruz County LCP, the riparian corridors within the Coastal Zone are also considered ESHAs and the riparian vegetation associated with Moran Creek is an ESHA. Areas which provide habitat for rare, endangered, or threatened species are also considered ESHA. The eucalyptus groves within Moran Lake County Park which provide overwintering habitat for the monarch butterfly are therefore also ESHAs.

2.1.3 Regional

The Santa Cruz County Code's Chapter 16.32 Sensitive Habitat Protection, section 16.32.040 defines ESHAs as Sensitive Habitat. Habitat is considered sensitive if it provides habitat for plant or animal species or communities that are locally unique or are recognized by the State or Federal Resource Agencies as being rare, threatened endangered, or a species of special concern (County of Santa Cruz 2024). The definition of sensitive habitat also included unique plant habitats, wetlands, coastal streams, rocky points, sea cliffs, intertidal areas, and kelp beds. Therefore, according to the Santa Cruz County LCP, the riparian corridors within the Coastal Zone are also considered ESHAs and the riparian vegetation associated with Moran Creek is an ESHA. Additionally, the marine and estuarine habitat that occurs in the southwestern portion of the Project Area, below the high tide line of the Pacific Ocean is also considered an ESHA. Areas which provide habitat for rare, endangered, or threatened species are also considered ESHA. The eucalyptus groves within Moran Lake County Park which provide overwintering habitat for the monarch butterfly are therefore also ESHAs.

County Code Chapter 16.34 Significant Trees Protection preserves significant trees and forest communities on private and public property in the County's Coastal Zone to protect and enhance the County's natural beauty, property values, and tourist industry. The ordinance prohibits the removal of significant trees without a Significant Tree Removal Permit. Significant trees include any tree, sprout clump, or group of trees, as follows:

- (A) Within the urban services line or rural services line, any tree which is equal to or greater than 20 inches d.b.h. (approximately five feet in circumference); any sprout clump of five or more stems each of which is greater than 12 inches d.b.h. (approximately three feet in circumference); or any group consisting of five or more trees on one parcel, each of which is greater than 12 inches d.b.h. (approximately three feet in circumference).
- (B) Outside the urban services line or rural services line, where visible from a scenic road, any beach, or within a designated scenic resource area, any tree which is equal to or greater than 40 inches d.b.h. (approximately 10 feet in circumference); any sprout clump of five or more stems, each of which is greater than 20 inches d.b.h. (approximately five feet in circumference); or, any group consisting of 10 or more trees on one parcel, each greater than 20 inches d.b.h. (approximately five feet in circumference).
- (C) Any tree located in a sensitive habitat as defined in Chapter 16.32 SCCC. Also see SCCC 16.34.090(C), exemption of projects with other permits.

Tree removal exemptions listed in Section 16.34.080 include allowances for emergency tree work that require immediate action to abate hazards to safety of life or property. 16.34.090 of the ordinance includes exemptions for tree removals authorized pursuant to a valid discretionary permit.

Biological and water resources are protected by the County of Santa Cruz General Plan and the Local Coastal Plan (LCP) policies outlined in *Chapter 5: Conservation and Open Space* of the General Plan.

Relevant policies for the Moran Lake County Park Improvement Project include those outlined under the following General Plan and Local Coastal Plan objectives: *5.1 Biological Diversity, 5.2 Riparian Corridors and Wetlands, 5.3 Aquatic and Marine Habitats, 5.4 Monterey Bay and Coastal Water Quality, and 5.7 Maintaining Surface Water Quality.*

2.2 Consistency with Other County Plans

The MBHMP is in the jurisdiction of two local land use plans: the Pleasure Point Community Plan and the Santa Cruz County 2024 General Plan and LCP. The Pleasure Point Community Plan was adopted in May 2010 through County ordinances and focuses primarily on design standards and public improvements in the Pleasure Point/26th Avenue area (Santa Cruz County 2010). Since the MBHMP does not propose construction of buildings, public improvements, or conventional land development governed by the Pleasure Point Community Plan, the Pleasure Point Community Plan does not apply and is not evaluated further within this document. However, the Santa Cruz County 2024 General Plan and LCP includes several policies that serve to protect sensitive habitat areas, and thus, avoid or mitigate potential impacts to sensitive habitat that may occur as a result of development in the County. The MBHMP’s consistency with these policies is discussed below.

Table 1 MBHMP Consistency with the 2024 General Plan and Local Coastal Program

County of Santa Cruz LCP Policy and Programs	Consistency Discussion
Agriculture, Natural Resources, and Conservation Element	
ARC-3.1.4 Sensitive Habitat Protection Ordinance (LCP). Implement protection of sensitive habitats and of ESHA through SCCC Chapters 16.32 Sensitive Habitat Protection, 16.30 Riparian Corridor and Wetlands Protection, and 13.20 Coastal Zone Regulations. Any amendments to this ordinance shall require a finding that sensitive habitats shall be afforded equal or greater protection by the amended language.	Consistent. The MBHMP in itself serves to protect the monarch butterfly overwintering habitat by setting forth management actions consistent with Policy ARC-3.1.4.
ARC-3.1.6 Development within Sensitive Habitats (LCP). Sensitive habitats shall be protected against any significant disruption of habitat values, and any proposed development within or adjacent to these areas must maintain or enhance the functional capacity of the habitat. Reduce in scale, redesign, or, if no other alternative exists, deny any project that cannot sufficiently mitigate significant adverse impacts on sensitive habitats unless approval of a project is legally necessary to allow a reasonable use of the land.	Consistent. The MBHMP in itself serves to protect the monarch butterfly overwintering habitat by setting forth management actions consistent with Policy ARC-3.1.6.

County of Santa Cruz LCP Policy and Programs	Consistency Discussion
ARC-3.1.7 Site Design and Use Regulations (LCP). Protect sensitive habitats against any significant disruption or degradation of habitat values in accordance with the Sensitive Habitat Protection ordinance. Utilize the following site design and use regulations on parcels containing these resources, excluding existing agricultural operations: (1) Structures, when allowed, shall be placed as far from the habitat as feasible. (2) Delineate development envelopes to specify location of development in minor land divisions and subdivisions. (3) Consider use of conservation or open space easements, deed restrictions, Conditions of Approval or equivalent measures to protect that portion of a sensitive habitat on a project parcel which is undisturbed by a proposed development activity or to protect sensitive habitats on adjacent parcels. (4) Limit or restrict outdoor access of domestic animals where they threaten sensitive habitats. Santa Cruz County General Plan Page 5-50 3/18/2024 (5) Limit removal of native vegetation to the minimum amount necessary for structures, landscaping, driveways, septic systems and gardens. (6) Maintain regulations and impose development permit conditions of approval as warranted, to limit landscaping with invasive or exotic species and to strongly encourage or require the use of characteristic native species, as well as consistency with the Water Efficient Landscaping Ordinance.	Consistent. The plan would not result in disruption or degradation of a sensitive habitat and would incorporate native plants as appropriate to improve habitat for monarchs and other native species at Moran Lake.
ARC-3.1.9 Biotic Assessments (LCP). Within the following areas, require a biotic assessment as part of normal project review to determine whether a full biotic report should be prepared by a qualified biologist, and require biotic permits as part of application reviews as may be needed: (1) Areas of biotic concern, mapped; (2) Sensitive habitats, mapped and unmapped; and (3) For sites within the coastal zone, for the presence of ESHA.	Consistent. The MBHMP serves as a biotic assessment of the monarch habitat of Moran Lake. The primary goal is to enhance the function of Moran Lake through restoration activities which would better sustain a native monarch population.
ARC-3.1.10 Species Protection (LCP). Recognize that habitat protection is only one aspect of maintaining biodiversity and that certain wildlife species, such as migratory birds, may not utilize specific habitats. Require protection of these rare, endangered, and threatened species and continue to update policies as new information becomes available.	Consistent. The MBHMP provides updated management recommendations based on current data that will aid in the restoration, preservation, and enhancement of monarch overwintering habitat at Moran Lake. Implementation of the plan would improve habitat protection for monarchs.
ARC-3.2.4 Removal of Invasive Plant Species (LCP). Encourage the removal of invasive species and their replacement with characteristic native plants, except where such invasive species provide significant habitat value and where removal of such species would severely degrade the existing habitat. In such cases, develop long-term plans for gradual conversion to native species providing equal or better habitat values. Support the responsible use of herbicides to assist with the removal of invasive plant species.	Consistent. While blue gum eucalyptus, cape ivy, and english ivy can be considered invasive species, they provide critical habitat value to monarchs at Moran Lake. Therefore, within the core habitat zone, these species will be managed to provide habitat benefit to monarchs. Outside of the core habitat zone, recommended replacement trees include native species to the extent feasible to provide biodiversity and to facilitate a long-term transition toward more native species. Replacement trees will be selected based on the specific soil, water, sunlight, and need for wind protection at each location.

County of Santa Cruz LCP Policy and Programs	Consistency Discussion
ARC-3.3.3 Activities Within Riparian Corridors and Wetlands (LCP). Development activities, land alteration, and vegetation disturbance within riparian corridors and wetlands and required buffers shall be prohibited unless an exception permit is granted per the Riparian Corridor and Wetlands Protection ordinance. As a condition of a riparian exception permit, require evidence of compliance with applicable permit or review requirements of the U.S. Army Corps of Engineers, California Department of Fish and Wildlife, and other federal or state agencies that may have regulatory authority over activities within riparian corridors and wetlands.	Consistent. The project site contains Moran Lake: the coastal lagoon and associated wetlands. Recommended tree planting would occur directly adjacent to these areas. However, removal and replanting of trees and other management activities contemplated under this plan would be required to comply with all applicable laws and regulations and the protective measures outlined in this plan. These actions would limit any adverse effects on water quality in Moran Lake and associated waterways. Finally, the approval of this plan will include a Biotic Approval permit to cover management activities included in the plan.
ARC-3.3.8 Environmental Review for Riparian Corridor and Wetland Protection (LCP). Require environmental review of all proposed development projects affecting riparian corridors or wetlands and preparation of a Biotic Report for projects that, as proposed, may have a significant effect on the corridors or wetlands. Compliance with County regulations is generally considered to prevent the possibility of significant environmental impacts, and any biotic and/or riparian exception permit process may involve project specifications and/or conditions that would also prevent the possibility of significant environmental impacts.	Consistent. The MBHMP in itself is a biotic report which identifies sensitive habitats on the project site and sets forth management actions and associated protective measures to improve and protect the habitat. Future management plan actions proposed under the plan would not have adverse effects on Moran Lake nor its associated wetlands.
ARC-5.1.9 Significant Tree Removal Ordinance (LCP). Maintain the standards in the County’s regulations that require a permit for removal of significant trees and other major vegetation located within the Coastal Zone, and provide appropriate protection for significant trees and other major vegetation in other areas of the County.	Consistent. The trees at Moran Lake are within sensitive habitat and are therefore considered significant. This plan provides specific recommendations for tree management, including regular assessment by a certified arborist, protective measures for tree work, removals, and replacement plantings to maintain sensitive monarch butterfly overwintering habitat. The plan requires mitigation for tree removals and that the mitigation be guided by a certified arborist and monarch butterfly specialist in order to enhance monarch habitat. Therefore, future management plan actions proposed under this plan will not have an adverse effect on the sensitive habitat and will be covered by a Biotic Approval and Riparian Exception, thereby meeting the requirements of the Significant Tree Removal Ordinance.
LCP = Local Coastal Plan; MBHMP = Monarch Butterfly Habitat Management Plan Source: Santa Cruz County 2024	

2.3 Community and Stakeholder Engagement

County Parks orchestrated significant stakeholder and community input over a three-year period during the development of the Moran Lake Monarch Butterfly Habitat Management Plan Update. Stakeholder and community input directly influenced the content and recommendations of the habitat management plan (HMP). Community and stakeholder engagement consisted of direct outreach to local regulatory agencies and monarch experts including the USFWS, the California Department of Fish and Wildlife, John Dayton, the Xerces Society, the California Coastal Commission, and Santa Cruz County Environmental Planning during development of the draft

habitat management plan in 2023 and 2024 to solicit feedback on the plan and to ensure that site-specific data on historic monarch roost locations and activities were incorporated in the plan.

In addition, County Parks shared a public draft of the HMP at a community meeting on July 23, 2024 and via email to neighbors, stakeholders, and other interested parties. The draft HMP was also posted on the County Parks website. Comments were collected during the public meeting, and the public comment period was open until August 16, 2024. Most of the public comments focused on the need for increased tree management and assessment and the need to prioritize public safety while protecting monarch habitat. Some commenters did not agree with recent tree planting at the park and expressed concern that private views were impacted, open space was being lost, and that County Parks did not conduct sufficient public comment prior to the planting. Other commenters expressed support for the recent tree planting and requested additional tree planting. Several commenters suggested that only California native species be planted. Other comments focused on the need to protect the existing eucalyptus trees, and some comments requested preservation of the trees on the 40 Moran Way parcel.

Based on feedback provided during the community meeting and in subsequent comments, County Parks, in partnership with the Sanitation District and First District Supervisor Manu Koenig, contracted with Althouse and Meade and Dr. Stu Weiss to prepare a wind study to analyze the relationship between the height of the existing eucalyptus trees and the wind protection that they provide to the monarch overwintering habitat. The wind study was completed in June 2025. Recommendations from the wind study, proposed changes to the habitat management plan that were informed by the wind study, as well as plans for conducting tree management in Summer 2025, were presented at a community meeting on June 24, 2025. The community meeting presentation was posted on the County Parks website, and the public comment period was open until July 11, 2025.

Most of the public comments expressed support for the increased management actions outlined in the presentation. Comments from neighbors expressed concern that eucalyptus trees along Placer Street and in the Southeast Grove were not scheduled for tree work in Summer 2025. Several commenters expressed concern that the management actions would not receive sufficient funding. Some comments noted the statewide significance of the monarch habitat at Moran Lake and expressed disagreement with the wind study results showing that removal of trees around the lake would not negatively impact overwintering habitat and expressed concern that the wind study did not take into account impacts to the fall roost sites in the South Creekside area. Other commenters noted that the findings of the wind study suggested that no additional trees needed to be planted around the lake and requested that planting locations prioritize the preservation of views from private residences and that County Parks conduct a robust public comment process prior to planting additional trees in the park. Some comments requested that Parks prioritize drainage improvements to the 40 Moran Way parcel and around areas of the lagoon with historic ponding.

3 Site Description

3.1 Location

The site is located in and around Moran Lake County Park in the unincorporated Live Oak area of the County, approximately 0.25-mile west of Soquel Point and directly northeast of the Pacific Ocean (Figure 1). The site is surrounded by residential neighborhoods to the west, north, east, and south, as well as Moran Lake Beach to the southwest (Figure 2). The site is depicted on the *Soquel, California* United States Geological Survey (USGS) 7.5-minute topographic quadrangle map and is located in Township 11 South, Range 1 West, Section 21.

The site is located within the Central Coast geographic subregion of California (Baldwin et al. 2012). The climate in this region is characterized by warm, dry summers and mild, wet winters. The average high temperature during summer months (June through September) is 75 degrees Fahrenheit (°F) and the average low temperature is 50 °F. The average high temperature during the winter months (December through March) is 62 °F and the average low temperature is 40 °F. Average annual precipitation is 29.3 inches, with the majority of rainfall occurring during November through March (Western Regional Climate Center 2022). Topography on-site is generally flat, with elevations ranging from approximately 10 to 50 feet above mean sea level.

The management area³ for this MBHMP update includes the monarch butterfly overwintering habitat which is the eucalyptus groves within Moran Lake County Park and surrounding the Sanitation Facility, Moran Lake and Creek (the coastal lagoon and associated wetlands), the sandy beach around the lake, and the vegetation that comprises the windbreak at the site. It also includes a small rectangular parcel at 40 Moran Way, which previously contained additional eucalyptus grove habitat. A separate plan and project addressing the Moran Lake County Park amenities (trails, picnic tables, the restroom, etc.) and the culvert at East Cliff Drive will be prepared to address those features. Sensitive habitat on private properties immediately adjacent to the management area contributes important windbreak for the site. While the County cannot manage the private land, the designation of the parcels as sensitive habitat will function to conserve the habitat.

3.2 Soils

The U.S. Department of Agriculture, Natural Resources Conservation Service (USDA NRCS) Web Soil Survey identifies three soil map units within the management area: Watsonville loam, 0 to 2 percent slopes; Watsonville loam, thick surface, 0 to 2 percent slopes; and Watsonville loam, thick surface, 2 to 15 percent slopes. Watsonville loam soils are derived from alluvium and formed on marine terraces from 0 to 1,200 feet in elevation. The depth to the water table is more than 80 inches. The frequency of flooding and ponding is none. The available water supply is very low (about 2.9 inches), and the soils are somewhat poorly drained (USDA NRCS 2022a). Watsonville loam soils are included on the NRCS list of hydric soils (USDA NRCS 2022b). The soils in many areas of the site, particularly on the northern edge of the lagoon, and within the 40 Moran Way parcel, suffer from poor drainage and are prone to ponding. This has led to the failure of large eucalyptus trees due to windthrow.

³ “Management area” and “Moran Lake site” will be used interchangeably throughout this report to refer to the outlined area depicted in Figure 2 and described in Section 3.1.

Figure 1 Regional Location

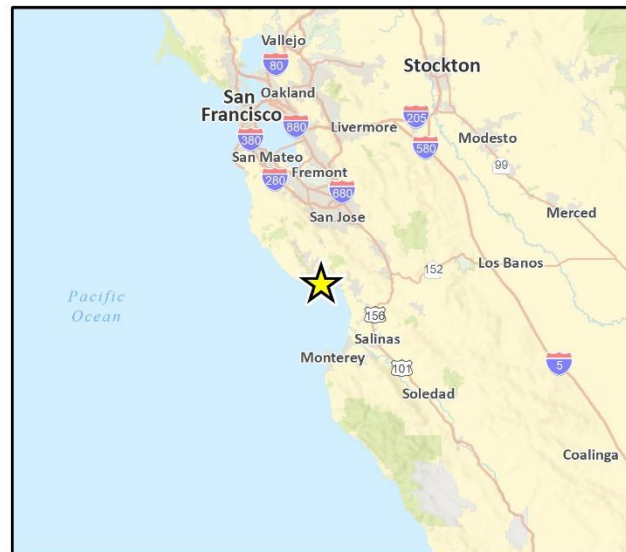
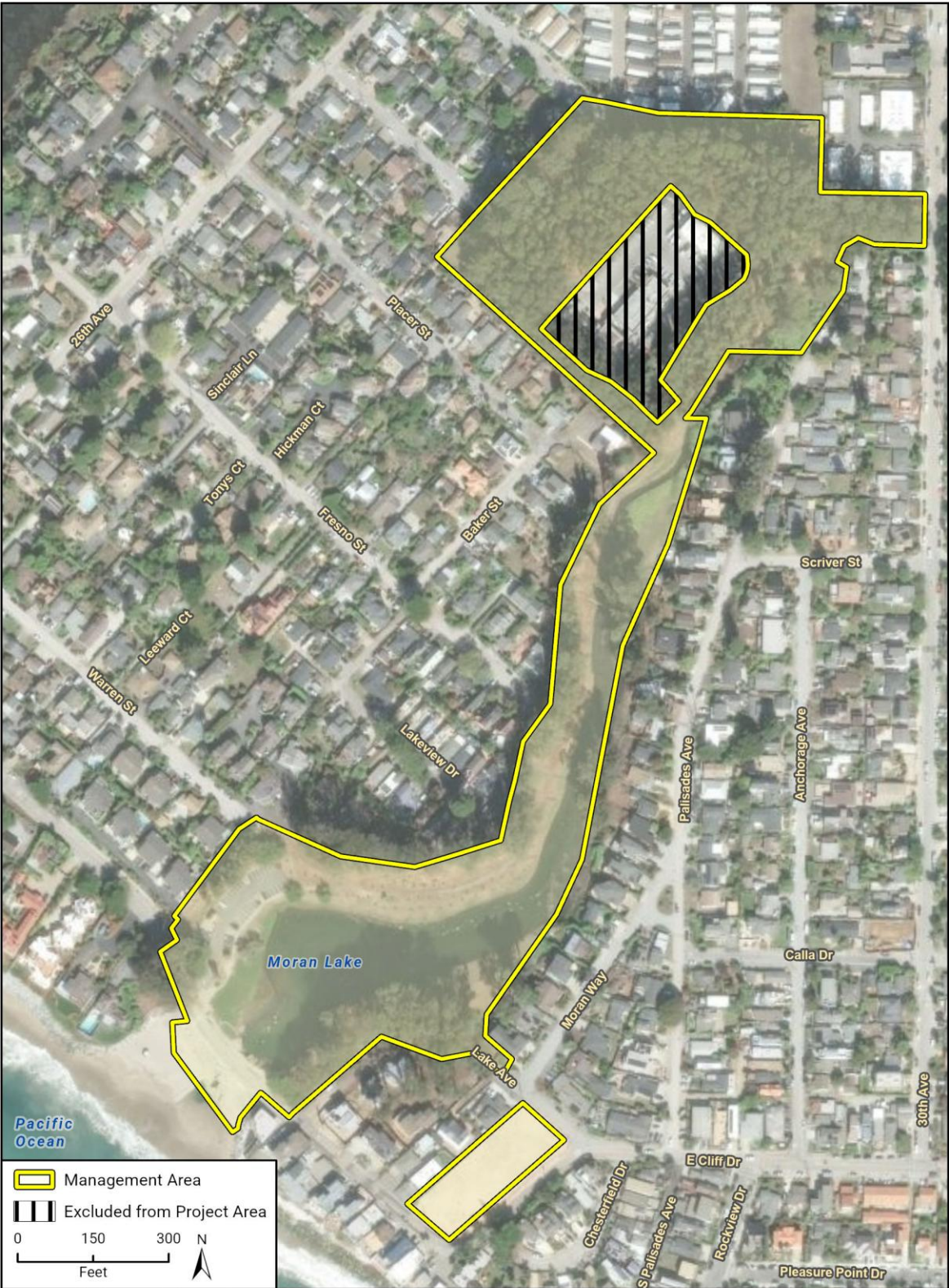


Fig 1 Regional Location

Figure 2 Monarch Habitat Management Area



3.3 Dominant Tree Community: Eucalyptus Grove

The eucalyptus groves in the management area currently most closely resemble the *Eucalyptus* spp. Woodland Semi-Natural Alliance (*Eucalyptus globulus* Association) described by Sawyer et al. (2009). Eucalyptus trees are dominant in this alliance and preclude most other plant species from growing in the understory. Eucalyptus groves were planted as windbreaks throughout California and have also been naturalized in many areas adjacent to streams and lakes.

Eucalyptus groves cover approximately 8.18 acres of the management area, with dense stands growing around the border of the D.A. Porath Sanitation Facility in the northern portion of the management area, along the western edge of the lagoon near the center of the management area, along the southeastern corner of the lagoon, and previously within the 40 Moran Way Parcel in the easternmost portion of the management area (Figure 2). The understory of the eucalyptus groves is generally scarce. Poison oak (*Toxicodendron diversilobum*) dominates the shrubby understory, forming low density and coverage thickets, and the herbaceous understory is generally absent, except for patches of English Ivy (*Hedera helix*). Although eucalyptus groves are non-native, they do comprise the important overwintering habitat for monarch butterflies on-site.

Rincon prepared the Moran Lake Arborist Report in 2022, which details the findings from the tree survey conducted by International Society of Arboriculture (ISA) certified arborist Casey Clark and Rincon Biologist Kate Ludwig on June 7 and June 8, 2022. During the survey, the location, species, diameter at breast height (DBH), height, canopy spread, general health condition, and any relevant notes (particularly pertaining to structural integrity) were recorded for each tree. A tree tag was also assigned to each tree surveyed. The 2022 Arborist Report is included in Appendix A.

3.4 Other Vegetation Communities

In addition to eucalyptus groves, the management area includes a coastal lagoon (Moran Lake) and its surrounding wetlands, which have been heavily modified by urban development and the introduction of non-native plant species. The 2005 Redevelopment Agency document discussed the trend/transition of vegetation on-site to dominant non-natives as “somewhat disturbing” when they compared the number of native shrubs and herbaceous plants then, to the 1980 Environmental Baseline Study for the Moran Lake Enhancement Plan. Upland native vegetation species identified in 1980 but not in 2004 include deerweed (*Lotus scoparius*), sky lupine (*Lupinus nanus*), bush lupine (*Lupinus arboreus*), coyote brush (*Baccharis pilularis*), California poppy (*Eschscholzia californica*), coast hedge nettle (*Stachys chamissonis*), seaside dandelion (*Agoseris apargioides*), loosestrife (*Lythrum hyssopifolia*), slough sedge (*Carex obnupta*), and bulrush (*Scirpus americanus*).

The following vegetation communities and land cover types exist within the management area: eucalyptus groves, pickleweed mats, disturbed riparian scrub, ice plant mats, sandy beach, annual grassland, ruderal, and developed. The Biological Resources Assessment Report prepared in 2022 provides a full discussion regarding vegetation communities and other biological resources and is included as part of Appendix A.

3.5 Current Management

A Memorandum of Understanding (MOU) for management of the monarch butterfly habitat surrounding the Sanitation Facility was approved between Parks and Sanitation in September 2025. Under the MOU, Parks is responsible for managing the habitat on Sanitation property in accordance

with the approved HMP. Previously, the monarch habitat on the two properties was managed independently, and general management activities within the two properties are described below. This new approach, whereby Parks manages the entire habitat, will lead to a more holistic and better coordinated management of monarch habitat.

3.5.1 County Parks Management

Regular vegetation maintenance is conducted at Moran Lake County Park, including annual high weed mowing along the east and west bank walkways, trimming of eucalyptus tree limbs upon County Parks' consulting arborist's recommendation (not more than one third of the new growth), and removal of small saplings that sprout from trunks of previously failed or removed eucalyptus trees. Parks' certified arborist conducts hazard tree assessments and identifies trees to be pruned or removed for the safety of the public and infrastructure. Potential removals are reviewed by a biologist/monarch butterfly specialist. Drainage features are maintained along the edges of Moran Lake to reduce the amount and duration of ponding water at the base of eucalyptus trees. Tree saplings are planted on an as-needed basis to fill in gaps in the windbreak and improve monarch habitat.

3.5.2 Sanitation District Management

Ongoing maintenance activities within the eucalyptus grove surrounding the D.A. Porath Sanitation Facility have been conducted to reduce the risk of falling limbs or trees, fire, and unauthorized encampment activities at the Sanitation Facility and adjacent properties. Regular maintenance consists of brush clearing, vegetation removal, and debris removal in the undergrowth of the grove. Vegetation management is carefully conducted to preserve nectar sources for monarchs. In addition, tree trimming is conducted on an as-needed basis to reduce the risk of tree failure into the Sanitation Facility, towards adjacent homes and trails. An ISA-certified arborist and Biologist/monarch butterfly specialist provided guidance and recommendations for all tree trimming and vegetation removal activities. Tree planting is conducted on an as-needed basis to fill in gaps in the canopy and improve monarch habitat within the grove, and saplings are irrigated and maintained to ensure survival. Saplings are flagged so they are not negatively impacted by vegetation clearing activities. Drainage features including ditches and storm drain pipes, are regularly maintained to prevent flooding and erosion within the grove.

3.5.3 Sensitive Habitat on Privately Owned Property

The hillsides, vegetation (including trees) and structures on private property immediately adjacent to the management area, provide critical windbreak to the habitat. Figure 3 displays the location of the sensitive habitat on private land. The County Board of Supervisors required that the sensitive habitat be designated and mapped through an amendment at the 2011 adoption of the 2010 Plan. These areas should be managed consistent with the actions described for the wind shelter and in coordination with the butterfly specialist.

3.6 Overwintering Habitat Zones

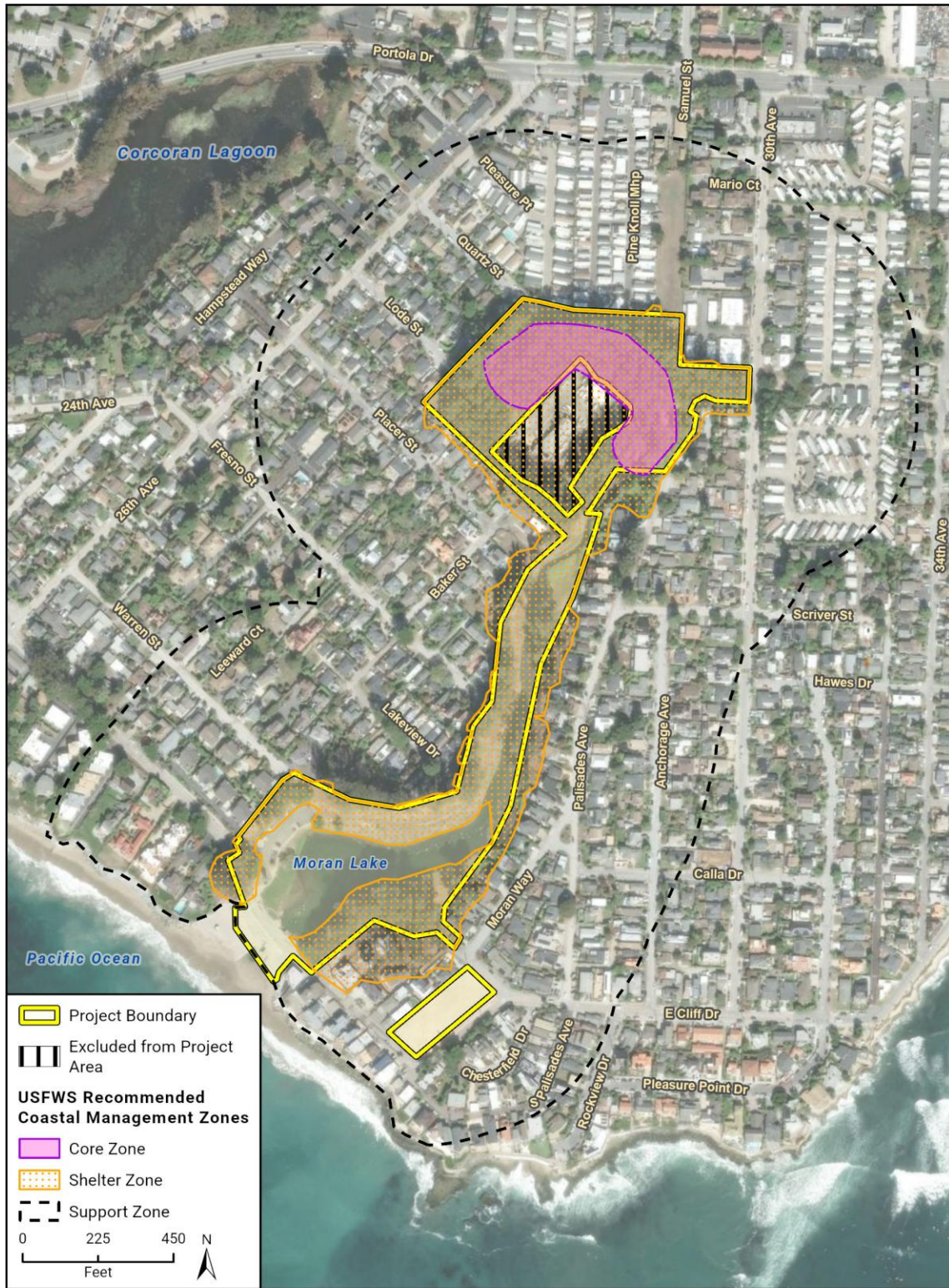
This plan update implements the USFWS Western Monarch Butterfly Conservation Recommendations (February 2023) to manage coastal California overwintering habitat as three zones.. The zones are the core zone (cluster area), shelter zone (wind protection and outer site

boundaries surrounding core zone) and support zone (area within 500 feet of an overwintering site that provides nectar, hydration, and microclimate protection). and are shown on Figure 4

Figure 3 Moran Lake Sensitive Habitat on Private Land



Figure 4 Moran Lake Monarch Butterfly Overwintering Habitat Zones



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21-11388 BIO
Fig 4 Moran Lake MBHMP Management Area_Overwintering Zones

3.7 Climate Change

Climate change and sea level rise is impacting all coastal communities around the world. In the past century, average global temperatures have increased by about 1.4 °F, and average global sea level has increased by 17 to 21 centimeters (7 to 8 inches) (Intergovernmental Panel on Climate Change 2013). Western monarchs are particularly vulnerable to climate change, due to their reliance on coastal overwintering habitat and their dependence on environmental cues to trigger reproduction, migration, and hibernation (Advani 2015). Increased temperatures, wildfires, and drought conditions are impacting eucalyptus grove habitat along the California coast, resulting in degraded or destroyed monarch overwintering habitat in multiple locations (Xerces Society 2020). Drought has impacted the health of the eucalyptus trees surrounding Moran Lake in recent decades, and climate change will likely continue to exacerbate both drought conditions and intense, episodic storm events. This plan serves to guide the management actions of the habitat to accommodate current and future climate change impacts, for example by adjusting the approach for tree replacement planting from requiring tree replacements at a 2:1 ratio to requiring replanting that supports the functional need of the habitat.

Coastal Santa Cruz County is already experiencing the impacts of climate change, and coastal lagoons in the county, including Moran Lake, are predicted to become more vulnerable to tidal inundation and coastal flooding in the coming years (Central Coast Wetlands Group 2017). Sea-level rise could alter salinity in Moran Lake and potentially impact the eucalyptus grove habitat surrounding Moran Lake. These impacts are most likely to occur during large swell and/or high-tide events, when the ocean inundates the lagoon and surrounding area and could affect eucalyptus trees directly and/or increase the soil salinity in and around the groves. For example, if winter storms cause the ocean to overtop and spill into Moran Lake with relative regularity, higher salinity inputs may negatively affect vegetation that cannot survive in higher saline environments. Around Moran Lake, if the water level rises, the salinity and saturated soils will rise with it and could cause trees and other vegetation to die off and retreat from the water line. Management recommendations provided in Section 5 below will aid in protecting and enhancing monarch overwintering habitat in the face of changing climatic conditions.

The Climate Action and Adaptation Plan (CAAP) developed by the County in December 2022 includes a number of strategies and objectives for responding to climate change. One of the strategies outlined in the CAAP is to increase the urban tree canopy (County 2022). The recommendations outlined in this MBHMP (e.g., improving the health of existing eucalyptus trees and planting new trees within eucalyptus groves at the Moran Lake site) will directly align with the objectives laid out in the CAAP for increasing the urban tree canopy in the county.

4 Monarch Overwintering Information

4.1 History of Counts

Xerces notes on their website that the past 25 years of data demonstrate that overwintering western monarchs have undergone a greater than 90 percent decline since the 1980s. Western monarch butterfly population numbers have generally seen a downward trajectory, since the inception of the Western Monarch Count in 1997, and counts have fluctuated widely over the years throughout California. The Moran Lake overwintering population is typically the third largest in Santa Cruz County, behind the Natural Bridges State Beach and Lighthouse Field sites.

The Moran Lake Overwintering Site boundary defined by the Xerces Society is roughly the same as the management area depicted in Figure 2, except for the inclusion of a small portion of the residential neighborhood around the lake. Monarch butterflies are present in the Moran Lake overwintering habitat from October through February in most years, and small numbers of monarchs have been observed as early as mid-August and as late as April in some years. Based on its continual occupation by monarch butterflies throughout the wintering period, the habitat at Moran Lake is classified as full-term overwintering habitat.

The current and historic estimated overwintering population numbers for the Moran Lake site were obtained through the Western Monarch Count (Xerces Society 2022). The Western Monarch Count is a citizen scientist-powered organization that is sponsored by the Xerces Society. The Western Monarch Count conducts annual population counts at overwintering sites throughout California each Thanksgiving and at the start of each new year (Xerces Society 2022). These data are used by many agencies and conservation organizations to aid in conservation efforts and estimate population trends for the western monarch butterfly.

Table 2 below provides the estimated monarch count at the Moran Lake site, along with every other overwintering site in the county, since the inception of the Western Monarch Count in 1997. Additionally, Table 2 provides the total number of overwintering monarchs in the county and California since 1997, the percentage of overwintering monarchs at the Moran Lake site each year in comparison to the total population of overwintering monarchs in the county, the percentage of overwintering monarchs at the Moran Lake site each year in comparison to the total number of overwintering monarchs in California, the yearly average of overwintering monarchs at each overwintering site, the county, and California since 1997, and the 10 year average of overwintering monarchs at each overwintering site, the county, and California (Xerces Society 2022).

These numbers help to identify regional and statewide fluctuations, to understand if fluctuations in the Moran Lake overwintering counts are consistent with the regional and state-wide changes, and to determine how the regional and statewide importance of Moran Lake as an overwintering site has changed since 1997.

Table 2 Western Monarch Count Statistics for Santa Cruz County Since 1997

Count Year	Overwintering Sites in Santa Cruz County					California Total	% in Comparison to Santa Cruz County	% in Comparison to California
	Moran Lake	Natural Bridges State Beach	Lighthouse Field	Seascape Golf Course, Aptos	Santa Cruz County Total			
1997	70,000	120,000	70,000	--	260,000	1,235,490	27%	5.7%
1998	8,000	60,000	50,000	240	119,898	564,349	7%	1.4%
1999	4,500	15,000	9,500	280	31,958	267,574	14%	1.7%
2000	4,000	20,000	35,000	1,050	62,961	390,057	6%	1.0%
2001	1,500	3,000	--	1,400	6,123	209,570	24%	0.7%
2002	1,000	6,000	3,200	4	10,234	99,353	10%	1.0%
2003	6,000	5,700	11,000	--	22,704	254,378	26%	2.4%
2004	4,500	9,600	9,600	950	25,276	205,085	18%	2.2%
2005	3,400	3,900	14,000	--	22,045	218,679	15%	1.6%
2006	6,600	7,300	10,300	2,000	28,271	221,058	23%	3.0%
2007	2,200	2,700	5,700	48	10,675	86,437	21%	2.5%
2008	4,023	3,500	2,607	1,560	12,127	131,889	33%	3.1%
2009	2,276	1,300	4,000	23	7,674	58,468	30%	3.9%
2010	3,000	2,300	4,000	1,000	10,332	143,204	29%	2.1%
2011	4,500	3,000	18,100	--	25,600	222,525	18%	2.0%
2012	2,500	500	3,200	2,500	9,316	144,812	27%	1.7%
2013	790	4,600	4,500	0	11,497	211,275	7%	0.4%
2014	4,300	3,400	7,000	--	15,981	234,731	27%	1.8%
2015	5,800	8,000	12,000	1,800	29,870	292,888	19%	2.0%
2016	4,000	3,500	12,000	1,000	28,101	298,464	14%	1.3%
2017	5,400	9,000	12,000	100	29,918	192,624	18%	2.8%
2018	1,373	1,120	1,802	--	5,043	27,721	27%	5.0%
2019	400	1,997	3,402	0	6,057	29,436	7%	1.4%
2020	50	550	50	0	711	1,899	7%	2.6%
2021	1,100	2,100	410	700	5,418	247,237	20%	0.4%
2022	5,701	7,500	3,365	500	17,861	335,479	32%	1.7%
2023	7,050	6,500	10,000	252	25,967	233,394	27%	11%
Average Count Since 1997	6,073	11,558	11,731	571	31,171	242,892	21%	2.1%
10-Year Average	2,856	3,842	5,430	733	14,525	183,324	20%	1.6%

It is important to note that the number of sites monitored fluctuates any given year. Over the past 7 years, more than 200 sites were monitored, whereas in years prior less than 200 sites were monitored.

4.2 Monarch Activity History

The 2010 MBHMP provides a summary of historical patterns of monarchs at Moran Lake. See Figure 5 for a map of roost areas and windbreak areas, and that was adapted and updated from the 2010 MBHMP. Names of roost areas and windbreak areas used throughout this document are shown on this map. The text below was taken from the 2010 MBHMP:

“Monarch butterflies are present in the Moran Lake wintering habitat from October through February in most years, and small numbers have been observed as early as mid-August and as late as April in some years. Based on its continual occupation by monarch butterflies throughout the wintering period, the habitat at Moran Lake is classified as a full-term overwintering habitat.

In the past (1980s), monarchs typically began to congregate along the northwestern shore of Moran Lake during early October, and formed clusters in the North and South Lakeside roost areas. As the population increased during October, clusters also formed in the North and South Creekside roost areas and the lakeside butterflies gradually shifted north into the more sheltered Creekside roost areas (Figure 5). Then around mid-November the population shifted its clusters into the Primary Roosting area where they remained until warming temperatures initiated the spring migration sometime in February.

The North Lakeside roost area usually supported clusters of roosting monarchs throughout the month of October, whereas the South Lakeside roost area typically supported clusters only intermittently during the fall. Thus the North Lakeside roost area historically functioned as an autumnal roost area and the South Lakeside roost area functioned as refuge/bivouac habitat. Tree and limb loss in these habitats has since reduced wind protection and eliminated many of the lower roost limbs that once supported clusters. Currently both roost areas function as refuge/bivouac habitats.

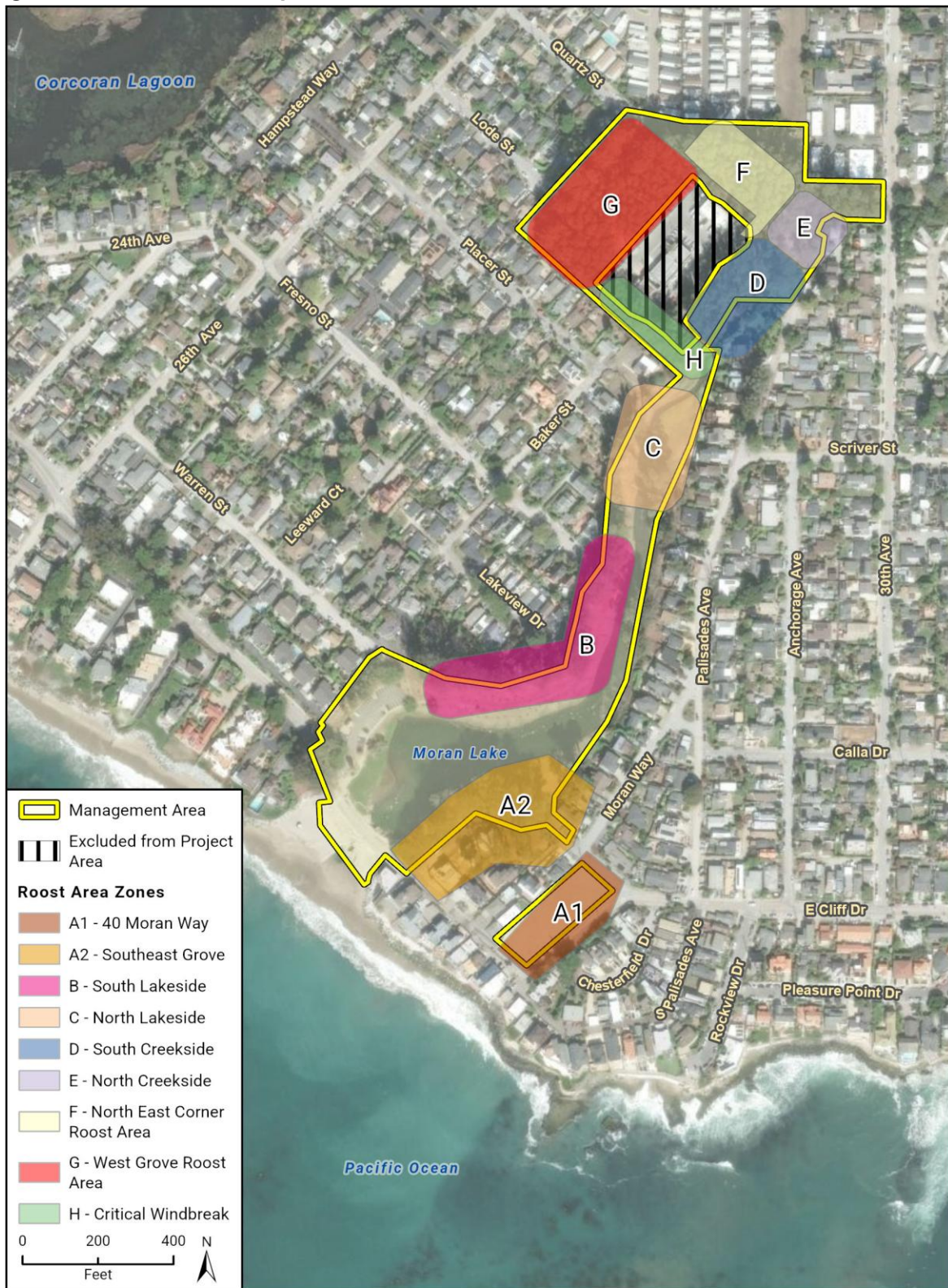
Tree and limb losses in the North Creekside roost area have degraded this habitat over the past ten years resulting in less frequent occupation of the North Creekside roost area and a gradual shift of occupation to the South Creekside roost area. In March/April of 1999, residents on the property adjacent to the South Creekside roost area removed all the eucalyptus trees on their property along the east side of the creek and in that process eliminated all of the eastern windbreak/shade trees that sheltered the South Creekside roost area. During the winter preceding the tree removal (1998-99) the entire wintering population at Moran Lake (approximately 18,000 monarchs) occupied the South Creekside roost area from early October through most of November. During the winter of 1999-2000, no clusters were observed in the South Creekside roost area. Both North and South Creekside roost areas now function only intermittently as refuge/bivouac habitat.

The Primary Roosting area, despite several significant tree removal events, has consistently supported mid-winter monarch populations for at least the past twenty years. With the loss of suitable autumnal habitat in the Lakeside and Creekside roost areas, the Primary Roosting area has now begun to function additionally as autumnal roost habitat. The Primary Roosting area is the only consistently occupied roost area remaining in the Moran Lake monarch wintering habitat.

The grove of eucalyptus at the southeastern end of Moran Lake—the Southeastern Grove, which includes the Moran Way Windrow—in addition to providing critical wind protection for

the lake area, functions intermittently as refuge/bivouac habitat and occasionally supports small clusters during periods when monarchs are migrating and winds are relatively calm.”

Figure 5 Monarch Butterfly Roost and Windbreak Areas



4.3 Roosting and Basking Sites

The entire management area and adjacent sensitive habitat provide the overwintering habitat for the monarch butterflies, which has been broken into distinct roost and windbreak areas for ease of discussion (Figure 5). The southeast eucalyptus grove provides a wind protected zone close to the coast which may help draw migrating monarchs to the area. The areas around the southeastern grove function intermittently as refuge/bivouac habitat and occasionally support small clusters during periods when monarchs are migrating and when winds are relatively calm (J. Dayton, personal communication, December 2023). The eucalyptus trees and structures on either side of the lake provide windbreak to the site. The eucalyptus trees provide upper canopy windbreak, and the higher topography along the southeastern side of the lake provides low and mid-level wind break. Figure 6 shows an overview of the core zone/roosting sites.

North of Moran Lake, the main eucalyptus grove surrounds the Santa Cruz Sanitation District's D.A. Porath Facility and comprises the primary roosting areas. Within the main grove, there are three distinct roost areas where the monarchs cluster and overwinter during the coldest and most inclement weather of the year and are shown in Figure 6: the creek side roost area (CSRA), the northeast corner roost area (NECRA), and the west groove roost area (WGRA) (J. Dayton, personal communication, December 2024). CSRA serves as an autumnal roost area, and NECRA and WGRA serve as the two winter roost areas, where the most protection is provided. Each roost area includes both trees that support clusters and that are typically located in the interior of the groves with the most wind protection, and trees that support basking aggregations and that are typically located on the edges of the grove where more sunlight is available. Monarchs bask in the sun to get warm and to reach the temperature at which they are able to fly. The basking areas are located toward the inner edge of the roost area adjacent to the Sanitation District facility, where more sunlight is available. (Note that basking aggregations may become clusters during appropriate weather conditions.) The interior roost (cluster) trees at NECRA and WGRA are not necessarily both used each year; typically, interior clusters form only in one of the two areas each year (J. Dayton, personal communication, December 2023). For example, the interior roost trees at the WGRA were not used in the 2021–22 wintering period, whereas the WGRA basking aggregation trees were used, even though most of the population remained clustered at NECRA, mostly above the road, but also including some clusters in the interior area (J. Dayton, personal communication, December 2023).

Figure 6 Moran Lake Monarch Butterfly Roosting Site/Core Zone

West Grove Roost Area North East Corner Roost Area Creekside Roost Area

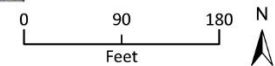
Basking Aggregation
Areas

Deep Shade
Roost Areas

Fall Nectar
Resources



Source: John Dayton, 12/2023.



4.4 Current Habitat Condition

An ideal overwintering site should have trees in good condition that are evenly spaced out and have healthy foliage and good vigor. An ideal overwintering site will also have saplings in the understory to replace trees as they die and a continuous, well-stratified canopy at the outer edges to offer wind protection. However, the canopy will not be so dense to prevent the entry of the necessary amount of direct and dappled insulating light. Insolation is primarily a factor on the southerly exposures.

Tree health was assessed and reported in the 2022 Arborist Report. This plan addresses the trees, habitat, management area, and the grove as a whole. When discussing the condition of the habitat, individual tree health is always considered, but equally and possibly more important is the management of the trees collectively. The creek's wet soils, ponds and puddles provide the water for the monarchs to drink. The late fall and winter blooming eucalyptus tree flowers provide critical nectar for the monarchs to consume while they overwinter.

In 2024, Weiss (2022) provided a habitat assessment using hemispherical photography, LiDAR, and wind measurements to understand canopy structure and resultant microclimates within the grove. Key conclusions regarding canopy structure and monarch use from that study include:

The primary cluster zone within the grove north of the sanitation yard (North East Corner Roost Zone in Figure 5) has good insolation exposure through the south edge facing the open yard but also has good wind shelter from the trees across the yard along Placer Street.

The main vulnerability of the primary cluster zone is wind exposure from the "Boneyard" to the north. The open trail/road into the grove from this edge allows northerly winds to penetrate into the cluster zone. When strong northerly winds occur, monarchs tend to leave this zone and move to Creekside. The assessment recommended planting a row of cypress in the Boneyard to block this gap into the primary cluster zone.

At Creekside, there is high morning insolation exposure, but also high wind exposure to the east and southeast. Monarchs will cluster in this zone early in the season before storms occur, and during calm sunny periods, but will move to the primary cluster zone when winds become too strong.

In 2025, an additional study (Weiss and Matley 2025) was conducted to answer specific questions about the effects of grove modifications on wind exposure within the primary cluster zone. This study used LiDAR and wind modeling with Eddy 3D to simulate wind patterns within the complex grove. Several scenarios regarding tree height reductions and tree removals were explored. Estimating the height of the Placer Street trees necessary for maintaining wind shelter from southwest winds at the primary cluster zone was a major goal. But other tree removal and height reduction scenarios were also explored.

Selected results of the 2025 wind study are interspersed in this document at the appropriate spots. (especially Critical Windbreak along Placer Street – Area H below).

Both full reports are attached as Appendix D.

4.4.1 Roosting and Basking Habitat (Sanitation District and County-Owned Land)

The north, northeastern, and northwestern portion of the main eucalyptus grove on Sanitation Facility property that is home to the Northeast Corner Roost Area (NECRA), the Creekside Roost Area (CSRA), and the West Grove Roost Area (WGRA) is well-established with spaced-out trees that are generally in good health. Young saplings are distributed naturally throughout. Blue gums to the south and western sides of the grove are generally in fair health. The nature of blue gums includes shedding bark and branch and limb loss, and it is not unusual for the species to be rated with fair to poor health.

One area near the southern corner of the Sanitation Facility immediately south of the small pump station in the Critical Windbreak Area H is missing a tree canopy wind break. This gap in canopy creates the opportunity for wind and cold temperatures to blow into the roosting and basking areas and should be filled. Additionally, there are gaps in the Critical Windbreak Area H along Placer Street that should be planted with replacement trees. The narrowness of this area presents a particular challenge because there is limited space to plant windbreak trees.

Grove specific measurements, including, but not limited to, an assessment of wind measurements, light exposure, and canopy height and structure derived from hemispherical photographs and LiDAR are provided in Appendix A. These measurements represent why the main cluster site is suitable for overwintering monarchs.

Currently, the Creekside Roost Area (CSRA) is one of the areas most in need of repair and to enhance with mitigation planting. Recent tree failures and removals have exposed this area to disturbance by east-southeast winds and excessive sun exposure. Approximately 1,000 monarchs roosted in this area during much of November 2021 (J. Dayton, Personal Communication, December 2023).

4.4.2 North and South Lakeside Habitat (County-Owned Land)

As mentioned, the eucalyptus trees, hillside, vegetation, and structures along the southeastern and eastern side of the lake provide an important wind break to the management area, as do the trees, vegetation and structures on the western side of the lake.

Eucalyptus trees have died or have been removed in the past in the North and South Lakeside areas, without replacement, which has led to reduced wind protection and stands that are comprised of mostly mature trees with minimal mid-level wind protection and high canopies that are exposed to windthrow. Eucalyptus along the North and South Lakeside areas have experienced die back likely related to ponded water and saturated soils in low areas along the trail and at the base of the trees. This area is in need of drainage improvements and replacement plantings to enhance the windbreak and ensure long-term survival of the trees.

A portion of the North Lakeside habitat on the east side of the creek, where eucalyptus trees are absent, is comprised of a low-lying riparian meadow where a bed of grasses and other herbaceous species are present and offers the potential for nectar planting.

4.4.3 Southeast Grove and 40 Moran Way Habitat (County- and Privately Owned Land)

The Southeast Grove is located on the southeast side of the County-owned Moran Lake property, and on private parcels along Moran Way and the recently built Ryan’s Way. As development of the private property in this area has progressed over the years, this area has lost many of its trees. The remaining portion of the grove still functions in providing wind protection—though substantially diminished—for the surrounding habitat. However, it only very rarely provides wind protected roost habitat for Fall migrants; it is currently too open to wind and sun to support roosting monarchs in the Fall (J. Dayton, Personal Communication, December 2023).

More recently, during development of this HMP update, the February 2024 high-wind event resulted in the failure of 20 eucalyptus trees on the 40 Moran Way parcel, which further degraded the ability of this area to function as a windbreak. This widespread failure of trees on the 40 Moran Way parcel left the remaining trees more exposed to winds and therefore more vulnerable to windthrow. In response, the County’s ISA-certified consulting arborist recommended that the remaining eucalyptus trees on the parcel be removed to reduce the risk of additional failures. The County’s consulting arborist and monarch butterfly specialist determined that the 40 Moran Way property no longer functioned as a viable windbreak and approved the removals. The trees were removed in Summer of 2025. The property was re-graded in Fall 2025 to improve drainage in preparation for future re-planting of the parcel with native trees and shrubs. Planting is currently scheduled for Fall 2026.

4.5 Nectar Sources

Monarchs are less likely to use nectar plants in deep shade, so the forest understory near the main clustering sites are poor places for nectar plants. The most important nectar plants are those that bloom in the fall (October through November), because they help retain monarchs at the site, which in turn attracts more butterflies that are passing by.

The main sources of nectar plants for monarchs at Moran Lake are the blue gum eucalyptus flowers. Nectar for early to mid-fall is from introduced plants. The most common introduced nectar plants on-site, along with their bloom periods, are listed in order of abundance in Table 3 below. English ivy (*Hedera helix*) and Cape ivy (*Delairea odorata*) are found growing throughout the understory of the eucalyptus groves, and some have climbed up the trunks of trees where they function as important nectar sources for the monarchs. Ivy on the ground has limited utility as a monarch nectar source due to heavy shade. Ice plant (*Carpobrotus edulis*) and pride-of-Madeira (*Echium candicans*) are found growing adjacent to the parking lot and the Park’s hiking trail.

Bermuda sorrel is present on the site, but is rarely used by monarchs when other, preferable nectar sources are present. Wild radish and jointed charlock are present near the Moran Lake Park parking area—and are often used as nectar sources by monarchs at other sites—but are too far from the roost areas for practical use at Moran Lake (J. Dayton, personal communication, December 2023).

Table 3 Fall and Winter Monarch Nectar Plants in the Management Area

Species	Bloom Period
Blue gum eucalyptus (<i>Eucalyptus globulus</i>)	December through March
English ivy (<i>Hedera helix</i>)	October through November

Cape ivy (<i>Delairea odorata</i>)	Variable bloom period depends on sun/shade availability, usually December-January
Ice plant (<i>Carpobrotus edulis</i>)	Typically October-March
Pride-of-Madeira (<i>Echium candicans</i>)	Late February-March

The existing Cape ivy, English ivy, ice plant, and pride-of-Madeira within the management area provide an important and abundant supply of nectar for fall returning and overwintering monarchs, which is currently not supplied in the management area, or its vicinity, by native plants (See Table 3). Due to its importance as a nectar supply, Ivy requires careful management, rather than wholesale removal. Both species of Ivy only bloom when they receive sufficient sun exposure. English Ivy only blooms when it has climbed up a structure (tree).

4.6 Hazardous Trees

The eucalyptus trees provide the overwintering habitat, but all trees have risk or liability. An ISA certified arborist with the ISA's Tree Risk Assessment Qualification assessed the trees in the management area for risk in 2022, using the diagnostic techniques developed by ISA. A tree risk assessment is conducted to identify and manage the risk of trees for safety. The results of the assessment are included in the Arborist Report. Risks are evaluated based on a number of elements, including structural deficiencies and visible presence of disease or rot, etc. The locations of all potentially hazardous trees, as well as specific notes regarding each potentially hazardous tree and their removal or hazard pruning recommendation as of 2022, are provided in the appendix of the Existing Conditions Report which is Appendix A of this Habitat Management Plan.

County Parks' consulting arborist has been implementing routine risk assessments of all trees on County Parks and Sanitation District property since Fall 2025 to comply with recommendations of this Plan. The Tree Risk Assessment from January 2026 supersedes the 2022 Risk Assessment, and is included in Appendix H. The document includes identification of potential risk categories, identifies specific trees of concern, and provides recommendations to mitigate risks.

4.7 Fire Risk Assessment

Managing the habitat and fire risk should be done in coordination with the fire department and the monarch butterfly specialist or entomologist. Research conducted in California show that species that produce oily resins, such as blue gum, are far more ignitable than those that do not. On a scale of 1 to 10 for ignition potential, with 1 representing species most easy to ignite and 10 most difficult, blue gum scored 1 to 2 (very high ignition potential). For comparison, oak/bay woodland received a score of 6 to 8, redwood 8, scrub vegetation 4 to 8, and annual grassland vegetation 1 to 3 (LSA Associates 2009).

Ladder fuels are one of the most important considerations for the spread of fire. The monarch habitat contains very little ladder fuel, and the understory is generally sparse and contains poison oak, Cape ivy, and English ivy, when present. These are evergreen species and are generally nonflammable. Due to the lack of ladder fuels within the management area (as a result of ongoing site management by the Sanitation District), the urban/developed surroundings, and the persistent summer coastal fog, the risk of a severe crown fire spreading into or originating within the site is relatively low.

4.8 Monarch Predators

While the monarch's distinctive colors are known to display to others that they are distasteful and toxic, predators affect monarchs as eggs, caterpillars, and adults. Predators include ants, spiders, and wasps, as well as birds and rats. Predators at the Moran Lake site are not well documented or understood. However, it is likely that they are present and impact the overwintering adult population to some degree. When winds blow the monarchs onto the ground, overnight or during cool temperatures, their bodies are not warm enough to fly and predation increases. Understory brush and vegetation located beneath aggregation and transitory sites can be instrumental in limiting predation by catching the monarchs prior to landing on the ground and providing structure for them to climb off the ground.

5 Management Plan Actions

The management actions recommended here focus on the preservation of the overwintering habitat, trees, and features that create them. The continued recommendations are to maintain the grove's spatial configuration and size and preserve and/or enhance windbreak trees, appropriate nectar and water sources and understory vegetation within the management area. A general recommended timeline to implement each action is provided in the tables at the end of each section. In the tables, Year 1 means the action is recommended for action now; Ongoing means now and each year after unless otherwise stated in the section, and As-Needed means that actions will be taken if identified as necessary by County staff or consultants following the guidelines established in this plan.

5.1 Monarch Surveys

Assessing overwintering monarchs' use of the management area will be crucial to assessing the effectiveness of this site management plan and to adapting habitat restoration and enhancement techniques. Volunteers and biologists monitor the overwintering clusters at Moran Lake, as well as other local overwintering sites and collect important data as part of the Xerces Western Monarch Thanksgiving Count and New Year's Count.

Additional monitoring (ideally twice monthly from October through March) for a minimum of 1 year after major management actions would provide the information needed to track how monarchs respond to changes in grove conditions. Recording monarch clusters' size and location over the course of the overwintering season will help refine the current understanding of monarchs' use of the site and can directly inform management actions in future years.

An approach for conducting surveys is to train and use the County's maintenance staff, who are on-site regularly, to conduct the twice-monthly surveys. Staff would need to be trained to:

- Know where historic roosting and basking sites are located
- Know how to conduct counts by attending the virtual trainings for the Western Monarch Count at the Xerces' Help Count Monarchs website
- Coordinate with the Xerces Regional Coordinator once annually, in the early part of the overwintering season, to calibrate counting with Xerces
- Record information for each count in a consistent way and post the results so that the public can access the information

Action	Year 1	Ongoing	As-Needed
Monarch Surveys and Monitoring		X	

5.2 Monarch Habitat Monitoring

Annual monitoring of the grove's suitability for monarchs will be conducted to identify potential grove issues as soon as possible. Any additional threats or conservation issues (e.g., new tree fall, pest infestations) will be added to the management records and incorporated into the management

plan. This will help managers plan future management actions (at both short-and long-term time scales) and obtain funding as needed.

County Parks' monarch specialists and ISA-certified arborists will continue to assess the management area at least once a year to identify any potential issues and develop strategies for planting or replanting of trees that comprise the habitat.

The management area will be monitored for a change in predators, such as increased rat dens and observations of Steller's jays. If predators increase the County will consult with the monarch specialist regarding changes that can be made. The management area will continue to be kept clear of trash and food.

Tools that can be used as the standard protocols and data sheets for assessing grove health (Habitat Assessments) are available at www.westernmonarchcount.org and are included in Appendix D.

Action	Year 1	Ongoing	As-Needed
Monarch Habitat Monitoring		X	

5.3 Habitat/Forest Management

Habitat and Forest Management will be planned and implemented to achieve the following goals:

- Prioritization of public safety
- Protection and improvement of monarch habitat
- Restoration of native species and habitat for biodiversity

The most important forest management action is to regularly assess trees for risk of failure and to mitigate that risk through trimming or removals. Tree failure poses a hazard to the public and to monarch habitat. Hazardous trees will be addressed as quickly as possible by trimming or removing the trees to alleviate risk to the public and the roosting and basking sites. Trimming or removal recommendations will be made by a certified arborist. Hazardous trees and proactive risk assessment are addressed in more detail in Section 5.3.2.

The monarch overwintering season at Moran Lake is loosely defined as October through March.

- No tree work will occur within the **core habitat zone** (Figure 4) between October 1 through March 31 unless a true emergency arises.
- Outside of the core habitat zone and within the **shelter habitat zone** (Figure 4), no tree work will occur between October 15 through March 15 unless a true emergency arises.

If a hazardous tree must be removed during either of these times, then a certified arborist and qualified monarch butterfly specialist will be retained by the County to monitor and provide input regarding the tree maintenance activities prior to and during the removal.

Management of the overwintering habitat will be approached as a forest versus single trees and in compliance with Section 2.1.3. above. The forest is comprised of thousands of trees; it is dynamic and changes continually due to a number of factors, including weather and storm events. As discussed in Section 4.3, the spacing and composition of the tree canopy is what creates the overwintering habitat and wind protection for the monarchs. Because of this, replacing trees that have been removed or succumb to die-off with another single tree or trees may or may not be advisable. Whether to plant replacement trees will be determined in collaboration with a certified

arborist and the County’s monarch specialist. This will be done in alignment with the three goals noted above. To protect and improve monarch habitat, tree planting is recommended in certain areas to add or replace canopy that was previously lost or is absent in the eucalyptus groves and windbreaks. See section 5.3.1 for more information on tree planting and management.

Nectaring plants will be planted to boost overwintering population numbers; see section 5.3.4 for more information on nectaring plants.

Drainage improvements were installed by County Parks staff in Fall 2024 at the northern edge of the southeastern windrow, at the 40 Moran Way parcel, and in other problematic areas around the margins of the lagoon in the North and South Lakeside areas to reduce ponding water and saturated soils at the tree bases. These areas should continue to be maintained to reduce ponding water. See section 5.3.5 for more information on drainage.

Tortoise beetles and eucalyptus long-horned beetles are two major pests that can damage or kill blue gum eucalyptus trees. While an effective control for these pests has not yet been developed, the County should proactively remove dead wood from the eucalyptus groves, since the presence of dead wood has been shown to increase infestations. The County Parks staff should be informed about how to identify these and other local pests and the damage they can cause. County Parks staff should report observations of infestations observed to their supervisor and the information should be shared with the County-approved arborist immediately.

The recommendations in subsections below for timing of implementation of management actions have been developed in collaboration with County Parks staff, the County’s ISA-certified arborists, and the County’s monarch butterfly specialists after viewing the management area conditions and dynamics as a group during development of the HMP. Figure 7 shows the general approach for planting replacement trees and nectaring plants, and locations where drainage management is needed.

A summary of all recommended habitat/forest management actions and their required protective measures are outlined in Table 6 at the end of this section. The protective measures outlined in Table 6 will be required for all management actions in order to avoid and minimize impacts to the maximum extent feasible.

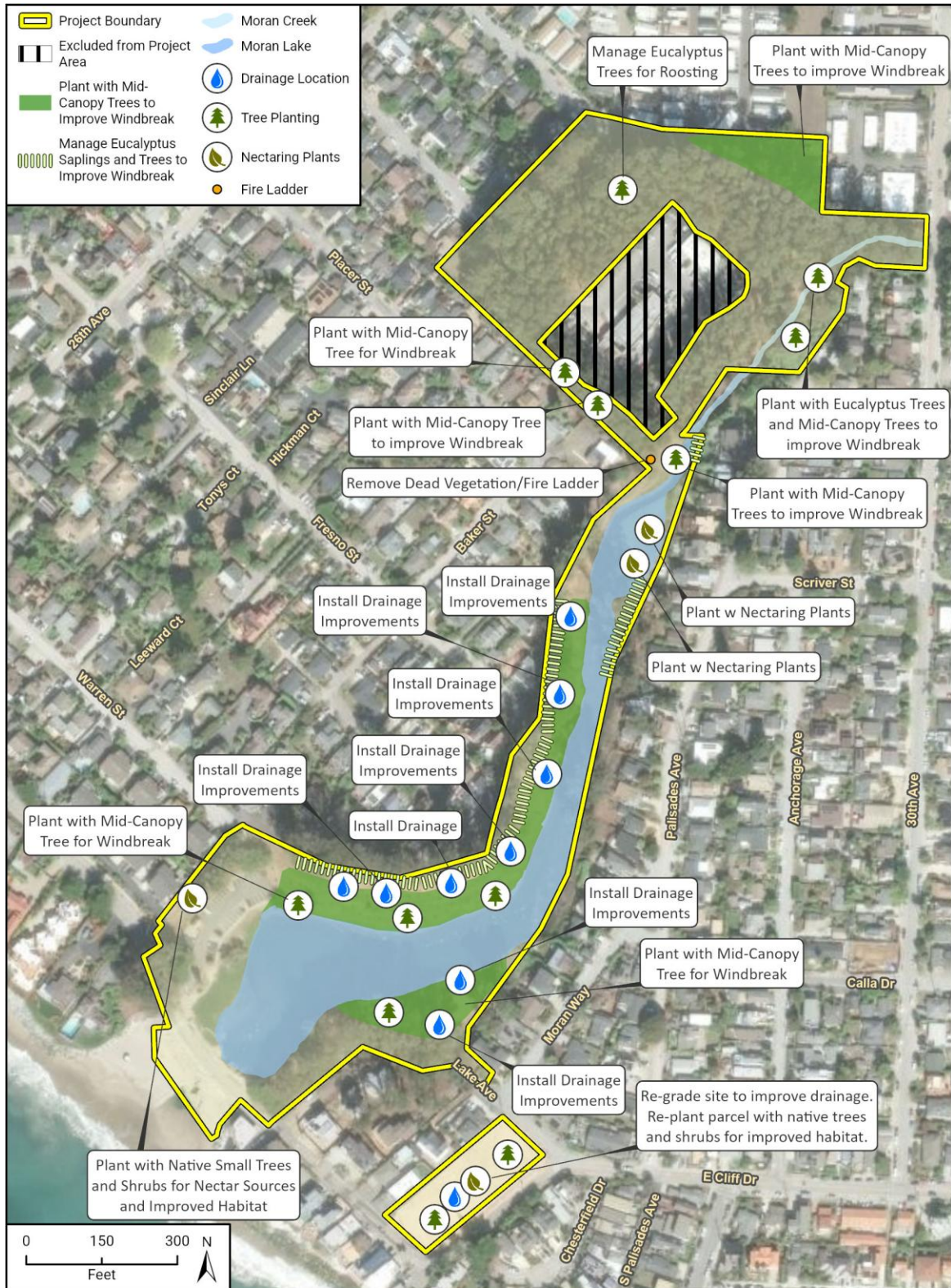
Overwintering Habitat on Private Property

Trees and vegetation on private property adjacent to the management area, shown in Figure 3, will be designated by the County as Sensitive Habitat. This will serve to clarify where Sensitive Habitat restrictions are to be applied for adjacent development. This clarification was required by the County Board of Supervisors by amendment at the 2011 adoption of the 2010 Plan.

Action	Year 1	Ongoing	As-needed
Habitat & Forest Management*		X	

*General habitat & Forest Management will be conducted every year. Refer to subsequent sections for specific actions and frequencies.

Figure 7 Recommended Overall Management Actions



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Fig 7 Recommended Overall Management Actions

5.3.1 Tree Planting and Management

Recommendations for tree planting were developed by Creekside Science’s Dr. Stu Weiss in collaboration with County staff and the County’s consulting team of certified arborists and biologists. Past reports with recommendations from the County’s arborist and monarch specialist also address issues discussed in this section and applicable recommendations from past documents are included in this section for continuity. Appendix D provides past studies and reports for the management area. Tree planting location recommendations are shown in Figure 7, and recommended tree species to be planted in each habitat area (Areas A-H, as defined in Figure 5) are shown in Table 4, and discussed in greater detail below. Some of the recommendations are based on addressing existing deficiencies and are expected to improve monarch habitat over time. Other recommendations are to address replacements for potential failures or removals that could occur in the future.

When existing trees or branches fail, or become hazardous and need to be removed, their removal can negatively impact the monarch habitat. Failures and removals will be assessed by a certified arborist and the County’s monarch specialist, and will include a recommendation for replacement, or a justification for why replacement is not recommended. The number, location, and species of the replacement tree(s) will be determined in collaboration with a certified arborist and the County’s monarch specialist. The recommendations above will be based on achieving the three overarching goals of forest/habitat management described by this Plan:

- Prioritization of public safety
- Protection and improvement of monarch habitat
- Restoration of native species and habitat for biodiversity

Determining what tree species **not** to plant is as important as outlining recommended species. Section 7 of this plan contains a table documenting the species, location, and observations for tree species which have been planted at Moran Lake and which have failed (Table 7). The County should systematically track this information so that it can be used to inform future tree planting efforts.

Table 4 Tree Species to Plant in Specific Habitat Areas on Figure 5

Zones D, E, F, & G – Main Eucalyptus Groves & Roosting and Basking Areas		
Species	Canopy Replacement	Notes
Blue gum eucalyptus (<i>Eucalyptus globulus</i>)	Upper, highest canopy in habitat area	Compatible with existing BGE in groves. Important nectar source for Monarchs. Plant w/in 50’ of roosting or basking areas and where canopy higher than 50’ is needed
Red ironbark (<i>Eucalyptus sideroxylon</i>)	Mid to upper canopy, typically not as high as blue gum	Use to replace BGE where canopy up to 50’ is needed. Plant away from public paths and structures.
Monterey Cypress (<i>Hesperocyparis macrocarpa</i>)	Mid-canopy, varies based on age and location	Plant along north and east edges of main grove as windbreak. Regional native. Good salinity, coastal, and wind tolerance.
Coast Redwood (<i>Sequoia sempervirens</i>)	Upper, highest canopy in habitat area	Plant only along east side of Creek. Regional native. Riparian adapted.
Zone H – Critical Windbreak (along Placer Way)		
Species	Canopy Replacement	Notes

Monterey Pine (<i>Pinus radiata</i>)	Mid to upper canopy	Plant to fill in mid to upper canopy gaps in the critical windbreak. California and regional native.
Canary Island Pine (<i>Pinus canariensis</i>)	Mid to upper canopy	Plant to fill in mid to upper canopy gaps in the critical windbreak
Blue gum eucalyptus (<i>Eucalyptus globulus</i>)	Upper, highest canopy in habitat area	Plant where highest canopy replacement is needed in the critical windbreak.

Zones A2, B & C – Southeast Grove and South and North Lakeside

Species	Canopy Replacement	Notes
Red Alder (<i>Alnus rubra</i>)	Mid to upper canopy	Regional native. Good salinity tolerance, coastal and riparian adapted.
Monterey Cypress (<i>Hesperocyparis macrocarpa</i>)	Mid-canopy, varies based on age and location	Regional native. Good salinity, coastal, and wind tolerance.
Monterey Pine (<i>Pinus radiata</i>)	Mid to upper canopy	Plant to fill in mid to upper canopy gaps in the critical windbreak. California and regional native.
Torrey Pine (<i>Pinus torreyana</i>)	Lower to mid-canopy	California native. Good salinity and coastal tolerance, wind resistance.
Island Oak (<i>Quercus tomentella</i>)	Lower to mid-canopy	California native. Good salinity and coastal tolerance, wind resistance.
Coast Live Oak (<i>Quercus agrifolia</i>)	Lower to mid-canopy	Regional native. Good salinity and coastal tolerance, wind resistance.
Arroyo Willow (<i>Salix lasiolepis</i>)	Low canopy	Regional native. Good salinity and flooding tolerance. Riparian adapted. Winter nectar source.

Zone A1 - 40 Moran Way

Species	Canopy Replacement	Notes
Monterey Cypress (<i>Hesperocyparis macrocarpa</i>)	Mid-canopy, varies based on age and location	Regional native. Good salinity, coastal, and wind tolerance.
Toyon (<i>Heteromeles arbutifolia</i>)	Lower canopy	Regional native. Good salinity, coastal, and wind tolerance. Good general habitat tree.
California buckeye (<i>Aesculus californica</i>)	Lower to mid-canopy	Regional native. Good salinity, coastal, and wind tolerance. Good general habitat tree.
Coast Live Oak (<i>Quercus agrifolia</i>)	Lower to mid-canopy	Regional native. Good salinity and coastal tolerance, wind resistance. Good habitat tree.
Arroyo Willow (<i>Salix lasiolepis</i>)	Low canopy	Regional native. Good salinity and flooding tolerance. Riparian adapted. Winter nectar source.
Blue Elderberry (<i>Sambucus mexicana</i>)	Low canopy	Regional native. Coastal tolerance. Good general habitat tree.

The following recommendations update the guidelines in the 2010 Plan on page 20 under New Tree Planting and Monitoring Guidelines.

Tree removals must be considered with the input of a certified arborist and the County's monarch specialist and if a replacement tree is recommended, it must be replaced by the next rainy season with a tree that will fulfill the functional needs of the overwintering habitat and the forest. The previous recommendation to replace every removed tree with a minimum of two trees is not viable

within the management area. The limiting factor is space; there is not enough space to double the number of trees on-site and maintain a healthy forest and functional overwintering habitat.

The **core habitat zone** (Figure 4) is where monarchs roost and bask during the overwintering season. This is the most sensitive part of the monarch habitat. The core habitat zone is expected to remain a mostly eucalyptus grove for the foreseeable future. Failures and removals of eucalyptus trees in the core habitat zone will be assessed by a certified arborist and the County's monarch specialist for replacement. If recommended, they will be replaced with Blue gum eucalyptus (*Eucalyptus globulus*) or Red ironbark eucalyptus (*Eucalyptus sideroxylon*) trees, or in limited cases, Monterey Cypress (*Hesperocyparis macrocarpa*) trees. The species selection will depend upon the canopy need. Blue gums will be used when the replacements are made in or within 50 feet of the roosting and basking areas and when canopy roughly 50-feet high or more is needed. Red ironbark will be used to replace blue gums when canopy roughly 25- to 50-feet high is needed. Blue gums provide consistency in canopy structure and red ironbark trees have been observed to be more drought resistant in the region. Planting red ironbark also serves to diversify the species of the grove. Red ironbark will be located away from public paths and structures due to their potential for limb failure. Monterey Cypress provides lower-level canopy and roosting locations within the larger eucalyptus grove. If, at some time in the future the trees become overcrowded, forest thinning may be considered to promote an increase in the health condition and vigor in the grove. Thinning will only be done with the input of the certified arborist and monarch butterfly specialist.

The **shelter habitat zone** surrounds the core habitat zone and serves to buffer the core habitat zone from adverse weather conditions. Failures and removals within the shelter habitat zone will be assessed by a certified arborist and the County's monarch specialist for replacement. If replacement(s) are recommended, potential species that will be considered for planting include Monterey Cypress (*Hesperocyparis macrocarpa*), Coast Live Oak (*Quercus agrifolia*), Island Oak (*Quercus tomentella*), Monterey Pine (*Pinus radiata*), Torrey Pine (*Pinus torreyana*), Canary Island Pine (*Pinus canariensis*), Toyon (*Heteromeles arbutifolia*), Red Alder (*Alnus rubra*), and Red Ironback (*Eucalyptus sideroxylon*). Blue Gum Eucalyptus (*Eucalyptus globulus*) will only be planted in specific situations where high canopy is required and other replacement species have failed. Native trees are preferred and will be planted where feasible. Shorter stature trees and trees that can withstand wind and coastal pressure, will be planted along the southwestern boundary of the management area nearest the coast. Additional native and eucalyptus tree species are being considered and these recommendations may need to be modified over time. Replacing and maintaining the tree wind shelter around the core habitat zone is essential to the site's longevity. In areas where blue gums have experienced consistent failures, the County will explore planting different species and/or a more diverse palette of tree species that are less prone to failure, thereby reducing the risk of negative impacts to the habitat and public safety. As noted above, native tree species are preferred. The County's long-term goal outside of the core habitat zone is to plant enough native trees to eventually replace the blue gum eucalyptus with trees that are better suited to the site conditions, do not grow as tall, and that support native biodiversity.

Eucalyptus trees are generally not available for purchase in the nursery trade; therefore, the County will make arrangements as needed to grow the trees with an entity such as Cal Poly or UC Santa Cruz, which have the expertise and ability to grow them on a regular basis.

Planted trees will generally be in either a 5-gallon or 15-gallon (or a comparable container size used for native plants), largely due to the expense and difficulty of planting a larger tree in the forest, and the fact that native trees perform better when planted at a smaller size. The trees will be inspected

by a certified arborist to ensure they are in good health. The contract with the tree grower will specify that root bound trees will not be accepted.

The exact location, species, and number of replacement trees to be planted will be determined in collaboration with County staff, a certified arborist, and a monarch specialist prior to or immediately following (within 15 working days) of a tree removal. Replacement tree plantings will be:

- Staked with two lodge pole stakes per tree and secured with flexible ties
- Mulched with a 3-inch-deep layer of wood chips at a minimum radius of 3 feet from the trunk, contingent on their locations and surrounding growing conditions. Mulch material must also be set back at least 4 inches from the trunk.
- Irrigated or hand watered as-needed in order to grow at optimal rates, with either a ring of Netafim Irrigation Tubing placed over the root ball or with two emitters per tree for irrigation, or the use of tree watering bags or donuts to facilitate efficient hand watering.

Maintenance of the replacement trees is also critical to ensure tree survival and to optimize tree growth. Either the County Parks staff or a landscape contractor will:

- Conduct twice-monthly inspections to ensure that the irrigation system is functioning and that weed competition is eradicated around the new trees
- Replenish the wood chip mulch around the trees periodically
- Remove the tree support stakes 3 years after installation and ties must be adjusted annually as not to girdle the tree where it's tied to the stakes
- The irrigation system will be adjusted over time to correctly be placed over tree root zones and to adjust the volume of water required to ensure optimal tree growth.

If tree replacement plantings fail (die), they must be replaced with a tree that fulfills the need of the overwintering habitat. Tree failures should be investigated to determine cause of death and records kept of successful and unsuccessful trees species to improve long-term management of the habitat.

Replacing and maintaining the trees that create the wind shelter around the perimeter of the management area is also essential to the site's longevity.

Specific Area Recommendations for Management Areas (Refer to Figure 5 for location of Management areas)

Northeast Corner Roost Area – Area F

- Plant Monterey cypress to fill the gaps between eucalyptus rows at the outer northeast and northwest edges of the area, north of the Sanitation Facility. There is some concern about maintaining sightlines into the grove to detect occupancy by unauthorized occupants so close coordination with public safety agencies is important.
- Plant Monterey cypress in the Sanitation District's 'Boneyard' area (northeast of the main eucalyptus grove) to block low and mid-level wind. Center the planting on the existing gap in the tree canopy created by the maintenance access road.
- Encourage blue gum saplings to grow and do not remove them within the roosting sites when they serve to provide canopies in the open row spaces.
- Maintain a partially open canopy along the boundary of the yard so that direct sunlight can penetrate from the yard edge for basking. This is one of the most important habitat

improvements and will allow the butterflies to remain in the interior when strong northerly winds occur.

- Keeping the future option of selective precise thinning of specific parts of the grove is important. Maintaining individual tree health in the face of aridification may require reduction of basal area. The remaining trees will fill in the canopy, as water and light availability allow. Pruning, if it occurs, will be directed by a certified arborist and the County's monarch specialist.

Critical Windbreak along Placer Street – Area H

- Maintaining wind shelter along the southwest boundary of the entire grove in the District's land is crucial for the monarchs clustering on the opposite side of the Sanitation Facility, particularly along Placer Street where the windbreak is narrow and there is limited space to plant trees. The eucalyptus in this area also abut residential properties along Placer Street, complicating management of the trees.
- Tree risks will be considered routinely and if trimming trees and removing hazard branches in this area is necessary, it will be done in collaboration with the County's monarch butterfly specialist and certified arborist to minimize impacts to the windbreak. Trees that have posed risks to the neighbors were topped in the past to reduce the risk while still maintaining the trees' ability to function as a windbreak. These topped trees will require more frequent maintenance and assessment by an arborist to remove weakly attached branches. Management of this windbreak should focus on preserving and enhancing a semi-permeable barrier of vegetation to allow for moderation of wind.
- The windbreak along Placer was one of the focus areas of the wind study conducted by Dr. Stu Weiss and Althouse & Meade that was completed in June 2025. The wind study simulated canopy height reductions along the Placer Street windbreak. The wind study model showed minimal changes in wind speed in the monarch habitat for canopy heights down to 80 feet. Canopy heights between 80 feet and 60 feet demonstrated slight increases in wind speed in the monarch habitat. Canopy heights below 60 feet resulted in rapid increases in wind speed throughout the monarch habitat. Therefore, the wind study analysis suggested that the critical height of tree canopy along Placer Street is approximately 80 feet. This height provides sufficient wind protection for the monarch habitat and provides a buffer of 10-20 feet of canopy height before monarch habitat is negatively impacted.
- Trees planted along the Placer Street windbreak must therefore have a mature height of roughly 80 feet in order to align with the results of the wind study and to provide sufficient long-term wind protection for monarch habitat.
- There are existing gaps in the Placer Street windbreak. Plant these gaps with the following tree species, with species selection to be based on specific canopy needs:
 - Canary Island Pine (*Pinus canariensis*)
 - Monterey Pine (*Pinus radiata*)
 - Other species if specifically recommended by a certified arborist and the County's monarch specialist
- Blue gum eucalyptus (*Eucalyptus globulus*) will be planted if the other species above do not demonstrate good health and the potential to create a sufficient windbreak after a period of 5 years from planting, as determined by an arborist and monarch butterfly specialist. Factors that the arborist and monarch butterfly specialist may use to determine if the trees demonstrate potential to create a sufficient windbreak include: tolerance of soil, moisture,

and light conditions at the planting site, successful establishment adjacent to mature blue gum eucalyptus trees, demonstration of active growth, and the tree reaching an appropriate size for its age.

- Redwood trees were planted at this location in the past but did not successfully establish in part due to a lack of irrigation, and the fact that this location is ill-suited for Redwood's higher water needs.
- The wind study also analyzed the effects of partial removal of the existing blue gum eucalyptus trees. This was done to simulate the long-term plan to selectively remove some of the existing blue gum eucalyptus and replace them with a lower-growing tree species that still reaches roughly 80' to provide sufficient windbreak for the monarch habitat. The study showed that existing trees could be selectively removed from the Placer Street windbreak without negatively impacting the monarch habitat.
- Once existing gaps in the windbreak are planted, and the newly planted trees are in good health and demonstrate good structure after a period of at least 3 years, consider selectively removing 1-3 existing blue gum eucalyptus trees that were previously topped in consultation with a certified arborist and the County's monarch specialist as part of a pilot program to eventually replace the mature blue gum eucalyptus with lower-growing trees that still reach the 80' critical height. After removal, plant a replacement tree from the list above for each removed tree no later than the next rainy season. Evaluate the success of the pilot replacement program every 3 years by monitoring growth of the replacement tree and monitoring monarch behavior in the overwintering habitat. If the pilot replacements are successful, work with a certified arborist and the County's monarch specialist to continue selective replacement without negatively impacting monarch habitat.
- Plant a small stand of Monterey cypress at the southern corner of the Sanitation Facility, just south of the small, separate pump station, opposite the trail opening, to close the canopy gap and prevent southerly winds that penetrate into the grove along the trail and drive the monarchs away from the interior cluster site.

North and South Creekside Roost Area – Areas D and E

- In the Creekside Area, maintain and fill-in the row of trees southeast of the creek on the County-owned parcel that is east of the Creek and north of the Humphrey's parcel (APN 028-291-57). The public property is dominated by shrubs, including blackberries and other shrubs. Interplanting trees, such as Coast Redwood (*Sequoia sempervirens*) and Monterey Cypress (*Hesperocyparis macrocarpa*), will reinforce existing wind shelter. However, care must be taken over the long run to not deeply shade the cluster sites along the creek.
- There are several eucalyptus trees that have previously been topped in the area west of the Humphrey's parcel. These trees should be monitored by an arborist for future management needs.
- There are several redwoods on the Sanitation Facility side of the drainage ditch at the southeast corner of the yard, that appear to be in poor to fair health. Monitor their progress, and if they do not maintain a healthy canopy or if they fail, replace them with blue gum or red iron bark eucalyptus for high-canopy wind shelter and Monterey cypress for mid-canopy wind shelter.

North and South Lakeside Roost Areas – Areas B and C

- Poor drainage along the margins of the lagoon contributed to past failures of blue gums between the trail and adjacent private properties in the North and South Lakeside areas. To

mitigate this, and to ensure the viability of the remaining trees, drainage features will be created and maintained so that standing water does not occur along the trail and at the base of the trees. Drainage improvements were installed in winter 2024/2025 and were recently improved in fall 2025. The drainage improvements will be routinely assessed and maintained. See section 5.3.5 below for more information regarding drainage.

- Approximately 47 Monterey cypress (*Hesperocyparis macrocarpa*) were planted between the lagoon and the trail in Area B in December 2024. Once mature, the trees will provide additional mid-level wind protection. This species has proven to do well in the immediate area. The recently planted trees will be maintained and additional trees will be planted in future years to enhance the windbreak, improve native habitat and biodiversity, and contribute to a long-term goal of eventually replacing the blue gum eucalyptus species in this part of the habitat with appropriate native species.
- Additional native trees such as Monterey Cypress, Monterey Pine (*Pinus radiata*), Coast Live Oak (*Quercus agrifolia*), and Island Oak (*Quercus tomentella*) should be planted along the lagoon banks in Area C to fill in gaps in the windbreak where there is sufficient space.
- Salt-tolerant smaller trees and shrubs such as Arroyo Willow (*Salix lasiolepis*), Toyon (*Heteromeles arbutifolia*), Ceanothus species, and Coyote Brush (*Baccharis pilularis*) will be added along the lagoon banks to improve riparian habitat and native biodiversity. These plantings will include species that provide nectar to overwintering monarchs where possible.
- For Area C primarily, plant nectar plants of various species (see section 5.3.4 below) in areas that receive morning sun, or in spots with dappled light. The moist soil here allows for many species to thrive, as there are a variety of microhabitats available including marshy areas, creekbanks, and open grassy fields. Other narrow zones, between the trail and water on the west side of the lagoon, should also be planted with nectaring plants. Table 5 below provides recommended nectaring plants.
- For trees on the east side of the creek in Area C, where soil conditions are appropriate (not too wet), plant shorter stature trees and shrubs that can withstand wind and coastal pressure such as Arroyo Willow (*Salix lasiolepis*), Shining Willow (*Salix lasiandra*), Coyote Brush (*Baccharis pilularis*), Mulefat (*Baccharis salicifolia*), or Saltmarsh Baccharis (*Baccharis glutinosa*). These species are also nectaring sources for monarchs.

Southeast Grove – Area A2

- This area includes the southeast shore of the lagoon where there is a large, low-lying roughly triangular shaped piece of land that is available for tree planting. This area should be planted to enhance the existing windbreak and to facilitate the eventual replacement of blue gums with native trees. Drainage improvements were installed in this area in winter 2024/25 to reduce ponding of water. Eleven White Alder and six Monterey Cypress trees were planted in this area in December 2024. The White Alders did not survive, potentially due to lack of summer irrigation. Additional tree species should continue to be planted in this area to determine what will be successful. If the soil conditions allow tree roots to grow and succeed over time, evergreen trees such as Monterey Cypress and Monterey Pine (*Pinus radiata*) should be planted. If soil conditions are not appropriate for evergreen trees, California white alder (*Alnus rhombifolia*) and/or Red alder (*Alnus rubra*) were both recommended in the 2010 HMP and should be planted, but additional summer irrigation will likely be required for establishment. Arroyo Willow (*Salix lasiolepis*) should be planted along the east and southern portion of this area adjacent to the drainage swale.

Parcel at 40 Moran Way – Area A1

- The eucalyptus trees on the parcel at 40 Moran Way have experienced fungus and pest infestations and some have fallen or have been removed in the past. More recently, the February 2024 high-wind event caused 20 trees to fall and caused damage to adjacent private residences, property, and vehicles. Many of the remaining trees were weakened and four hazardous trees were immediately removed as a result of the storm; the remainder were topped in Summer 2024 to reduce their potential to fall. After the widespread failure of eucalyptus trees at this location, the County’s certified arborist and monarch butterfly specialist determined that the property no longer functioned as a viable windbreak. Further, the County’s certified arborist recommended removal of all eucalyptus trees on the property. All of the remaining trees were removed from the property and any stumps were ground in Summer 2025. The property was then completely re-graded in Fall 2025 to create positive drainage across the property and seeded annual grasses and legumes to provide erosion control.
- The parcel will be re-planted with at least 45 native trees and additional native shrubs in Fall 2026. The planting list for the parcel was developed by County Parks staff in conjunction with a certified arborist, biologists, and a monarch butterfly specialist, and consists of the following native trees: California Buckeye (*Aesculus californica*), Monterey Cypress (*Hesperocyparis macrocarpa*), Coast Live Oak (*Quercus agrifolia*), Island Oak (*Quercus tomentella*), Arroyo Willow (*Salix lasiolepis*), Toyon (*Heteromeles arbutifolia*), and Blue Elderberry (*Sambucus mexicana*). Native shrubs such as Baccharis species, Ceanothus species, Bush Monkeyflower (*Diplacus aurantiacus*), California Coffeeberry (*Frangula californica*), Coast Silktassel (*Garrya elliptica*), Pacific Wax Myrtle (*Morella californica*), and Pink Flowering Currant (*Ribes sanguineum* var. *glutinosum*) will also be planted. All plants are well-adapted to the specific conditions at this location, including wind and coastal conditions, and will provide improved habitat value for monarchs, pollinators, and other native species. None of the trees proposed for the property grow as tall as blue-gum eucalyptus, and large trees will be located away from private residences. Small trees and large shrubs will be planted along the western edge of the property bordering houses.

West of the Parking Lot

- In the area west of the parking lot and restrooms, shorter stature vegetation (small trees and large shrubs) that can withstand wind and coastal pressure, and that offer nectar or other habitat value should be planted such as Arroyo Willow (*Salix lasiolepis*), Toyon (*Heteromeles arbutifolia*), Blue Elderberry (*Sambucus mexicana*), Baccharis species, Ceanothus species, Bush Monkeyflower (*Diplacus aurantiacus*), California Coffeeberry (*Frangula californica*), Coast Silktassel (*Garrya elliptica*), Pacific Wax Myrtle (*Morella californica*), and Pink Flowering Currant (*Ribes sanguineum* var. *glutinosum*).

Tree planting described above will be conducted in the short term (1-3 years). Additional plantings in the future will be done in response to changes in the forest. A certified arborist and qualified entomologist will be consulted regarding future planting recommendations.

Action	Year 1	Ongoing	As-needed
Tree Planting		X	X

5.3.2 Hazard Trees

A certified arborist with a Tree Risk Assessment Qualification (TRAQ) from the International Society for Arboriculture (ISA) will routinely and proactively assess trees on County owned property at least twice a year, once in the spring and once in the fall. A TRAQ-certified arborist will also assess trees on an as-needed basis following major storm events and if a new risk is identified. If hazards or other issues are identified, they will be addressed as noted below.

Hazard pruning and/or hazard removal recommendations to address identified hazards will be made by a certified arborist and will be based on the tree's health condition, structural integrity, and its hazard potential using standardized protocol and guidance from ISA. In general, if the tree is dead or declining or poses a hazardous condition but is located within a natural area with low to no human traffic, the tree is typically not recommended for removal or hazard pruning. However, removal or pruning is typically recommended for hazard trees that are located within a high-traffic area, in areas adjacent to residences, in areas with sensitive infrastructure, and for dead trees within the groves surrounding the Sanitation Facility. The County will prioritize public safety in tree management actions. As such, trees will be maintained routinely through trimming and/or removal when they pose a hazard to public safety.

Safety pruning, rather than removal, is preferred where it is feasible to address identified hazards. Topping of trees is not recommended due to the weakly attached nature of epicormic shoots; rather safety pruning should be conducted to preserve the health of the tree while addressing the hazard. Removals will also be done to reduce risk of tree failure when identified as necessary by a certified arborist as noted above. This may negate benefits of the tree for monarch habitat, but the County will prioritize public safety when addressing hazardous trees. If hazardous tree(s) are removed, a certified arborist and monarch specialist will assess the impact of the removal(s) on monarch habitat and recommend replacement tree(s), if appropriate. Replacement trees, if recommended per above, will be planted at the beginning of the next rainy season to ensure optimal growing conditions and survival.

If hazards are identified within the **core habitat zone**, special care will be taken in assessing urgency and targets of falling trees/branches. The potential for opening the cluster sites to wind if any of the trees or their branches are removed will be assessed by a monarch specialist prior to removal. Removal of trees or branches will be the minimum necessary to sufficiently reduce the hazard to minimize changes that could potentially degrade the monarch habitat.

No tree work will occur within the **core habitat zone** (Figure 4) between **October 1 through March 31** unless a true emergency arises. Outside of the core habitat zone and within the **shelter habitat zone** (Figure 4), no tree work will occur between **October 15 through March 15** unless a true emergency arises. If a hazardous tree must be removed during either of these times, then a certified arborist and qualified monarch butterfly specialist will be retained by the County to monitor and provide input regarding the tree maintenance activities prior to and during the removal. The protective measures outlined in Table 6 will be required for all tree work to avoid and minimize impacts to the maximum extent feasible.

Tree risk assessments will be conducted routinely and on an as-needed basis. Hazardous tree or branch removals will be done as needed to mitigate safety risk to the public, monarch habitat, and park resources.

Action	Year 1	On-Going	As-needed
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Tree Risk Assessments	X	X
Safety Pruning and/or Hazardous Tree Removal		X

5.3.3 Fire Risk Abatement

Mid-story trees and shrubs can potentially create ladder fuels in the management area. However, the vertical continuity of fuels could be partially ameliorated by spatial separation of the shrub layer from the mid-story tree layer, via offset plantings. Exact configurations of these wind shelterbelts will require detailed field examination and will need to consider light availability and potential crowding. If a vertical continuity of fuels (i.e., ladder fuels) is created through the addition of mid-story trees and shrubs, the risk of a ground fire spreading into a high intensity canopy fire rises.

Blue gum limbs and trees that have naturally fallen throughout the management area will be actively removed to decrease fuel loading and eliminate ladder fuel within the understory of the groves on-site. If the Sanitation Facility groves' understory is sealed with mid-story trees and shrubs, they will be spatially separated from each other and the blue gum canopy by offsetting the plantings to avoid the creation of ladder fuels to the maximum extent feasible.

The existing plants will be maintained during Year 1 and until the new nectaring plants are planted, have established, and are flowering.

Action	Year 1	Ongoing	As-needed
Fire Risk Abatement		X	

5.3.4 Nectaring Plants

Monarchs are less likely to use nectar plants in deep shade. Therefore, nectar plants of various species will be planted primarily in sunny areas, or in areas with dappled light outside the blue gum groves. Nectar plants of various species (listed in the 2010 draft plan and in the Xerces Society lists) will be planted primarily in areas that receive morning sun, or in spots with dappled light. Spring and summer nectar sources and milkweeds (*Asclepias* spp.) will not be planted in the management area. These plants disrupt the monarchs natural spring migration pattern. Disrupting the monarchs' natural migration pattern can lead to further conditions that may contribute to population decline. Although introduced plants also provide nectar for monarchs, native plants are recommended for planting due to the additional ecological value that they provide, as well as being adapted to their local environment (e.g., drought, coastal influence, soil).

Allowing ivy to climb up trees without negatively impacting the health of the tree is an important management goal. Ivy that has climbed into tree canopies will be managed by cutting it back and removing it from the canopy. Starting at the tip of the ivy, it will be removed until it is no longer harming the health of the tree. Ivy will be retained on roughly 25 trees for nectar and will be trimmed regularly to prevent entry to the canopies. Ivy located on the east side of the grove where it receives morning insolation is likely to be preferred by monarchs.

North and South Lakeside – Areas B & C

The prime area for nectaring plants is on the east side of the creek in the sunny grassy area at the head of the lagoon. The moist soil here allows for many species to thrive, and on a microscale, the variety of habitats available including marshy areas, creekbanks, and open grassy fields. Other

narrow zones between the trail and water on the west side of the lagoon will be considered. Table 5 provides a list of recommended nectar plants, their bloom periods, and species-specific notes for the Moran Creek Bank.

Table 5 Recommended Nectaring Plants

Moran Creek Banks		
Shrubs/Small Trees		
Species	Bloom period	Notes
Douglas' Baccharis (<i>Baccharis glutinosa</i>)	July through October	Likely entire genus is attractive to monarchs. Important nectar source for many insects
Coyote Brush (<i>Baccharis pilularis</i>)	All year	
Mulefat (<i>Baccharis salicifolia</i>)	All year	
Arroyo Willow (<i>Salix lasiolepis</i>)	Winter & Spring	High quality riparian habitat plant and nectar source.
Perennial Herbaceous Plants		
Species	Bloom period	Notes
Coastal gumweed (<i>Grindelia stricta</i>)	May through October	-
Western goldenrod (<i>Euthamia occidentalis</i>)	July through November	Likely entire genus is attractive to monarchs
Canada goldenrod (<i>Solidago canadensis</i>)	August through October	Likely the entire genus is attractive to monarchs. Great late season nectar source
Seaside daisy (<i>Erigeron glaucus</i>)	January through August	-

Nectaring plants will be planted in the short term (1-3 years) and monitored for survival. If plants do not survive they will be replaced in-kind immediately. Some plants are likely to die-off over time. Plantings will be monitored annually and replanted when/as plants die-off.

Additional Recommended Nectaring Plants

The Xerces Society recommends nectaring plants for coastal California that should also be considered. The list, in Appendix G, includes the blooming season of the plants. For the purposes of this plan, the County should plant those that bloom in the fall, winter and spring when monarchs are overwintering on site.

Action	Year 1	Ongoing	As-needed
Nectar Planting		X	

5.3.5 Drainage Improvements

Several areas of the habitat management area suffer from poor drainage. This had led to saturated soils and water-ponding around the base of existing trees. The saturated soils and ponding has in turn likely contributed to tree failure. Therefore, improving drainage is a critical goal to prevent additional tree failures and improve the health of existing trees. In addition, some areas will require improved drainage before replacement trees can be successfully grown.

South Lakeside and North Lakeside – Areas B & C

When the D.A. Porath Sanitation Facility was built in 1953, a sewer line was also installed along the western margins of the lake. The installation of the sewer line modified drainage patterns along the western side of the lake, creating artificial mounds and low-spots that restrict runoff flowing toward the lake. These problems persist today.

Ponding water and saturated soils are present at the base of the eucalyptus windrow along the western boundary of the management area between the residences and the trail along Moran Lake. The wet condition within the critical root zone of the eucalyptus trees negatively impacts roots. Simple drainages will be created to allow the water to flow to the lake. The drainages will be placed at the lowest points where ponding occurs and as shown in Figure 6.

40 Moran Way – Area A1

A majority of this parcel is poorly drained and experiences saturated soil conditions during the rainy season. This parcel experienced 20 tree failures during the February 2024 high-wind event. There is an existing drain inlet along East Cliff Drive at the southeastern corner of the parcel. The County regraded the entire parcel in Fall 2025 to create positive drainage that directs runoff toward the existing drain inlet and reduces ponding and soil saturation. The drainage of this parcel should be monitored and maintained on an ongoing basis.

Action	Year 1	Ongoing	As-needed
Install Drainages	X		X
Maintain Drainages		X	

Table 6 Summary of Management Actions and associated Protective Measures

Action	Timeline	Protective Measures
Tree risk assessment	Ongoing	A certified arborist with a Tree risk Assessment Qualification (TRAQ) from ISA will assess trees on County owned property at least twice a year, once in the spring and once in the fall. A TRAQ-certified arborist will also assess trees as needed following major storm events and if a new risk is identified. If hazards or other issues are identified, they will be addressed as noted below.
Maintenance pruning and other routine tree work	As-needed	A certified arborist will recommend maintenance pruning and other routine tree work as part of the tree risk assessments to reduce risk to public safety and monarch habitat. Recommended tree work will occur outside of the monarch overwintering season (core habitat zone Oct 1 – Mar 31; shelter habitat zone Oct 15 – Mar 15), unless a true emergency arises (see emergency tree work below). Tree work will be conducted by a California-licensed tree contractor that has experience conducting work in sensitive habitat. Tree work will avoid damaging adjacent trees or limbs. A nesting bird survey will be required if tree work is conducted during nesting bird season. If necessary, preconstruction training will be required for contractors performing tree work to avoid and minimize impacts to sensitive resources.
Removal of hazardous tree or limbs	As-needed	Removals will be assessed by a certified arborist. Removals will occur outside of the monarch overwintering season (core habitat zone Oct 1 – Mar 31; shelter habitat zone Oct 15 – Mar 15), unless a true emergency arises (see emergency tree work below). Removals will be conducted by a California-licensed tree contractor that has experience conducting work in sensitive habitat. Removals will avoid damaging adjacent trees or limbs. A nesting bird survey will be required if removals are conducted during nesting bird season, and if nesting birds are found Certified arborist and monarch specialist will assess impact of removal on monarch habitat and recommend replacement tree, if appropriate. Plant replacement tree if recommended per above at the beginning of the next rainy season. If necessary, preconstruction training will be required for contractors performing tree work to avoid and minimize impacts to sensitive resources.
Failure of tree within monarch habitat	As-needed	Failures will be assessed by a certified arborist. Tree work associated with failures will occur outside of the monarch overwintering season (core habitat zone Oct 1 – Mar 31; shelter habitat zone Oct 15 – Mar 15), unless a true emergency arises (see emergency tree work below). A nesting bird survey will be required if tree work is conducted during nesting bird season. Certified arborist and monarch specialist assess impact of failure on monarch habitat and recommend replacement tree, if appropriate. Plant replacement tree if recommended per above at the beginning of the next rainy season.

Action	Timeline	Protective Measures
Emergency tree work (during monarch overwintering season)	As-needed	Tree work will be overseen by a certified arborist and monarch specialist who will recommend best management practices to avoid and minimize impacts to monarchs. Tree work will be conducted by a California-licensed tree contractor that has experience conducting work in sensitive habitat. Tree work will minimize damage to adjacent trees or limbs. Certified arborist and monarch specialist will assess impact of removal on monarch habitat and recommend replacement tree, if appropriate. Plant replacement tree if recommended per above at the beginning of the next rainy season. Preconstruction training will be required for contractors performing tree work to avoid and minimize impacts to sensitive resources.
Critical Windbreak Tree Replacement (Pilot Project)	As-needed	The critical windbreak will be enhanced by planting existing gaps in the windbreak with recommended tree species in Table 4. Selective removal of existing eucalyptus will be recommended by a certified arborist and monarch specialist and will not occur unless the existing gaps in the windbreak are planted. Removals will be overseen by a certified arborist and monarch specialist who will recommend best management practices to avoid and minimize impacts to monarchs. Removals will be conducted by a California-licensed tree contractor that has experience conducting work in sensitive habitat. Removals will minimize damage to adjacent trees or limbs. Certified arborist and monarch specialist will assess impact of removal on monarch habitat and recommend replacement trees. Follow guidelines for tree height established by the wind study to avoid negatively impacting monarch habitat.
Install and maintain positive drainage at base of trees to reduce ponding	Ongoing	Install and maintain drainages using best management practices to reduce erosion and prevent sediment deposition into Moran Lagoon. Prepare drainages prior to rainy season.
Maintenance of understory in eucalyptus groves	Ongoing	The understory within the eucalyptus groves will be managed to avoid the growth of ladder fuels and to keep sight-lines clear. Vegetation management will minimize impacts to monarch habitat by preserving nectar sources where feasible. If needed, a monarch specialist will advise vegetation management. Ivy that has climbed into trees will not be trimmed without input from a monarch specialist.
Removal of invasive species	Ongoing	Invasive species, other than blue gum eucalyptus that are necessary for monarch habitat, may be removed to restore native biodiversity and habitat. Where invasive species are removed, they will be replaced by wood chip mulch or native species that will achieve the habitat and restoration goals in this habitat management plan.
Tree and shrub planting	Ongoing	Tree planting will conform to the guidelines in this habitat management plan or be recommended by a certified arborist and monarch specialist. Native species will be planted where feasible, unless non-native species are necessary for monarch habitat enhancement or protection as outlined in this habitat management plan. Species selected for shrub planting will align with the public safety, habitat, and restoration goals in this habitat management plan.

Action	Timeline	Protective Measures
Removal of dead eucalyptus wood to reduce potential for eucalyptus pests	Ongoing	Not applicable

6 Monitoring Plan

This plan serves to manage and maintain the overwintering habitat at Moran Lake. Table 1 provides the historic data and counts of overwintering monarchs here. The two factors to be monitored are the number of monarchs that overwinter at Moran Lake and the quality of the habitat that the management area provides. Data in Table 1 helps to display regional and state-wide fluctuations, and to understand if the Moran Lake overwintering counts are consistent with the other sites in the county or possibly if the Moran Lake site is playing a more, or less, important role over time.

In order to analyze the effectiveness of the Moran Lake habitat, annual counts at Moran should be compared to other sites across the state and the immediate region as monarch counts will inevitably fluctuate between years. The goal should be to ensure that Moran Lake is hosting numbers that are proportionally similar to, or above, other regional sites. This will help determine whether habitat quality at Moran is the limiting factor in increasing the population of overwintering Monarchs at Moran.

6.1 Monarch Surveys

Monarch surveys will be conducted at least twice annually, and twice monthly as possible, during the overwintering season (October 15 to March 31). Surveys will be consistent with the Xerces Society's standards. Results will be recorded, uploaded to the Western Monarch Count database, and included in the annual report for this management plan.

6.2 Habitat Assessments

The long-term functionality of the management area habitat depends on the replacement trees survival and resulting wind protection needed by the overwintering monarchs. Replacement tree establishment must be prioritized by County Parks.

Depending upon the size of the trees planted and planting conditions (soil, water availability, etc.), trees could take up to 20 years or longer to reach full maturity and height, and shrubs could take 5 to 10 years. The goal of the plantings is to provide wind protection in the management area and particularly at the roosting and basking areas. Wind penetration will be measured using current wind modeling technology and applications every 3 to 5 years to understand the effectiveness of the plantings.

Tree health will continue to be assessed and monitored annually to identify hazardous trees and to identify trees with declining health. Health will be monitored by County's certified arborist and could be monitored by County's maintenance staff regularly. County staff can collaborate with the certified arborist to be aware of and notify them of situations like insect infestation or new potential tree hazards, so the arborist can monitor anything of significance.

6.3 Monarch Predator Assessments

During monarch surveys any change in the presence or evidence of predators will be recorded and discussed with the monarch butterfly specialist to determine if and what action may be needed.

6.4 Annual Report

Monitoring the tree plantings, habitat health, establishment of nectaring plants and other forest management actions will be done in Year 1 and annually. An annual monitoring report detailing the progress and findings will be prepared. Logs documenting implementation of the forest management actions will be completed and saved by the County. The report will include, as an appendix, other reports from the County arborist and monarch specialist.

The report will be used to determine if changes in management actions are necessary. Any corrective actions implemented to address threats to monarch habitat (i.e., pests, diseases, flood/erosion) and changes to monarch habitat use will be detailed in an annual monitoring report. The report will be saved by the County and be available to the public and resource agencies upon request.

6.5 USFWS Monitoring and Reporting Requirements 2022

County Parks was awarded a \$20,000 grant to prepare this MBHMP update. To meet the grant requirements, monitoring data and analyses will be summarized in annual performance report that will be submitted to the USFWS. The Work Plan is included as Appendix C. The annual performance reports will include:

- Year 1: A detailed description of activities completed by County Parks, including the scope of activities, the date(s) and the specific location(s) within the management area
- Year 2 and annually thereafter: A description of the activities completed since the last reporting period, with the specific dates, such as X day of X month during X year. Description with a figure or sketch specifying where all activities occurred during the time period. The report will include:
 - Photos, before and after (whatever is appropriate);
 - Statements explaining any problems or delays in implementing project tasks;
 - Lessons learned (if appropriate); and
 - Other Reporting: If submitting reports to other federal, State, and local agencies and the above annual report content met then submitting these reports is acceptable.

Additionally, a final report will be submitted to the USFWS that will include all the above information/headings with a synthesis of all project activities completed. Annual and final reports must be submitted to the USFWS Project Officer, whose contact information is provided below.

Samantha Marcum
Coastal Program Regional Coordinator
U.S. Fish and Wildlife Service

6.6 California Coastal Commission

The Project Area is located within the County's Coastal Zone and the habitat management actions in this Plan, including vegetation removal and planting, constitute development pursuant to the

California Coastal Act⁴, and thus coastal development permit (CDP) authorization is required. Portions of the recommended overall management actions (see Figure 7) fall within the original permitting jurisdiction of the California Coastal Commission, and therefore County Parks anticipates pursuing a consolidated CDP⁵ from the Coastal Commission to comply with the requirements of the Coastal Act. For the purposes of that CDP, County Parks proposes the following reporting and adaptive management actions:

- County Parks will seek a five-year authorization through to April 30, 2031 to implement the overall management actions described in this Plan. Additionally, County Parks proposes that this authorization may be extended beyond the initial five-year period subject to review and approval by the Commission's Executive Director with a finding that there are no changed circumstances that may affect consistency with the policies of Chapter 3 of the Coastal Act and thus warrant re-review of the authorization. County Parks will submit a five-year extension request in writing to the Commission's Central Coast District Office by December 1, 2030, and the Executive Director's determination will be made in writing to County Parks.
- Annual reports as described above in Section 6.4 will be submitted by March 31 (or another date, subject to Executive Director approval) annually to the Commission's Central Coast District Office for Executive Director review and approval and will include:
 - A description of the actions completed during the previous year, including, but not limited to: (1) the number, species, and location of trees removed and planted; (2) location and nature of major limbing activities; (3) photos of the site before and after work; (4) any actions taken to address pests or predators; (5) a discussion of other project implementation actions not already included above and subsequent performance; and (6) adaptive management actions County Parks plans to implement over the subsequent year to ensure continued or more successful management, and progress towards long term management goals.

The annual report submitted to the Coastal Commission will be an enforceable component of the Commission's CDP authorization for the Plan and will require review and approval by the Commission's Executive Director prior to implementing any adaptive management actions.

⁴ See Public Resources Code Section 30106.

⁵ See Public Resources Code Section 30601.3.

7 Adaptive Management

The Moran Lake monarch butterfly overwintering habitat is regionally important, and care has been taken to preserve it. However, climate changes are impacting monarch habitat throughout coastal California that may require the County and other landowners and managers to respond and adjust to changes in real time. Monarch counts in the future are likely to fluctuate greatly, regionally, and at this site due to many factors, including climate change. At this time, preserving and managing the habitat so that it retains the key characteristics for overwintering is the objective of this management plan. Several recommendations for adaptive management are below. The County Park's arborist and entomologist will be consulted prior to initiating management actions.

- If the health of blue gums within the grove decreases and mass foliage losses occur at the cluster sites, the grove will be assessed for additional management actions.
- Soil amendments will be considered to encourage new vegetation growth, and a drip irrigation system could be installed to provide additional water, which is likely the greatest limiting resource.

This MBHMP update is an adaptive action taken to address the changing conditions and needs of the habitat. As discussed, tracking and adjusting replacement tree species and numbers is another adaption meant to more specifically address the changing needs of the site. Table 7 provides information about tree species that did not thrive in the management area in the past. It will be important to track what species thrive and those that do not into the future and adjust accordingly.

Table 7 Tree Species Not Well-Suited to the Management Area

Tree Species	Location Planted in the Past	Observed issue
Pohutukawa	Between parking lot and lagoon	Poor growth, but the individual tree was planted in a very exposed location where no trees are currently thriving.
Coast redwood	Zones B and C – North and South Lakeside	Poor growth. This species is sensitive to salt spray and saline soils near the coast or tidal areas.
Coast Redwood	Zone H – Critical Windbreak along Placer Street	Trees died due to failed irrigation. May not be an appropriate area for coast redwoods due to lack of soil moisture.
Flooded-Gum Eucalyptus (<i>Eucalyptus rudis</i>)	North Lakeside	Infested by red-gum lerp psyllids.
Swamp gum	40 Moran Way	Insect infestation
California bay	Western margin of western grove, shaded area	Did not grow, potentially due to heavy shade, or competition from adjacent eucalyptus.

The 2010 Plan, Appendices 3.3 Recommended Plants for Overwintering Restoration, of included a list of species with their potential ecological role. Trees listed should be considered for planting in the appropriate locations and for the appropriate ecological role.

If plans or projects are developed in the future for Moran Lake, this plan will need to be incorporated into the plan with input from the County arborist and monarch specialist.

If the western monarch butterfly population is listed as a threatened or endangered by the USFWS, the agency will designate critical habitat for the species. It is likely the known or historic overwintering sites will be included as critical habitat. As a result, the regulatory setting for managing their habitat will become more complex and will include review and approval by USFWS. This management plan would very likely require an update or amendment to be consistent with the federal habitat protection requirements.

8 References

- Advani, N.K. 2015. World Wildlife Fund (WWF) Wildlife and Climate Change Series: Monarch Butterfly. World Wildlife Fund, Washington, DC.
https://c402277.ssl.cf1.rackcdn.com/publications/845/files/original/Monarch_butterfly_-_WWF_wildlife_and_climate_change_series.pdf
- Baldwin, B.G., Goldman, D.H., Keil, D.J., Patterson, R., Rosatti, T.J., and D.H. Wilken (Eds.). 2012. The Jepson Manual: Vascular Plants of California, Second Edition. University of California Press. Berkeley, California.
- Calflora. 2023. Information on Wild California Plants. www.calflora.org (accessed August 2022 and January 2023).
- Center for Biological Diversity. 2014. Petition to Protect the Monarch Butterfly (*Danaus plexippus plexippus*) Under the Endangered Species Act. Before the Secretary of the Interior. Submitted August 26, 2014. Petitioners Include: The Center for Biological Diversity, The Center for Food Safety, The Xerces Society, and Dr. Lincoln Brewer. Available at: https://www.biologicaldiversity.org/species/invertebrates/pdfs/Monarch_ESA_Petition.pdf.
- Central Coast Wetlands Group. 2017. Santa Cruz County Coastal Climate Change Vulnerability Report. Prepared for the County of Santa Cruz by the Central Coast Wetlands Group at Moss Landing Marine Labs.
- Dayton, John. Personal communication via email and in-person August and December 2023.
- Groundswell Coastal Ecology. 2023. Organization website. www.groundswellecology.org.
- Intergovernmental Panel on Climate Change. 2013. Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report (AR5) of the Intergovernmental Panel on Climate Change. [TF Stocker, D Qin, G Plattner, MMB Tignor, SK Allen, J Boschung, A Nauels, Y Xia, V Bex, PM Midgley (eds.)], Cambridge University Press: Cambridge, UK and New York, NY, USA. 1535pp. <https://www.ipcc.ch/report/ar5/>.
- John Gilchrist & Associates and Fall Creek Engineering. 2005. Moran Lake Water Quality Study & Conceptual Restoration Plan.
- Joni L. Janecki & Associates, Inc. 2004. Management Plan for the Monarch Butterfly Habitat at Moran Lake County Park.
- _____. 2010. Moran Lake Monarch Butterfly Habitat Management Plan. Prepared for the Santa Cruz County Parks, Open Space, and Cultural Services Department.
- LSA Associates. Wildfire hazard reduction and resource management plan. V. Vegetation management plan. 2009. Oakland, CA: East Bay Regional Park District. www.ebparks.org/Assets/files/fireplan/ebprd_whrrm_plan/5-VegMan.pdf (accessed March 23, 2014).
- Santa Cruz, County of. 2022. Climate Action and Adaptation Plan (CAAP). December 2022. <https://www.co.santacruz.ca.us/Portals/0/County/OR3/CAAP/2022%20Climate%20Action%20and%20Adaptation%20Plan%20%28CAAP%29.pdf>

- Santa Cruz, County of. 2024. Sensitive Habitat in Santa Cruz County. February 2024.
<https://sccoplanning.com/PlanningHome/Environmental/SensitiveHabitat/SensitiveHabitatinSantaCruzCounty.aspx#:~:text=In%20Santa%20Cruz%20County%2C%20habitat,a%20species%20of%20special%20concern.>
- Stern, Gary and Paul Courter, with Sally Sample. 1980. Report on Environmental Baseline Study for the Moran Lake Enhancement Plan. State of California-Coastal Conservancy.
- United States Fish and Wildlife Service (USFWS). 2020. Monarch (*Danaus plexippus*) Special Status Assessment Report. Version 2.1.
<https://www.fws.gov/sites/default/files/documents/Monarch-Butterfly-SSA-Report-September-2020.pdf>
- _____. 2022. Endangered and Threatened Wildlife and Plants; Review of Species that are Candidates for Listing as Endangered or Threatened; Annual Notification of Findings on Resubmitted Petitions; Annual Description of Progress of Listing Actions. A Proposed Rule by the USFWS on May 3, 2022. Federal Register (87 FR 26152).
[https://www.federalregister.gov/documents/2022/05/03/2022-09376/endangered-and-threatened-wildlife-and-plants-review-of-species-that-are-candidates-for-listing-as.](https://www.federalregister.gov/documents/2022/05/03/2022-09376/endangered-and-threatened-wildlife-and-plants-review-of-species-that-are-candidates-for-listing-as)
2023. Western Monarch Butterfly Conservation Recommendations
[21-015 03.pdf](#)
- Weiss, S.B. 2024. Assessment of Moran Lake Monarch Overwintering Habitat. Report by Creekside Science to Santa Cruz County Parks
- Weiss, S.B., Matley, C. 2025. Moran Lake Monarch Butterfly Habitat and Tree Management Assessment. Report by Creekside Science and Althouse & Meade to Santa Cruz County Parks
- Xerces Society. 2012. The Legal Status of Monarch Butterflies in California. Written in collaboration with The International Environmental Law Project.
<https://xerces.org/publications/reports/legal-status-of-monarchs-in-california>.
- _____. 2016. Monarch Nectar Plants: Coastal California.
https://www.nwf.org/~media/PDFs/Garden-for-Wildlife/Xerces-NWF/03-CA_Coast_Monarch_Plant_List_spread.ashx (accessed August 2022).
- _____. 2019. Monarch Nectar Plants: California. <https://xerces.org/publications/plant-lists/monarch-nectar-plants-california> (accessed August 2022).
- _____. 2020. The Vanishing Butterfly Groves of California. Written by Emma Pelton on January 27, 2020 for the Xerces Society Blog. <https://xerces.org/blog/vanishing-butterfly-groves-of-california>.
- _____. 2023a. Xerces Society website. www.xerces.org (accessed August 2022 and January 2023).
- _____. 2023b. Western Monarch Thanksgiving Count Data, 1997-2022.
www.westernmonarchcount.org (accessed August 2022 and January 2023).

Appendix A

Moran Lake Monarch Overwintering Habitat Existing Conditions Report and Associated Appendices



Moran Lake Existing Conditions Report

Monarch Butterfly Overwintering Habitat

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September 2022



RINCON CONSULTANTS, INC.

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Table of Contents

1	Introduction	1
2	Background	2
3	Methods.....	5
4	Results.....	6
4.1	Cluster Areas.....	6
4.2	Overwintering Site Condition.....	6
4.3	Microclimate Conditions.....	7
4.4	Major Vulnerabilities to Overwintering Habitat	7
4.5	Population Numbers.....	7
4.6	Potentially Hazardous Trees	9
4.7	Fire Risk Assessment	9
4.8	Fall and Winter Nectar Plants	11
5	Recommendations.....	13
5.1	Delineation of Management Zones.....	13
5.2	Vegetation Management.....	13
5.2.1	Tree and Shrub Plantings for Wind Shelter	13
5.2.2	Nectar Planting and Management.....	14
5.2.3	Existing Nectar Plant Management	16
5.2.4	Forest Thinning and Fire Risk Abatement	16
5.2.5	Tree Removals and Hazard Pruning.....	16
5.3	Management Action Thresholds	19
6	References.....	20

Tables

Table 1	Western Monarch Count Statistics for Santa Cruz County Since 1997	8
Table 2	Fall and Winter Monarch Nectar Plants found in the Park.....	11
Table 3	Recommended Fall and Winter Nectar Plants for Overwintering Monarchs	15
Table 4	Recommended Actions for Hazard Trees in the Park.....	17

Figures

Figure 1	Moran Lake Overwintering Clusters and Roost Area Zones Map	3
Figure 2	Potentially Hazardous Trees Map	10
Figure 3	Recommended Nectar Planting Map	12
Figure 4	Recommended Wind Shelter Plantings Map	18

Appendices

Appendix A Assessment of Moran Lake Monarch Overwintering Habitat

Appendix B Moran Lake Restoration Project Arborist Report

Appendix C Moran Lake County Park Improvement Project Biological Resources
Assessment

1 Introduction

This Monarch Butterfly Overwintering Habitat Existing Conditions Report (Report) was prepared to summarize data and information compiled during the monarch butterfly overwintering habitat monitoring and site assessment conducted by Creekside Science (Creekside) and Rincon Consultants, Inc. (Rincon) in the winter of 2021 through summer of 2022. It includes site management recommendations for the prolonged use and enhancement of monarch butterfly overwintering habitat at Moran Lake County Park (Park). This Report will be used to inform and update overwintering management decisions and the future Park restoration plan. More specifically, this Report provides historic monarch overwintering and habitat condition information from the 2010 Moran Lake County Park Habitat Management Plan, includes the methods and results of the 2021/2022 overwintering habitat monitoring and site assessment, and includes management recommendations based on current site conditions.

2 Background

Over the past thirty years much of the traditional monarch butterfly wintering habitat at Moran Lake has been significantly impacted due to several factors including: tree loss due to natural causes, permitted and non-permitted tree removal, and improper tree maintenance. These factors, combined with the absence of a cooperative management plan that coordinates the activities of county agencies and local property owners, place the monarch butterfly wintering habitat at Moran Lake in jeopardy.

Monarch butterflies are present in the Moran Lake wintering habitat from October through February in most years, and small numbers have been observed as early as mid-August and as late as April in some years. Based on its continual occupation by monarch butterflies throughout the wintering period, the habitat at Moran Lake is classified as full-term overwintering habitat.

In the past (1980s), monarchs typically began to congregate along the northwestern shore of Moran Lake during early October and formed clusters in the North and South Lakeside Roost Areas (Figure 1). As the population increased during October, clusters also formed in the North and South Creekside Roost Areas and the lakeside butterflies gradually shifted north into the more sheltered Creekside Roost Areas. Then around mid-November, the population shifted its clusters into the Primary Roosting Area where they remained until warming temperatures initiated the spring migration sometime in February. The North Lakeside Roost Area usually supported clusters of roosting monarchs throughout the month of October, whereas the South Lakeside Roost Area typically supported clusters only intermittently during the fall. Thus, the North Lakeside Roost Area historically functioned as an autumnal roost area and the South Lakeside Roost Area functioned as refuge/ bivouac habitat. Tree and limb loss in these habitats has since reduced wind protection and eliminated many of the lower roost limbs that once supported clusters. Currently both roost areas function as refuge/ bivouac habitats. Figure 1 delineates the monarch butterfly roosting areas in Moran Lake County Park.

Tree and limb losses in the North Creekside Roost Area have degraded this habitat over the past ten years resulting in less frequent occupation of the North Creekside Roost Area and a gradual shift of occupation to the South Creekside Roost Area. In March/April of 1999, residents on the property adjacent to the South Creekside Roost Area removed all the eucalyptus trees (*Eucalyptus* spp.) on their property along the east side of the creek and in that process eliminated all the eastern windbreak/ shade trees that sheltered the South Creekside Roost Area. During the winter preceding the tree removal (1998-99) the entire wintering population at Moran Lake (approximately 18,000 monarchs) occupied the South Creekside Roost Area from early October through most of November. During the winter of 1999-2000, no clusters were observed in the South Creekside Roost Area. Both North and South Creekside Roost Areas now function only intermittently as refuge/bivouac habitat.

The Primary Roosting Area, despite several significant tree removal events, has consistently supported mid-winter monarch populations for at least the past twenty years. With the loss of suitable autumnal habitat in the Lakeside and Creekside Roost Areas, the Primary Roosting Area has now begun to function additionally as autumnal roost habitat. The Primary Roosting Area is the only consistently occupied roost area remaining in the Moran Lake monarch wintering habitat.

The grove of eucalyptus at the southeastern end of Moran Lake—the Southeastern Grove, which includes the Moran Way Windrow—in addition to providing wind protection for the lake area,

Figure 1 Moran Lake Overwintering Clusters and Roost Area Zones Map

21-11388 Moran Lake Restoration Plan
Fig 1 Moran Lake Overwintering Cluster and Roost Area

Moran Lake Existing Conditions Report

functions intermittently as refuge/bivouac habitat and occasionally supports small clusters during periods when monarchs are migrating, and winds are relatively calm.

3 Methods

Cluster areas, population behavior, microclimate conditions, and major vulnerabilities to the Park's overwintering habitat were assessed by Dr. Stu Weiss of Creekside between October 2021 and June 2022. The monitoring and site assessment was conducted with the use of Light Detection and Ranging (LiDAR) technology and hemispherical photography. A detailed description of the LiDAR and hemispherical survey methods are provided in Attachment A: Assessment of Moran Lake Monarch Overwintering Habitat. Consultation with Samantha Marcum at the U.S. Fish and Wildlife Service (who has monitored Moran Lake monarchs for several years) identified key cluster areas over the past several years including 2021-2022. Direct observations by Creekside staff in November and January supplemented this information.

The overwintering site conditions, winter nectar sources, and identification of tree removals or hazard pruning were analyzed by Rincon through the results of the 2022 arborist, botanical, and biological resource assessment surveys. Factors such as tree species, health, density, forest stratification, and dead wooding were analyzed within the Park to determine the fire risk potential. A detailed description of the methods used during the 2022 arborist survey is provided in Attachment B: Moran Lake Restoration Project Arborist Report¹. A detailed description of the methods used for the completion of the 2022 botanical and biological resource assessment surveys is provided in Attachment C: Moran Lake County Park Improvement Project Biological Resources Assessment.

The Park's current and historic estimated overwintering population numbers were obtained through the Western Monarch Count (Xerces 2022). The Western Monarch Count is a citizen scientist powered organization that is sponsored by the Xerces Society. Western Monarch Count conducts annual population counts at overwintering sites throughout California each thanksgiving and at the start of each new year (Xerces 2022). These data are used by many agencies and conservation organizations to aid in conservation efforts and estimate population trends for the western monarch butterfly.

¹ Excluding the sanitation facility grove, all newly planted native trees in the park, landscape/ornamental trees, and all naturally occurring trees with a diameter at breast height (DBH) of 4 inches or greater were surveyed if they had any portion of their canopy in the Park. Due to time constraints, only priority trees (i.e., dead, dying [i.e., Poor Health trees], newly planted trees, and hazard trees) were surveyed within the sanitation facility grove (trees 3055 to 3092). However, notes on the grove's average DBH and DBH range, average height and height range, average canopy spread, total canopy coverage, and health condition were taken.

4 Results

4.1 Cluster Areas

Dr. Stu Weiss observed one monarch cluster overwintering in the large blue gum (*Eucalyptus globulus*) grove surrounding the sanitation facility (i.e., the sanitation facility grove) in November of 2021. The monarchs were observed clustering 20-30 feet up the blue gums in the northeastern sector of the grove (i.e., Roost Area F). In the last several years, Samantha Marcum reported two additional cluster sites along the southeastern boundary of Roost Area G, one on the northeastern and one on the southeastern side of the access road leading into the sanitation facility. In January, during a northerly wind event, monarchs were scarce in the northeastern cluster area due to its windward exposure. At this time, hundreds of monarchs were observed flying freely in the open areas on the leeward side of the sanitation facility grove in Roost Area D. This behavior corresponds to the historical descriptions reported by S. Marcum. Figure 1 provides the locations of the most recent and the historic overwintering roost locations in relation to the sanitation facility grove and the previously delineated Roost Areas.

The trees south of the sanitation facility grove (i.e., Roost Areas A, B, and C) were found to provide early season roosting habitat but were abandoned once storms brought substantial winds. The viability of the sanitation facility grove cluster sites is much less dependent on trees in these areas than the trees found within and surrounding the sanitation facility grove (i.e., Roost Areas D, E, F, G, and H). Roost Areas A, B, and C were observed being used opportunistically by the monarchs during the site assessment surveys but do not provide the microclimate conditions necessary to support overwintering clusters.

4.2 Overwintering Site Condition

The health of the blue gums within the sanitation facility grove is generally fair, excluding the northeastern portion of the grove which was more established and contained larger and more spaced-out trees in a good health condition. A copious amount of branch dieback and epicormic shoots were observed on the blue gums during the 2022 arborist survey along with several dead or dying trees, indicating stress. The grove is likely experiencing drought pressure and is generally overcrowded. Over time, many additional eucalyptus trees in the shaded understory will be outcompeted by larger trees and will die. An ideal overwintering site should have trees in good condition, that are evenly spaced out, have healthy foliage, and good vigor. An ideal overwintering site should also have saplings in the understory to replace trees as they die and a continuous, well stratified, canopy at the outer edges to offer wind protection. However, the canopy should not be so dense to prevent the entry of the necessary amount of direct and dappled insulating light. Insolation is primarily a factor on the southerly exposures.

Specific notes regarding the grove, including notes on its overall condition and the identification of specific dead, dying, and hazard trees, is provided in Attachment B: Moran Lake Restoration Project Arborist Report.

4.3 Microclimate Conditions

The microclimate conditions within the northeastern and northwestern portions of the sanitation facility grove (Roosting Areas F and G) are the most ideal for overwintering monarchs. The monarchs prefer these locations within the grove due to the presence of wind shelter and an adequate amount of direct and dappled light. The tall blue gums surrounding the inner boundary of the grove provide adequate wind shelter and the opening in the grove (where the sanitation facility is located) allows the necessary amount of solar insolation into the cluster areas. The microclimate conditions found throughout Roosting Areas A, B, and C are not suitable to support overwintering monarch clusters, largely due to the lack of adequate wind shelter.

Grove specific measurements, including, but not limited to, an assessment of wind measurements, light exposure, and canopy height and structure derived from hemispherical photographs and LiDAR are provided in Attachment A: Assessment of Moran Lake Monarch Overwintering Habitat. The measurements included within Attachment A represent why the main cluster site is suitable for overwintering monarchs.

4.4 Major Vulnerabilities to Overwintering Habitat

The biggest vulnerability of the Park's overwintering habitat is wind penetration into the sanitation facility grove. The microclimate conditions necessary to support overwintering monarchs is much less dependent on the trees outside of the sanitation facility grove. A list of the major vulnerabilities to the Park's overwintering habitat is provided below.

1. Northerly wind penetration into the northeastern cluster area (Roosting Area G) through the opening in the northeastern boundary of the grove.
2. Southerly wind penetration into the northeastern cluster area (Roosting Area G). Including a combination of penetration over the sanitation facility and around the northeastern corner of the sanitation facility through the creek.
3. Northerly wind penetration into the northwestern cluster area (Roosting Area F) through the rows of trees beneath the overstory and along the access road.
4. A gap in the southeastern portion of the grove produces a wind tunnel that allows wind to penetrate both cluster areas (Roosting Areas F and G).

4.5 Population Numbers

Western monarch butterfly population numbers have generally been seeing a steady decline, with some fluctuation, since the inception of the Western Monarch Count in 1997. In 1997, over 70,000 individual monarch butterflies were recorded overwintering at the Park and this previous year's count provided an estimated population of 1,100 individual monarchs (Xerces 2020). Since 2012, the Park has supported an average of approximately 2,500 monarchs a year, constituting approximately 17% (range 7% to 27%) of the County's total overwintering population. Additionally, the Park has supported an average of 1.9% of the entire California overwintering population (range 0.4% to 5%). In years of sharp declines in western monarchs (i.e., 2009 and 2018), the Park held 3.9% and 5%, respectively, of the entire California overwintering population. Table 1 below provides the estimated monarch count at the Park along with every other overwintering site in Santa Cruz County since the inception of the Western Monarch Count in 1997. Additionally, Table 1 provides the total

Moran Lake County Park
Moran Lake Existing Conditions Report

number of overwintering monarchs in Santa Cruz County and California since 1997, the percentage of overwintering monarchs at the Park each year in comparison to the total population of overwintering monarchs in Santa Cruz County, the percentage of overwintering monarchs at the Park each year in comparison to the total number of overwintering monarchs in California, the yearly average of overwintering monarchs at each overwintering site, the County, and California since 1997, and the ten year average of overwintering monarchs at each overwintering site, the County, and California.

Table 1 Western Monarch Count Statistics for Santa Cruz County Since 1997

Count Year	Moran Lake	Overwintering Sites in Santa Cruz County			Santa Cruz County Total	California Total	% in Comparison to Santa Cruz County	% in Comparison to California
		Natural Bridges State Beach	Lighthouse Field	Seascape Golf Course, Aptos				
1997	70,000	120,000	70,000	--	60,000	1,235,490	27%	5.7%
1998	8,000	60,000	50,000	240	19,898	564,349	7%	1.4%
1999	4,500	15,000	9,500	280	31,958	267,574	14%	1.7%
2000	4,000	20,000	35,000	1,050	62,961	390,057	6%	1.0%
2001	1,500	3,000	--	1,400	6,123	209,570	24%	0.7%
2002	1,000	6,000	3,200	4	10,234	99,353	10%	1.0%
2003	6,000	5,700	11,000	--	22,704	254,378	26%	2.4%
2004	4,500	9,600	9,600	950	25,276	205,085	18%	2.2%
2005	3,400	3,900	14,000	--	22,045	218,679	15%	1.6%
2006	6,600	7,300	10,300	2,000	28,271	221,058	23%	3.0%
2007	2,200	2,700	5,700	48	10,675	86,437	21%	2.5%
2008	4,023	3,500	2,607	1,560	12,127	131,889	33%	3.1%
2009	2,276	1,300	4,000	23	7,674	58,468	30%	3.9%
2010	3,000	2,300	4,000	1,000	10,332	143,204	29%	2.1%
2011	4,500	3,000	18,100	--	25,600	222,525	18%	2.0%
2012	2,500	500	3,200	2,500	9,316	144,812	27%	1.7%
2013	790	4,600	4,500	0	11,497	211,275	7%	0.4%
2014	4,300	3,400	7,000	--	15,981	234,731	27%	1.8%
2015	5,800	8,000	12,000	1,800	29,870	292,888	19%	2.0%
2016	4,000	3,500	12,000	1,000	28,101	298,464	14%	1.3%
2017	5,400	9,000	12,000	100	29,918	192,624	18%	2.8%
2018	1,373	1,120	1,802	--	5,043	27,721	27%	5.0%
2019	400	1,997	3,402	0	6,057	29,436	7%	1.4%
2020	50	550	50	0	711	1,899	7%	2.6%
2021	1,100	2,100	410	700	5,418	247,237	20%	0.4%
Average Count Since 1997	6,048	11,923	12,640	771	31,912	239,568	19%	2.1%
Ten Year Average	2,571	3,477	5,636	763	14,191	168,109	17%	2%

4.6 Potentially Hazardous Trees

Seven potentially hazardous trees were identified during the 2022 arborist survey. Three of these trees (tree numbers 3058, 3063, and 3076) are located within the sanitation facility grove. The remaining four potentially hazardous trees (tree numbers 1045, 1258, 1285, and 1342) are located south of the sanitation facility grove in Roost Areas A and B adjacent to the bike path and hiking trail, respectively. The locations of all potentially hazardous trees are shown in Figure 2 and specific notes regarding each potentially hazardous tree and their removal or hazard pruning recommendation is provided in Section 5.2.5.

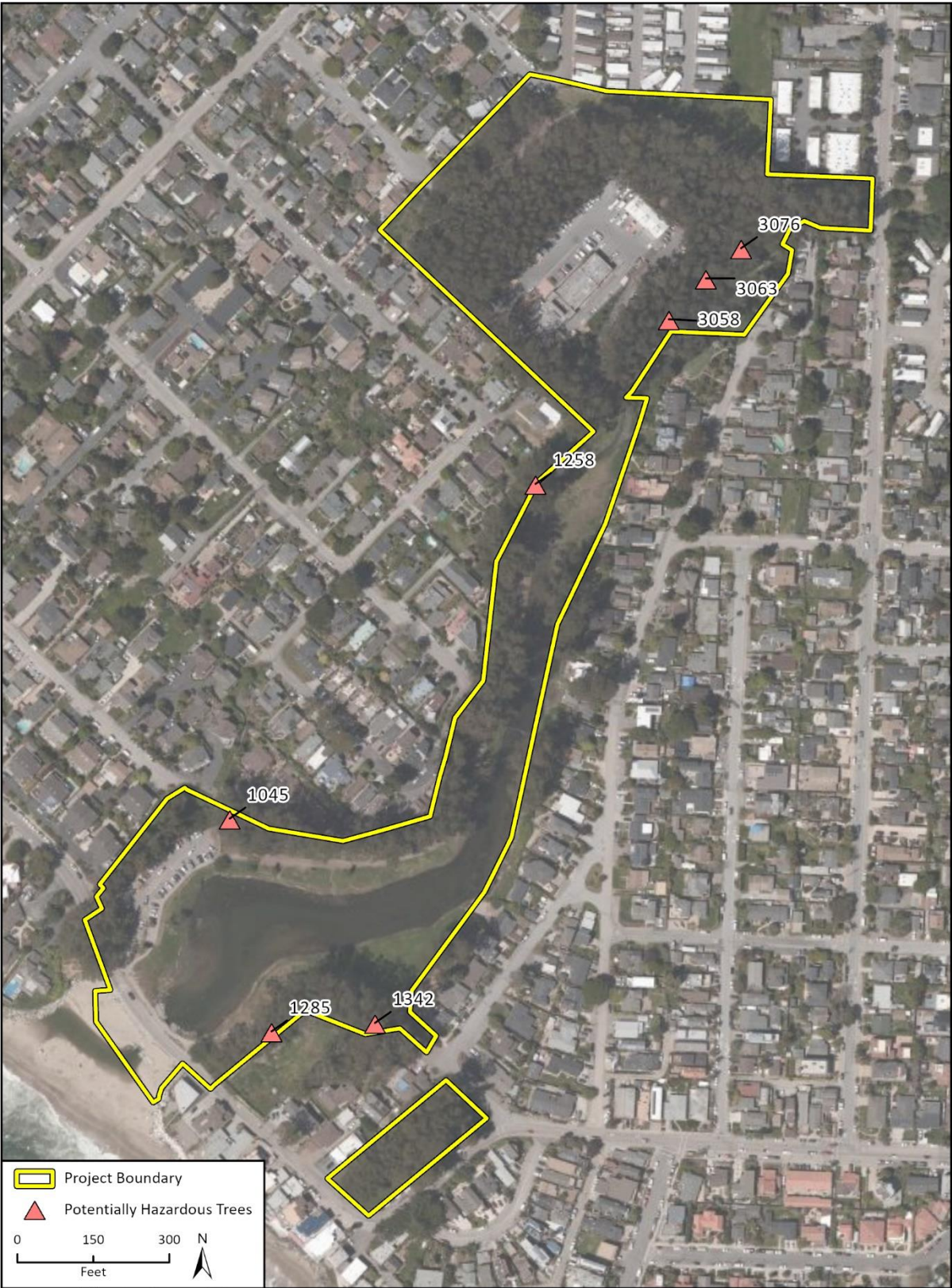
4.7 Fire Risk Assessment

If a fire were to originate or spread into the Park, the likelihood of that fire being a severe crown fire is very high. Blue gums are prone to fire and are known to produce combustible resins which are excreted through their leaves. Additionally, the eucalyptus canopies within the Park form a dense continuous layer and contain an ample amount of fuel loading and dead wood. A severe crown fire would most likely be spread through a house fire adjacent to any of the Parks eucalyptus groves. If a house fire did occur and spread into the groves canopy, the entire grove (and monarch overwintering habitat) would likely be destroyed due to the canopy's dense nature, flammable resins, and exposure to coastal wind patterns, which would spread the fire through the canopy rapidly.

However, the area surrounding the Park is developed and contains very little fuel and the understory of the grove, and the Park, is generally sparse and contains poison oak (*Toxicodendron diversilobum*), cape ivy (*Delairea odorata*), and English ivy (*Hedera helix*), when present. These are evergreen species and are generally nonflammable. Therefore, ladder fuels, which are required to spread a ground fire into a crown fire, are largely absent. Due to the lack of ladder fuels within the Park, and the Parks urban/developed surroundings, the risk of a severe crown fire spreading into or originating within the Park is relatively low.

It should be noted that to create good wind shelter, select edges of the sanitation facility groves understory should be sealed with mid-story trees and shrubs. This prescription potentially creates ladder fuels. However, the vertical continuity of fuels could be partially ameliorated by spatial separation of the shrub layer from the mid-story tree layer, via offset plantings. Exact configurations of these wind shelterbelts will require detailed field examination and will need to consider light availability and potential crowding. If a vertical continuity of fuels (i.e., ladder fuels) is created through the addition of mid-story trees and shrubs, the risk of a ground fire spreading into a high intensity canopy fire becomes moderate to high.

Figure 2 Potentially Hazardous Trees Map



4.8 Fall and Winter Nectar Plants

Native monarch nectar plants are absent in the Park. The sole source of nectar for fall returning and overwintering monarchs is from introduced plants. The most common introduced nectar plants in the Park, along with their bloom periods, are listed in order of abundance in Table 2 below. The English ivy and cape ivy are found growing throughout the understory of the eucalyptus groves and the ice plant (*Carpobrotus edulis*) and pride-of-madeira (*Echium candicans*) are found growing adjacent to the parking lot and the Park's hiking trail. The vegetation communities where these nectar plants occur are shown in Figure 3.

Table 2 Fall and Winter Monarch Nectar Plants found in the Park

Species	Bloom Period
English ivy (<i>Hedera helix</i>)	August through November
Cape ivy (<i>Delairea odorata</i>)	November through March
Ice plant (<i>Carpobrotus edulis</i>)	Typically year round
Pride-of-Madeira (<i>Echium candicans</i>)	February through October
Blue gum eucalyptus (<i>Eucalyptus globulus</i>)	January through March

Figure 3 Recommended Nectar Planting Map



5 Recommendations

The 2010 Monarch Butterfly Habitat Management Plan's focus of management is the preservation of trees that create and protect roosting areas. The plan recommended that the grooves should be designed to maintain their spatial configuration and size. The plan called for equally important considerations, including the preservation and/or enhancement of appropriate nectar and water sources and understory vegetation within the Park.

The Park's current management priority should focus on planting location specific tree species that provide additional wind shelter to the sanitation facility groves cluster sites. Monarch butterfly nectar plantings should be considered during the creation of the restoration plan to encourage a boost in overwintering population numbers. Forest thinning could be considered, especially if the groves health decreases, to promote an increase in the health condition and vigor in the grove.

Detailed recommendations regarding the delineation of management zones, vegetation management, and management action thresholds are provided below.

5.1 Delineation of Management Zones

The trees extending south along Moran Creek and Moran Lagoon, south of the sanitation facility grove (Roost Areas A, B, and C), appear to have minimal effect on the microclimate conditions of the sanitation facility grove. Therefore, management efforts should concentrate on the immediate surroundings of the sanitation facility grove and within the sanitation facility grove itself (Roost Areas D, E, F, G, and H).

5.2 Vegetation Management

5.2.1 Tree and Shrub Plantings for Wind Shelter

Recommendations for tree and shrub plantings for wind shelter were made based off the microclimate data obtained during the 2021/2022 site assessment surveys. Species specific recommendations were made based on suitability to the microclimate conditions found within that segment of the Park. Native plants are recommended for planting due to the additional ecological value they provide as well as being adapted to their local environment (e.g., drought, coastal influence, soil).

A series of plantings should be installed surrounding the sanitation facility grove to seal up the outer edges to wind exposure. The priority planting areas include the open northeastern and northwestern edges of the grove, within the grove's southeastern gap, and along the southeastern boundary of the grove, southeast of Moran Creek. Figure 4 depicts the wind shelter planting locations by the management recommendation number listed below.

The following wind shelter plantings are recommended:

1. California bay (*Umbellularia californica*), coast live oak (*Quercus agrifolia*), and/or Monterey cypress (*Hesperocyparis macrocarpa*) should be planted along the northeastern edge of the sanitation facility grove.

2. Coast live oaks and California bays should be planted along the northwestern boundary of the grove.
3. The existing blue gum saplings within the open rows of the grove should be encouraged to fill in the canopy. Additional blue gums should be planted in areas where saplings are not present and where there is an opening in the groves canopy.
4. A small stand of Monterey cypress trees should be planted along the southwestern corner of the northeastern boundary of the grove, opposite of the trail opening, to seal against northerly winds.
5. Evergreen trees, such as coast redwood (*Sequoia sempervirens*) or California bay, should be planted to fill in the existing row of trees along the southeastern boundary of the grove on the southeastern side of Moran Creek, if approved by the private land owners.
6. Blue gums should be planted at the top of the slope to fill in the grove's southeastern gap.

5.2.2 Nectar Planting and Management

Nectar planting and nectar plant management recommendations were made through a combination of literature review and background research and were location specific to the habitat documented during the 2022 Biological Resources Assessment field survey (Attachment C). The resources analyzed during the literature review and background research included the Xerces Society's recommended list for monarch nectar plants in California (Xerces 2019), Calflora's Information on Wild California Plants (Calflora 2022), and The Jepson Manual (Baldwin et al. 2012). These resources were analyzed to determine habitat specific monarch nectar plants that are known to occur within the vegetation communities in the Park and within the Park's vicinity. Only fall and winter nectar plants were recommended. Fall nectar plants were recommended to attract monarchs back to the site and to build up fat reserves for the winter and winter nectar plants were recommended to retain monarchs throughout the overwintering season and to provide them with the necessary sugars to build fat reserves prior to spring migration. Spring and summer nectar sources and milkweeds (*Asclepias* spp.) should not be planted in the Park. These plants disrupt the monarchs natural spring migration pattern. Disrupting the monarchs natural migration pattern can lead to further conditions which may contribute to population decline. Although introduced plants also provide nectar for monarchs, native plants are recommended for planting due to the additional ecological value they provide as well as being adapted to their local environment (e.g., drought, coastal influence, soil).

Monarchs are less likely to use nectar plants in deep shade. Therefore, nectar plants of various species should be planted primarily in sunny areas, or in areas with dappled light outside of the blue gum groves. Since monarchs will fly hundreds of meters to nectar sources, there are a variety of suitable planting locations within the Park. The most suitable nectar plant locations include the annual grasslands, ruderal land cover, and ice plant mat (if restored) areas. Figure 3 depicts the recommended planting locations, which are found south of the grove along the hiking trail and adjacent to Moran Creek, surrounding the parking lot, to the northwest and northeast of the grove, and south of Moran Lagoon. The banks of Moran Lagoon are also a suitable location for marsh nectar species. The banks of Moran Creek contain suitable habitat for riparian nectar species; however, this location is less likely to be used for nectaring due to the presence of a deep shade provided by the surrounding blue gums. A concentrated pollinator garden could be considered near the parking lot or in an open area adjacent to the hiking trail south of the sanitation facility grove.

Table 3 provides a list of recommended nectar plants, their bloom periods, and species-specific notes and is organized by the plant form (i.e., herbaceous plant, shrub, or tree) and the recommended habitat type for planting.

Table 3 Recommended Fall and Winter Nectar Plants for Overwintering Monarchs

Upland Areas (i.e., grasslands, ice plant mats, ruderal land cover)		
Shrubs		
Species	Bloom period	Notes
Brittle leaf manzanita (<i>Arctostaphylos crustacea</i>)	February through April	Likely entire genus is attractive to monarchs.
California goldenbrush (<i>Ericameria ericoides</i>)	September through November	Great late season nectar source.
Coyote bush (<i>Baccharis pilularis</i>)	September through January	Easy to grow, does well in previously disturbed areas. Entire genus is likely attractive to monarchs.
Hoary manzanita (<i>Arctostaphylos canescens</i>)	January through May	Likely entire genus is attractive to monarchs.
Santa Cruz manzanita (<i>Arctostaphylos andersonii</i>)	January through March	Endemic to Santa Cruz and surrounding counties. Likely entire genus is attractive to monarchs.
Perennial Herbaceous Plants		
Species	Bloom period	Notes
California goldenrod (<i>Solidago velutina</i>)	August through October	Likely the entire genus is attractive to monarchs. Great late season nectar source.
Roughleaf aster (<i>Eurybia radulina</i>)	January through October	-
Seaside daisy (<i>Erigeron glaucus</i>)	January through August	-
Moran Creek Banks		
Trees		
Species	Bloom period	Notes
Arroyo willow (<i>Salix lasiolepis</i>)	January through July	Deciduous – would not provide complete wind protection during the winter.
Red willow (<i>Salix laevigata</i>)	December through June	
Shrubs		
Species	Bloom period	Notes
Douglas’ baccharis (<i>Baccharis glutinosa</i>)	July through October	Likely entire genus is attractive to monarchs. Important nectar source for many insects.
Mulefat (<i>Baccharis salicifolia</i>)	All year	
Perennial Herbaceous Plants		
Species	Bloom period	Notes
Coastal gumweed (<i>Grindelia stricta</i>)	May through October	-
Western goldenrod (<i>Euthamia occidentalis</i>)	July through November	Likely entire genus is attractive to monarchs.

Moran Lagoon Banks		
Shrubs		
Species	Bloom period	Notes
Douglas' baccharis (<i>Baccharis glutinosa</i>)	July through October	Likely entire genus is attractive to monarchs. Important nectar source for many insects.
Perennial Herbaceous Plants		
Species	Bloom period	Notes
Coastal gumweed (<i>Grindelia stricta</i>)	May through October	-
Western goldenrod (<i>Euthamia occidentalis</i>)	July through November	Likely entire genus is attractive to monarchs.

5.2.3 Existing Nectar Plant Management

The Park's existing cape ivy, English ivy, ice plant, and pride-of-madeira should not be removed during restoration activities unless they occur directly within a designated restoration area or are actively impacting the health of a necessary wind shelter or roost tree within the sanitation facility grove. These species provide an abundant supply of nectar for fall returning and overwintering monarchs, which is currently not supplied in the Park, or the Park's vicinity, by native plants.

5.2.4 Forest Thinning and Fire Risk Abatement

Forest thinning recommendations were made based on the data gathered during the 2022 arborist survey. Grove health, density, and individual tree size were analyzed to determine the health of the grove in relation to the number of trees present.

Selective thinning would benefit the groves overall health. Selective thinning would reduce competition between trees, allowing the health of the remaining trees to increase noticeably. Trees selected for removal should include trees that are of lesser health (i.e., poor health trees mapped during the 2022 arborist survey [Attachment B]), trees that are generally within the understory of the grove and should include trees that are evenly spaced out to prevent large canopy openings. Selective thinning would reduce competition and free up valuable resources, allowing the remaining groves health to increase. The remaining blue gums canopy would expand and fill in the gaps of the removed trees over time. Selective thinning would also decrease the groves susceptibility to a high-intensity crown fire by decreasing the overall fuel load and dead wood within the canopy. Care should be taken to not overthin the grove. If selective thinning is pursued, a registered professional forester should be contracted to identify which trees should be removed and coordination should be undergone with the Project's entomologist to ensure removal would not alter the microclimate of the grove in such a way to negatively affect overwintering monarchs.

In addition to forest thinning, blue gum limbs and trees that have naturally fallen throughout the Park should be actively removed to decrease fuel loading and eliminate ladder fuel within the understory of the Park's groves. Lastly, if the sanitation facility groves understory is sealed with mid-story trees and shrubs, they should be spatially separated from each other and the blue gum canopy by offsetting the plantings to avoid the creation of ladder fuels to the maximum extent feasible.

5.2.5 Tree Removals and Hazard Pruning

Removal and hazard pruning recommendations were based on the tree's health condition, structural integrity, and its hazard potential. In general, if the tree is dead or declining or possess a

hazardous condition but is located within a natural area with low to no human traffic, the tree was not recommended for removal or hazard pruning. However, removal or pruning is recommended for hazard trees that are located within a high-traffic area, in areas with sensitive infrastructure, and for dead trees within the sanitation facility grove. Dead trees within the sanitation facility grove are located within a natural area with low to no human traffic; however, the dead trees and leafless branches do not contribute to monarch habitat and are a liability to nearby trees when they fall, which could decrease monarch roosting habitat and open up the grove to wind penetration.

Care should be taken in assessing the urgency of all current and future hazardous trees within the sanitation facility grove. The potential for opening the cluster sites to wind if any of the trees or their branches are removed shall be assessed prior to removal. The smallest amount of the tree should be removed as feasible to reduce the hazard. Topping of trees is not recommended due to the weakly attached nature of epicormic shoots. Additionally, epicormic shoots generally do not grow as tall as other mature eucalyptus trees and may not provide adequate wind protection for overwintering monarchs. These trees, and all other hazardous trees, should be removed or pruned in a timely manner. All tree work should occur outside of monarch overwintering season (October-March), unless a true emergency arises. The Project's entomologist should be consulted prior to any tree maintenance activities within the grove.

Removal of trees or branches of potentially hazardous trees outside of the sanitation facility grove should be routine if hazards are identified. Removal of these hazardous trees or their parts would likely not alter the microclimate conditions in such a way to negatively impact overwintering monarchs in the grove. Table 4 provides the potential hazard and the recommended action for each hazard tree identified during the 2022 arborist survey. The locations of the potential hazard trees are depicted in Figure 4. All dead trees located within the sanitation facility grove are depicted in Appendix A and Appendix B of the Moran Lake Restoration Project Arborist Report (Attachment B).

Table 4 Recommended Actions for Hazard Trees in the Park

Tree Number	Species	Potential Hazard	Recommendation
1045	Blue gum	Long heavy branches leaning over pathway.	Trees are outside of the sanitation facility grove. Tree maintenance will not impact the microclimate conditions within the overwintering cluster sites. Hazardous branches should be pruned back so they no longer overhang the pathway or hiking trail.
1258	Blue gum	Broken limb hanging over trail	
1285	Blue gum	Heavy codominant stem leaning over pathway.	
1342	Blue gum	Dead branches over hiking trail.	
3058	Blue gum	Dead tree that is significantly leaning over hiking trail.	Tree is within the sanitation facility grove, but it is dead with no canopy. Tree should be removed to eliminate the hazard.
3063	Blue gum	Fair health tree with a large heavy branch with included bark at its attachment overhanging the hiking trail.	Tree is within the sanitation facility grove but the large overhanging branch presents a potential hazard to hikers. The branch should be removed at its conjunction with the tree's trunk.
3076	Blue gum	Tree is significantly leaning over the hiking trail (60 degrees)	The tree is within the sanitation facility grove but presents a hazard to hikers. The tree is generally a smaller understory tree in fair condition, removal will likely not significantly impact the microclimate conditions within the grove. Tree should be removed.

Figure 4 Recommended Wind Shelter Plantings Map



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21-11388 Moran Lake Restoration Plan
Fig 2 Wind Shelter Management Map

5.3 Management Action Thresholds

If the health of blue gums within the grove decreases and mass foliage losses occur at the cluster sites, additional management actions within the grove should be assessed. Selective thinning should be considered to free up necessary resources, soil amendments should be considered to encourage new growth, and a drip irrigation system could be installed to provide additional water, which is likely the greatest limiting resource. The Park's arborist and entomologist should be consulted prior to initiating management actions.

If monarchs are not observed within the Park or within any other known overwintering grove throughout the central coast (i.e., Santa Barbara through Santa Cruz) for more than 5 consecutive years, they should be considered extirpated from the region. Management resources should be reallocated to other Park interests.

6 References

- Baldwin, B.G., Goldman, D.H., Keil, D.J., Patterson, R., Rosatti, T.J., and D.H. Wilken (Eds.). 2012. The Jepson Manual: Vascular Plants of California, Second Edition. University of California Press. Berkeley, California.
- Calflora. 2022. Information on wild California Plants. Available at www.calflora.org. Accessed August 2022.
- Joni L. Janecki & Associates, Inc. 2010. Moran Lake Monarch Butterfly Habitat Management Plan
- Rincon. 2022. Moran Lake County Park Improvement Project Biological Resources Assessment. Rincon Consultants, Inc. June 2022.
- Xerces Society. 2016. Monarch Nectar Plants: Coastal California. Available at https://www.nwf.org/~media/PDFs/Garden-for-Wildlife/Xerces-NWF/03-CA_Coast_Monarch_Plant_List_spread.ashx. Accessed August 2022.
- _____. 2019. Monarch Nectar Plants: California. Available at <https://xerces.org/publications/plant-lists/monarch-nectar-plants-california>. Accessed August 2022.
- _____. 2022. Western Monarch Thanksgiving Count Data, 1997-2021. Available at www.westernmonarchcount.org. Accessed August 2022.

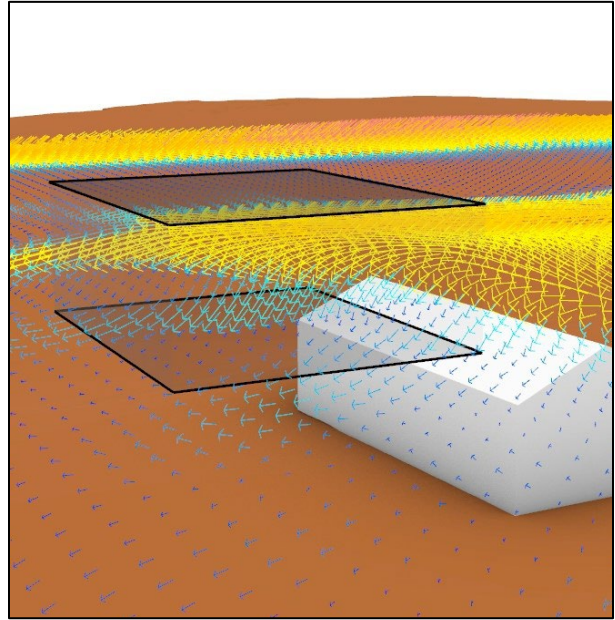
Appendix A

Assessment of Moran Lake Monarch Overwintering Habitat

Moran Lake Monarch Butterfly Habitat and Tree Management Assessment June 2025



Monarchs at Moran Lake



Wind Model Output

Stuart B. Weiss
Creekside Science

Corbin Matley
Althouse and Meade, Inc.



June 2025

Prepared for Robert Tidmore
Santa Cruz County Parks

Table of Contents

Executive Summary.....	5
Objectives	6
Table 1. Scenarios considered:	6
Map 1. Groves Overview	7
Methods.....	8
Choice of Wind Speeds	9
Table 2. Wind Speed Hours Per Year (October-February).....	9
Windrose.....	10
Data Visualizations	10
Scenarios	11
Scenario 1: Placer Street Windbreak Baseline and Critical Height	11
Photo 1. Panorama.....	12
Photo 2. Hemiphotos	12
Figure 1. Oblique View of Placer Street Windbreak	13
Figure 2. Oblique View of Placer Street Windbreak, Canopy Voxels Hidden	13
Figure 3. Vertical slice profile	14
Figure 4. Bird’s-eye View of Yard.....	14
Figure 5A. Vertical Slice for Current Conditions	15
Figure 5B. Vertical Slice for Complete Removal.	15
Figure 5C. Vertical Slice for 80 ft Placer Height	15
Figure 6. Comparison of current conditions (A) versus complete removal of Placer (B)	17
Figure 7. Comparison of Current Versus 80 ft Placer.....	18
Wind Speed Percentiles with Placer Height.....	19
Figure 8. Percentiles of Wind Speed Within the Cluster Zone	19
Scenario 2: Placer Street Windbreak at 1x Height to Target	20
Figure 9A Vertical Wind Profile with 1x Height to Target Scenario	20
Figure 9B Vertical Wind Profile Current Conditions	20
Figure 10. 1x Height to Target Scenario Statistics.....	21

Scenario 3 & 4: Complete Removal of Southern Groves	22
Figure 11. Histograms of Absolute Wind Speed in Cluster Zone for 200° 10m/s Wind.....	22
Scenario 5: 70-foot Canopy Height at Southern Groves	23
Fall roosting sites	23
Figure 12. Vertical Wind Profile with Scenario 5 Height Reduced to 70 Feet	23
Figure 13. Overhead View of Scenario 5, Sampled 30 Feet Above Ground.....	24
Figure 14. Scenario 5 Windspeed Distribution Graphs	25
Scenario 6: North Edge 1x Height to Target.....	27
Figure 15A. North-Edge Current Conditions	28
Figure 15B. North-Edge 1x Height to Target	28
Figure 16. 1x Height to Target on North Edge Histograms.....	29
Scenario 7: South Creekside at Critical Height	30
Figure 17 Histograms of Wind Speed for Creekside Height Reduction	30
Appendix A. Scenario 8: Sectional Removal of Placer Street Windbreak.....	31
Figure 18. Scenario 8 Removal Areas	31
Figure 19. Scenario 8 Vertical Slice Side Profile	32
Figure 20. Scenario 8 Histograms	33
References.....	34



Moran Lake monarchs clustering Creekside area November 2022

Executive Summary

To assess the effects of tree hazard management at the Moran Lake monarch overwintering site, we did intensive modeling of 10 m/s (22 mph) wind within the forest canopy under current conditions and under various management scenarios. We concentrated on the cluster zone in the grove NE of the sanitation yard.

Conclusions include:

- 1) Monarchs have opportunities to make small changes in distribution to track wind and sunlight within the cluster zone. The cluster zone grove itself provides significant, but not complete, wind shelter from SW winds.
- 2) The Placer Street trees provide a critical windbreak from SW winds but could be reduced to 80 ft and still provide suitable wind shelter from SW winds for the cluster zone NE of the sanitation facility yard.
- 3) An idealized scenario that reduces tree heights to 1x the distance to targets also provides suitable SW wind shelter for the cluster zone. The practicality of this configuration is deemed feasible in terms of tree health and structure.
- 4) The cluster zone is currently well-sheltered from SSW winds. Removal of the SE and S Lakeside groves has a minimal effect on SSW wind speeds in the cluster zone, which are below 2 m/s (5.2 mph). Removal of the N Lakeside grove in addition does increase SSW wind exposure so that 27% of the cluster zone experienced S-winds greater than 2 m/s.
- 5) Reducing the heights of these Lakeside groves to 70 ft provides better shelter than complete removal.
- 6) Reducing tree heights along the north-edge to equal the distance to the nearest target has minimal effect on north-wind exposure in the cluster zone. A previous recommendation for planting cypress trees in the “Boneyard” to block wind penetrating through an existing road/trail opening would secure this north-edge.
- 7) Several trees in the Creekside area are regularly occupied by monarchs, so no major modifications (beyond trimming immediate hazard branches) in this area are acceptable for monarchs.
- 8) The proposed tree removal and height reduction is compatible with tree health and possible with long-term commitments to grove management.

Objectives

Overwintering monarch butterflies are highly sensitive to wind, which along with sun exposure, is a fundamental driver of site occupancy and movements. Creating and maintaining suitable wind shelter is a critical aspect of overwintering site management. We seek to accomplish this while addressing public safety concerns from hazard trees. A detailed assessment of Moran Lake habitat conditions is presented by Weiss (2022).

The primary objective of this study is to model baseline wind conditions within the Moran Lake Monarch Overwintering Site (Xerces Society Site Identification 2983), and assess the effects of potential canopy modifications (to reduce treefall hazards to property) on the distribution of wind within the monarch cluster zone. We considered 7 scenarios designed to test various management treatments to different groups of trees across the site (Table 1, Map 1).

Table 1. Scenarios considered:

Scenario Number	Description
1	Placer Street Windbreak Critical Height and Baseline
2	Placer Street Windbreak 1x Height to Target
3&4	Complete Removal of Southern Groves
5	70-foot Canopy Height at Southern Groves
6	North Edge 1x Height to Target
7	South Creekside at Critical Height

Scenario 1 includes simulations of 10 ft incremental height reduction of the Placer Street trees to identify the critical height from 140 ft down to 30 ft. A complete removal was simulated as an “end member” (absolute/farthest possible end of a range) to evaluate the isolated sheltering effect of the forest edge in the cluster zone. See *Wind Speed Percentiles with Placer Height* section for why 80 ft was selected as the critical height.

Scenario 2 postulates a windbreak design that removes all canopy within 1x the distance to the nearest target along Placer Street with a “stepped back” design.

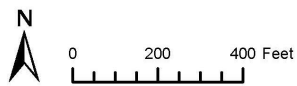
Scenarios 3 and 4 postulate complete removal of stands of trees around Moran Lake, south of Placer Street Windbreak and main monarch habitat around the sanitation yard. This includes North Lakeside, South Lakeside, and Southeast Groves.

Scenario 5 postulates reducing those southern groves to 70 ft.

Scenario 6 postulates height reduction to 1x distance to targets along the North Edge.

Scenario 7 considers reduction of tree heights in the Creekside Zone, SE of the yard.

Map 1. Groves Overview



Imagery Source: Google Imagery, 09/11/2022. Street Reference Source: ESRI



**Moran Lake Monarch Butterfly
Habitat and Tree Assessment**
Map Center: 36.95846°N 121.97596°W
Santa Cruz, California

Map Updated:
October 02, 2024 07:55 PM by CDM

Methods

The basic workflow to simulate wind conditions was as follows:

First we acquired LiDAR data from NOAA's Data Access Viewer ([OCM Partners, 2025](#)). The LiDAR dataset had an estimated point spacing of 0.19 meters. The LiDAR data was part of a collection effort that spanned the timeframe of 2020-03-22 to 2020-04-15.

The LiDAR point cloud came in the .las file format. Our first step in processing the point cloud was to load it in CloudCompare, where we separated the point cloud into classifications of ground, and unclassified points. We then exported the point clouds to the .e57 file format.

Next, we loaded the .e57 point cloud of ground classified points in Rhino 7 using Grasshopper and Volvox, plugins for Rhino 7. In Rhino 7 we used a Delaunay triangulation method to connect the ground points into a mesh surface representing ground terrain. In order to resolve imperfections in this resulting geometry we had to perform three iterations of quad-remeshing to smooth the geometry and produce a valid "good" mesh representing the ground. Some of the imperfections eliminated by this process include self-intersecting faces, mesh surfaces with aspect ratios greater than 1:5, and angles less than 60°.

We created building geometries by manually extruding box geometries to the maximum height and extent of each building nearest to the Placer Street windbreak, and north edge groves. Buildings within the sanitation yard were modeled with greater precision than those buildings surrounding the groves. This includes matching roof slope for the building closest to the main monarch cluster location.

Canopy/tree geometries were created using a voxel technique in which a 1 cubic meter voxel would be generated within a standard grid across the site if there were unclassified points located within that volume.

The software used to simulate wind conditions given these input geometries was Eddy3D. Eddy3D uses the OpenFOAM computational fluid dynamics toolbox to simulate wind conditions.

For each scenario we set the wind direction to be in-line with the canopy volume of interest and the main cluster zone. We used a standard wind speed of 10 m/s (22 mph), which represents a moderately strong wind that is likely to occur in any given year. Incoming wind directions were as follows for the scenarios:

Scenario 1: 225° SW

Scenario 2: 225° SW

Scenario 3&4: 200° SSW

Scenario 5: 200° SSW

Scenario 6: 0° N

Scenario 7: 180° S

Voxels were inputted to the Eddy3D model domain as Eddy3D tree objects with a 'Type' set to 'dense'.

Choice of Wind Speeds

We chose a standard wind speed of 10 m/s (22.5 mph) for modeling because that sustained wind threshold is encountered almost every year for at least an hour, especially for SW winds. The wind rose for Watsonville is the only detailed one available for the region and represents wind along the northern Monterey Bay coastline (Windrose).

The 10 m/s sustained hourly wind occurs on average 3.5 hours/year from all directions, from SW 1.6 and from S 1.5 hours per year (Table 2).

The choice of the 2 m/s threshold for monarch occupancy is based on Kingston Leong's published work (Leong 1990, 1991) and personal communications. Leong found that the occupancy of a monarch microsite was highly unlikely if the ground-level wind speed was greater than 2 m/s (5.2 mph). Because wind speeds generally increase with height in forest canopies, the wind speed at the monarch cluster sites (often 5-15 m height) will be greater. Therefore the 2 m/s threshold is conservative when considering the height of the clusters.

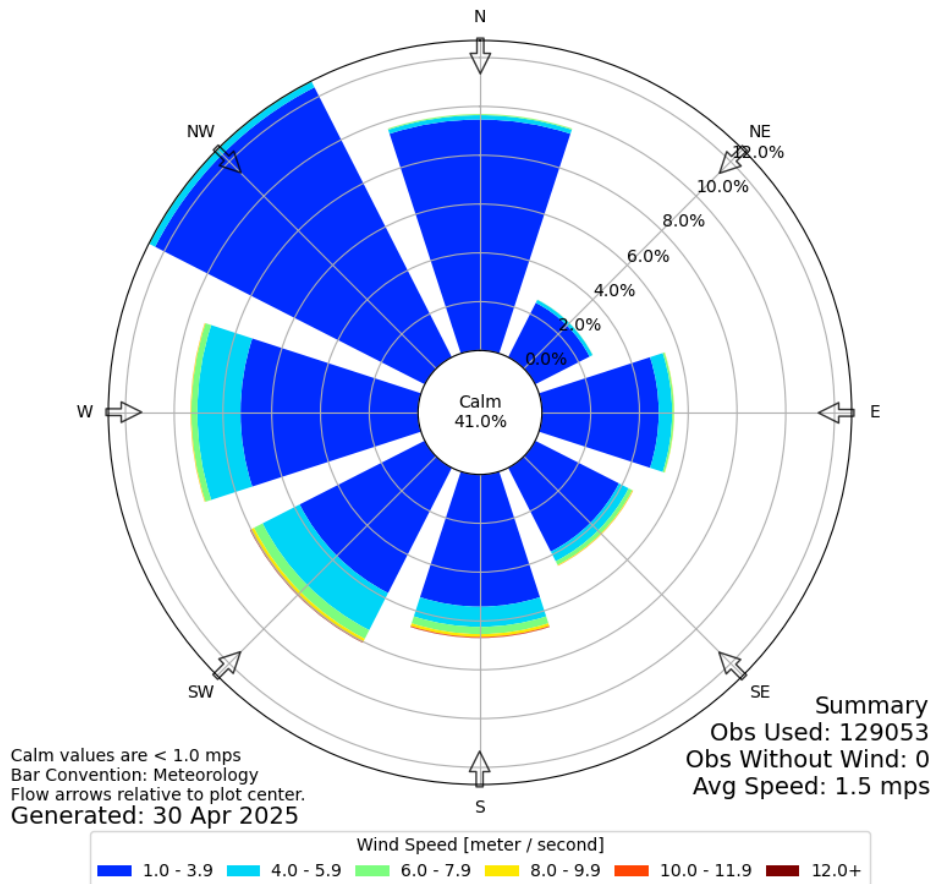
Table 2. Wind Speed Hours Per Year (October-February)

Direction	Hours per year >10m/s
N	0.0
NE	0.0
E	0.0
SE	0.2
S	1.5
SW	1.6
W	0.2
NW	0.0
Total	3.5

Windrose



Windrose Plot for [WVI] Watsonville
Obs Between: 01 Oct 1999 12:53 AM - 25 Feb 2025 12:53 AM America/Los_Angeles
↳ constraints: Oct 1 - Feb 28



Data Visualizations

We use a variety of data visualizations and statistical characterizations to compare scenarios. These include:

- 1) Oblique views with colorized wind vectors, and a birds-eye view for current conditions.
- 2) A consistent vertical slice taken perpendicular to the Placer Street windbreak (SW to NE) at the thinnest portion of the windbreak. This is the primary visualization of wind vectors for the Placer Street modifications. A similar vertical slice was taken for the N-edge simulation.
- 3) Statistical characterization of wind speeds within the cluster zone, based on 4,825 points within an 80 ft (along the fence line) x 65 ft (depth from the forest edge) x 30 ft

(30 ft to 60 ft height from ground) box that encompassed the cluster sites NE of the yard.

- a. Depth profiles of absolute wind speed, with density quantiles.
- b. Height depth profiles of differences from current conditions (including a scenario with no Placer Street windbreak to characterize the local sheltering effect of the NE forest edge).
- c. Histograms of differences.
- d. Percentiles of wind speeds with different Placer Street heights.
- e. Histograms of absolute wind speed in Scenarios 3-7.

Scenarios

Scenario 1: Placer Street Windbreak Baseline and Critical Height

Scenario 1 first establishes a baseline model of current conditions according to the state of the canopy at the time of LiDAR collection. All scenarios are compared with current conditions. We seek to identify the “critical height,” meaning the minimum height of the trees that would maintain acceptable wind conditions for the main cluster site of monarch butterflies. We identified the critical height by successively reducing the canopy height from current conditions (~145 ft tall). And produced a scenario with complete removal of Placer trees to understand the intrinsic shelter provided by the cluster zone trees themselves.

Wind patterns as the result of different canopy geometry can vary in counter-intuitive ways at fine scales because turbulent wind shadows behind obstacles tumble and create eddies. Eddies and waves downwind of canopy obstructions can direct wind in any direction depending on the specifics of the canopy geometry and wind speed. Especially when combined with planar visualizations, which only shows one dimension of the wind conditions, these patterns can cause wind speeds to increase in specific areas even when additional windbreak geometry is added. The inverse is also true, and some areas may show lower windspeeds when windbreak geometry is reduced. The wavelengths of the eddies also depend on the absolute wind speed modeled.

With these caveats in mind, we are looking for robust results that do not depend on these noisy aspects of wind modeling and provide some margin of safety for monarchs and people/property.

Photo 1. Panorama of Placer Street windbreak looking NE showing large gap in center



The vertical slice chosen for visualization runs through the gap, as a worst-case position with the highest wind speed. However, all statistics are done on the entirety of the cluster zone volume so the effects of this gap and more dense parts of the windbreak are spread over a larger volume.

Photo 2. Hemiphotos from an interior cluster location (949) and the N corner of yard (957), The Placer trees extend 10-15° above the horizon from the cluster site. Note that E and W are reversed from map views because the photos are taken looking upward.

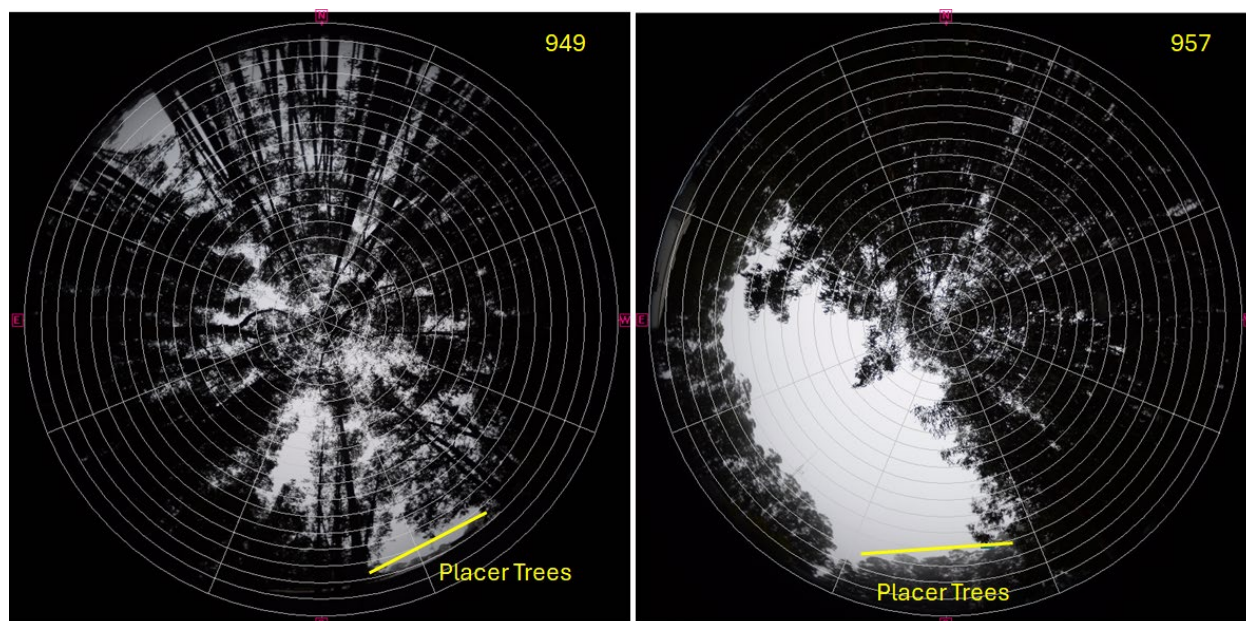


Photo 949 is a cluster site along the opening to the NE (old road access), 50 ft from the forest edge to the SE). The Placer trees occupy 10-15° above the horizon from the cluster site. Photo 957 is at the N corner of the yard; the Placer trees occupy ~20° above the horizon.

Figure 1. Oblique View of Placer Street Windbreak in the model, showing the same gaps as in the photo above. Vectors are wind conditions 30 feet above ground. Canopy voxels shown. The cluster zone is the white box visible at the end of the yard.

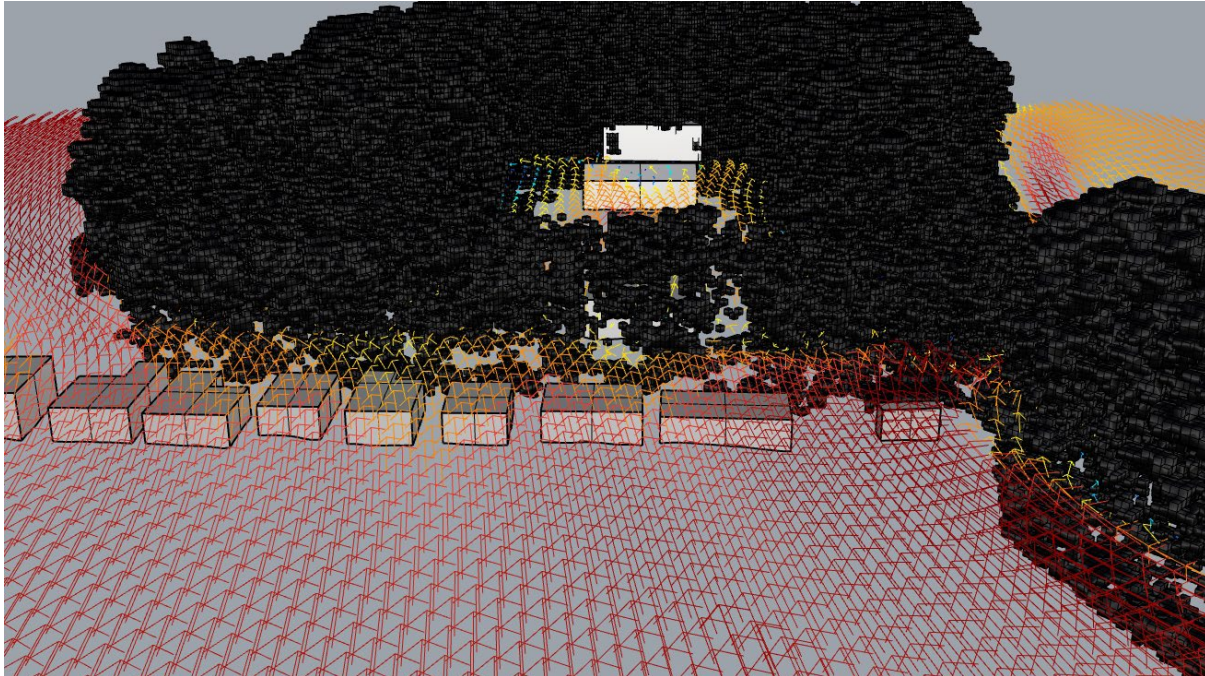


Figure 2. Oblique View of Placer Street Windbreak, Canopy Voxels Hidden. Current wind conditions 30 feet above ground.

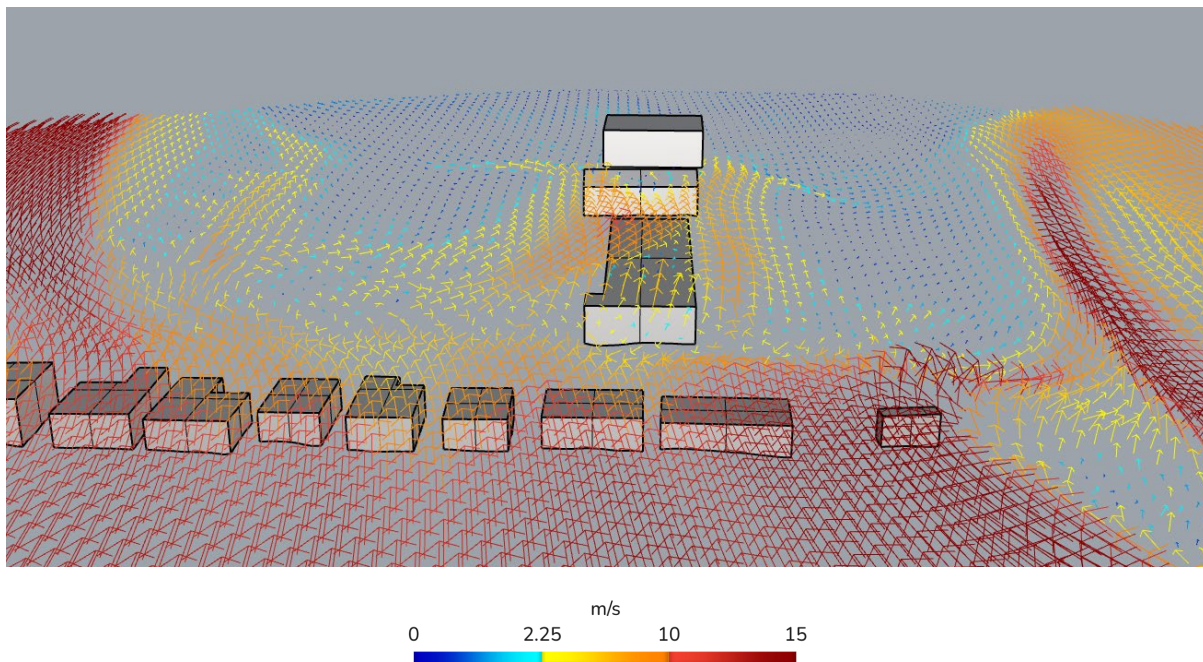


Figure 3. Vertical slice profile of wind through center of yard. Note the vertical variations in direction. From now on the vertical slice profile will be standard graphic.

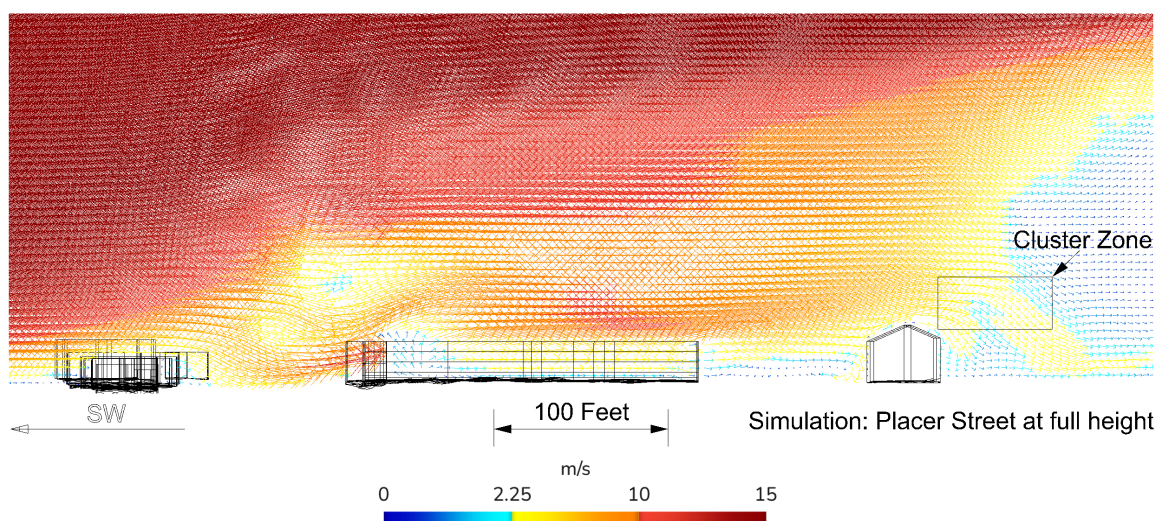
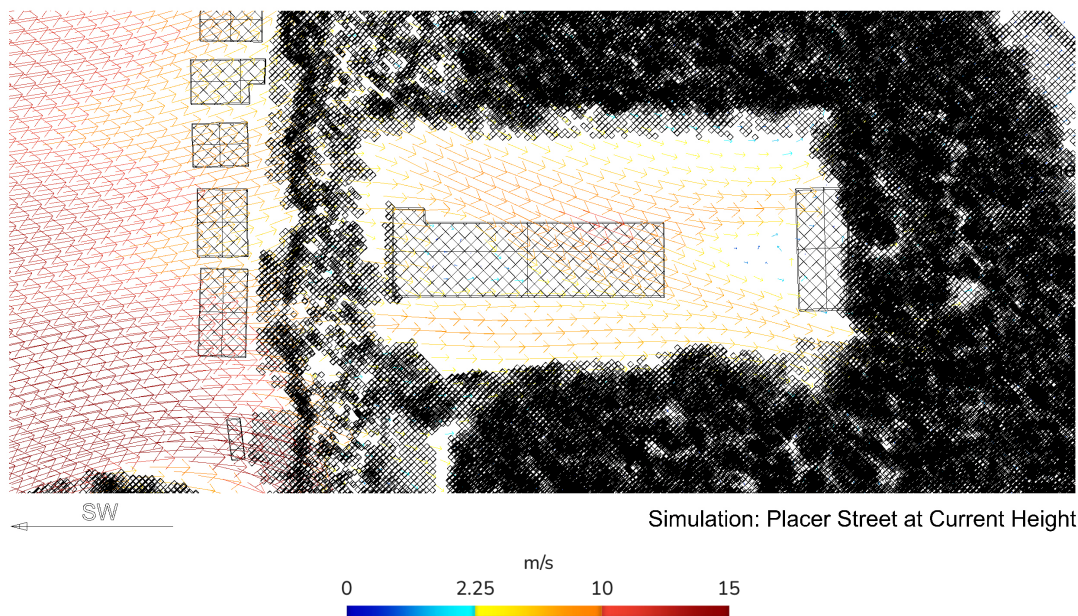


Figure 4. Bird's-eye View of Yard with incoming SW wind, tree voxels shown. Note the changes in wind direction within the yard.



Figures 3 and 4 show the current conditions from two views. Under current conditions, wind penetrates the Placer windbreak most in-line with the main building in the sanitation yard. The highest wind speeds over the yard are dispersed by the far building and canopy edge of the cluster zone (canopy voxels hidden in the representation). The slice of the cluster zone is all yellow and blue (wind speeds 1-3 m/s). The statistics of the entire cluster zone are shown below (Figure 6).

Figure 5A. Vertical Slice for Current Conditions, canopy voxels not shown

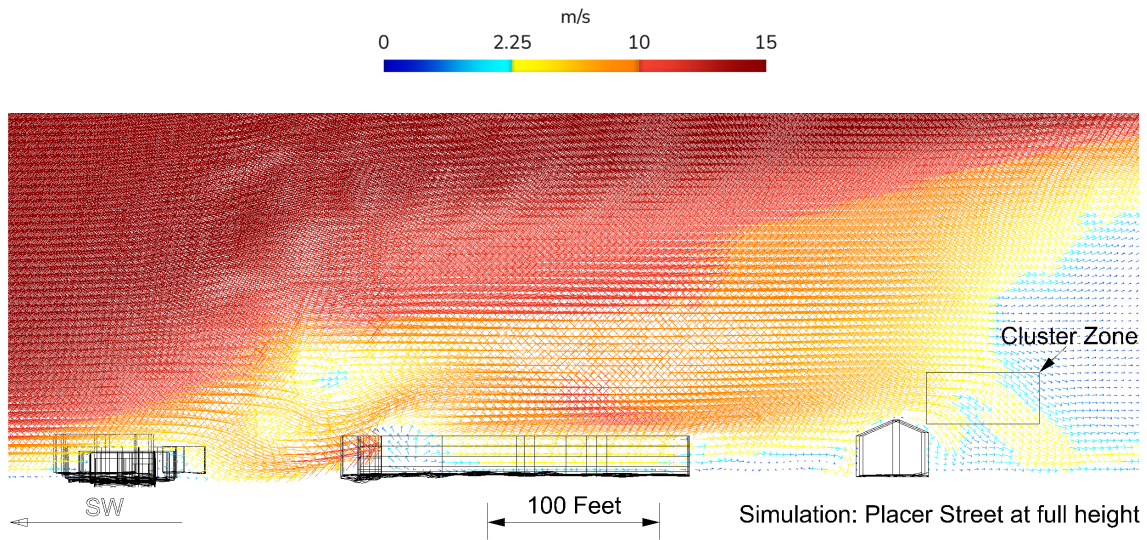


Figure 5B. Vertical Slice for Complete Removal.

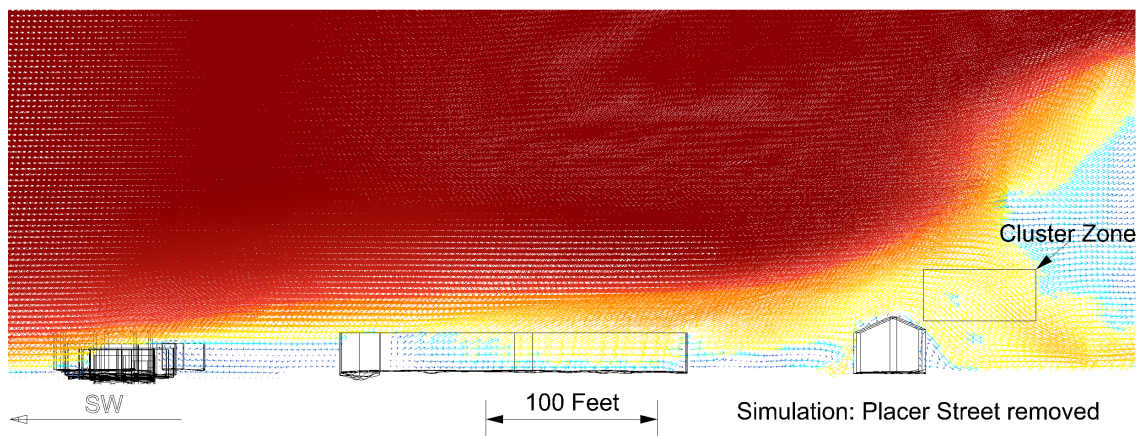
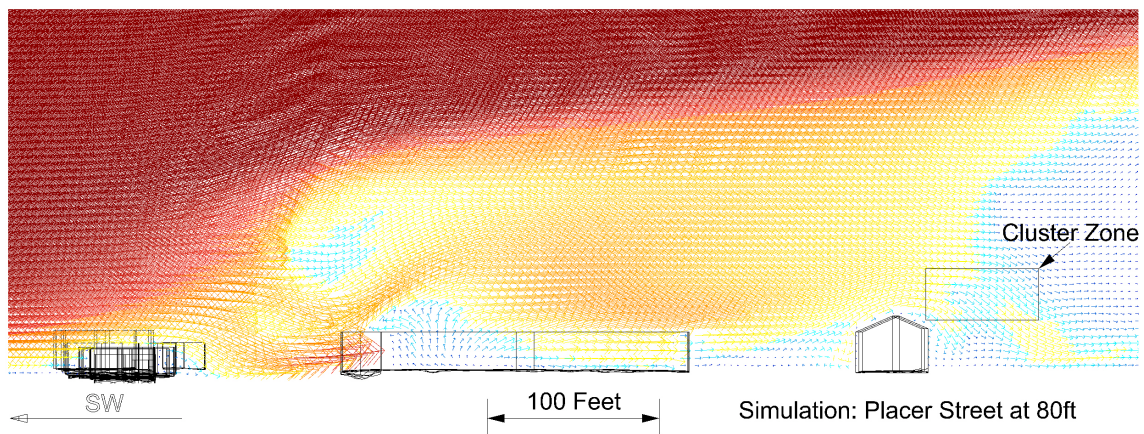


Figure 5C. Vertical Slice for 80 ft Placer Height

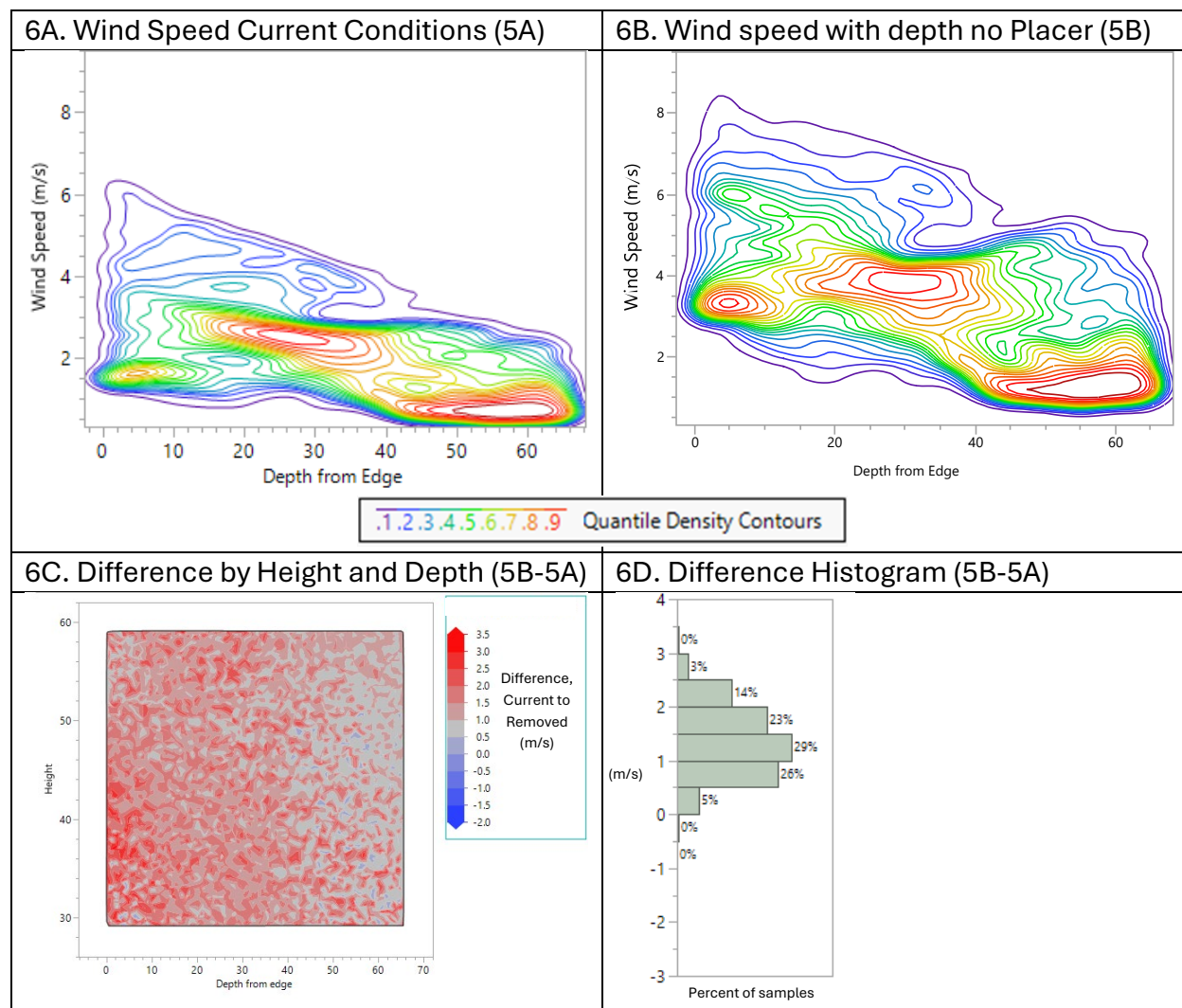


Some of the interesting details of Figure 5 and the variations include:

- 1) Under current conditions (5A), wind ascends over the Placer trees and there is a calm spot in the middle of the trees.
- 2) The wind shadow of the Placer trees extends downwind over the entire reach shown.
- 3) Wind penetrates at low heights through the gap in Photo 1 and Figure 1. That wind ascends and an eddy forms over the main building.
- 4) The wind accelerates back to ~10 m/s again past that eddy just above the main building.
- 5) Wind slows to ~3-5 m/s (yellow) at the edge of the cluster zone above the far-right building.
- 6) The wind descends over the far-right building, and the cluster zone is primarily blue and yellow. The taller trees above the cluster zone attenuate the wind to less than 2 m/s. The open understory below the cluster zone allows wind to remain above 2 m/s near ground level.
- 7) Under complete removal (5B), the wind stays at 10 m/s across the yard and the friction effect of the main building slows the wind in the first 20 ft above.
- 8) The red zone of high wind ascends at the forest edge above the cluster zone, but the high interior of the grove is below 2 m/s.
- 9) The blue vectors in the cluster zone virtually disappear with full removal.
- 10) The 80 ft Placer scenario (5C) is very similar to the current condition (5A).

The full distribution of wind speeds within the cluster zone are treated in Figure 6 below.

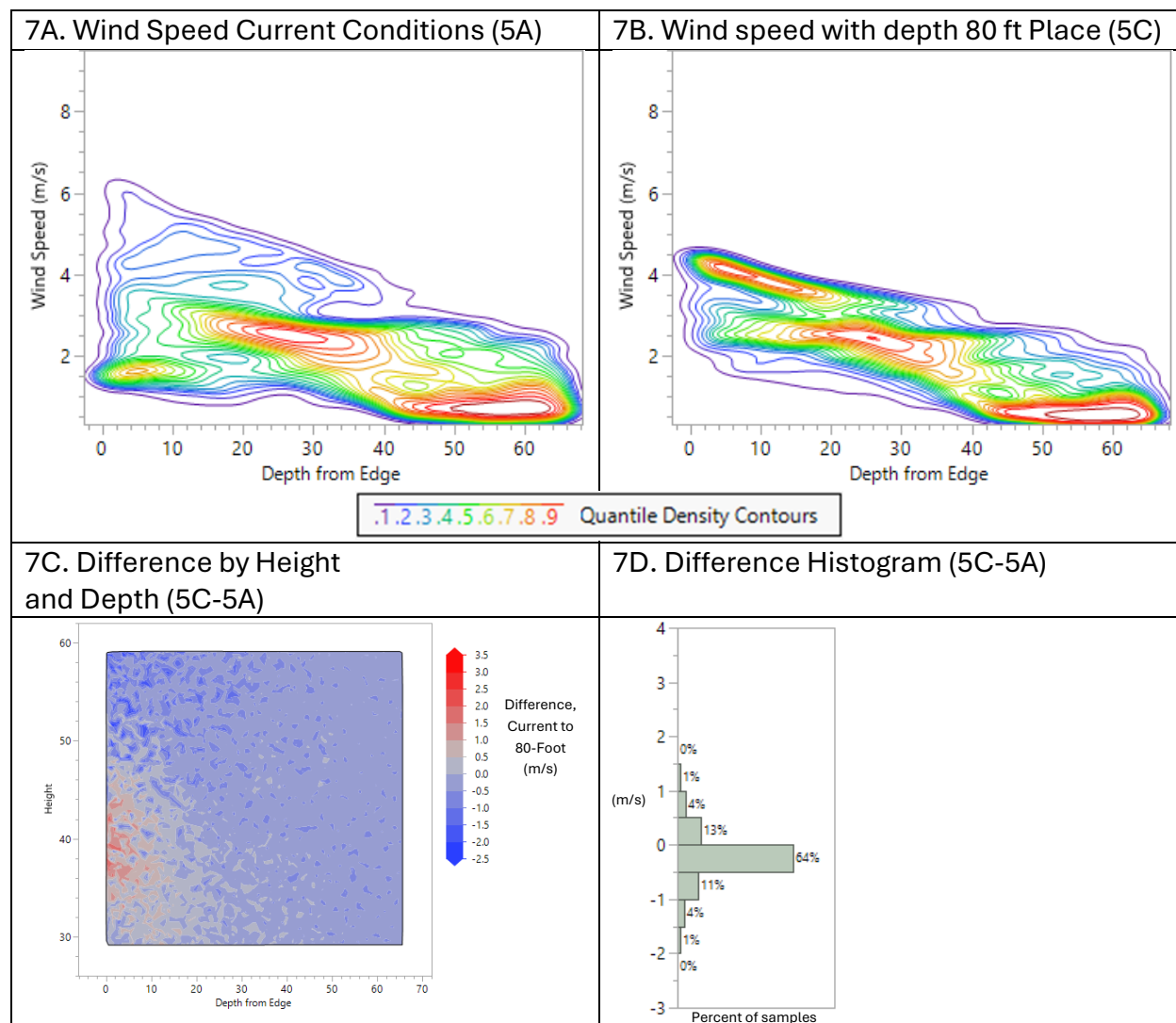
Figure 6. Comparison of current conditions (A) versus complete removal of Placer (B) with depth from edge. Orange and red quantile contours show the relative density of points. The difference by height and depth (C) and the difference histogram (D).



The complete removal scenario is an “end member” so that the wind attenuation of the cluster zone grove itself is isolated. With the current conditions (6A), there are many sites with wind less than 2 m/s at all depths, especially deeper into the cluster zone (40 ft and beyond). With complete removal (6B), the only sites below 2 m/s are greater than 40 ft from the edge. The contour plot of the differences (6C) shows increased wind speed throughout the height and depth of the cluster zone, up to 3 m/s near the edge. The histogram shows 69% of the sites increasing by 1 m/s or more, and 17% increasing by 2 m/s or more.

Remember that the cluster microsites are 40 – 60 ft from the edge.

Figure 7. Comparison of Current Versus 80 ft Placer with depth from edge. Layout is the same as previous figure.



With the 80 ft Placer, the zone close to the edge loses lower wind speeds, but the deeper zone remains less than 2 m/s (7B). When the difference is plotted with height and depth (7C), wind speeds increase (grey and red) primarily within ~20 ft of the edge. 64% of the cluster zone has no change (7D). The 40-60 ft depth zone where the monarchs cluster exhibits little change.

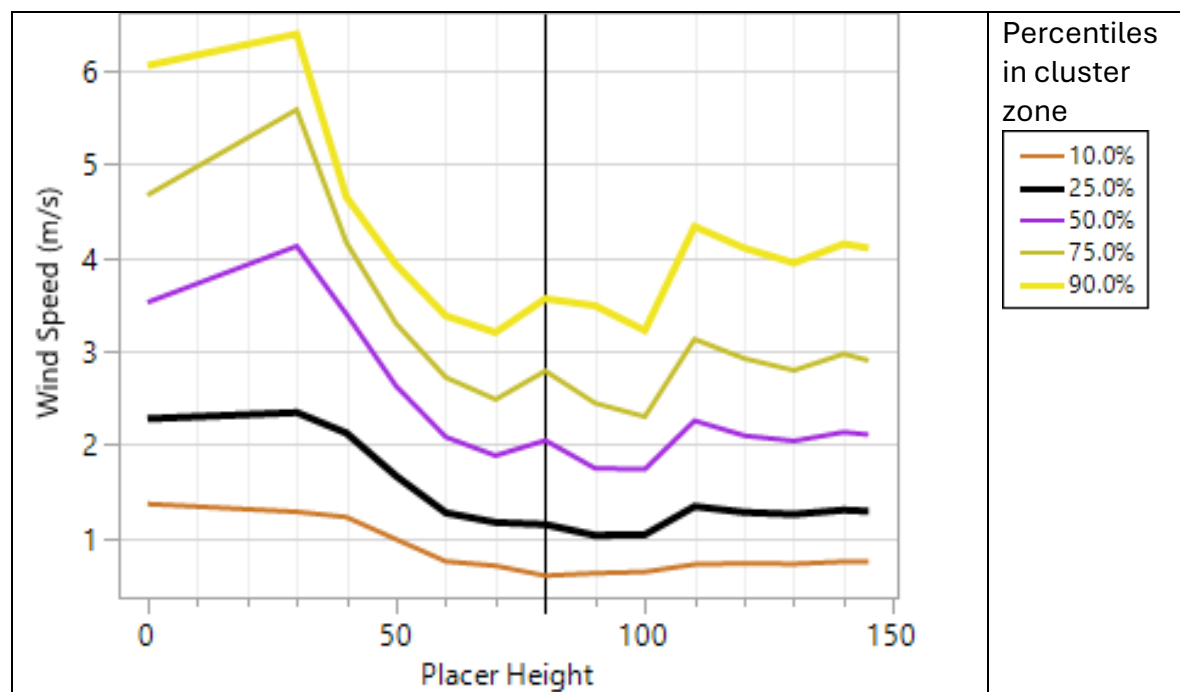
These graphics have been generated for all of the Placer heights considered, but these three scenarios provide sufficient examples of how the wind attenuation works that little will be gained by presenting them all. The synthesis of all the runs is below in Figure 8 with an analysis of wind speed percentiles within the cluster zone.

Wind Speed Percentiles with Placer Height

The results of all the Placer height scenarios are summarized in Figure 8 below. The percentiles of wind speed within the cluster zone are plotted for each Placer height scenario and connected (145 is the current condition, 0 is complete removal as an end member). The black line is the 25th percentile (i.e. 25% of the points within the cluster zone are less than that wind speed). For the 80 ft Placer scenario (vertical line), the 25th percentile (1.15 m/s) and the 50th percentile (2.04 m/s) are virtually the same as in the current condition. Only when Placer is reduced to below 60 ft, do the 25th percentile and other percentiles start to rise. The irregularities in the curves (such as the bump at 110 ft) reflect some of the complex turbulent wavelengths generated by different Placer heights and may vary in shape for different wind speeds.

This analysis provides strong support for the 80 ft height being a safe option, leaving another 10 to 20 ft buffer before wind speed percentiles rise rapidly.

Figure 8. Percentiles of Wind Speed Within the Cluster Zone by the height of the Placer trees (X-axis)



Scenario 2: Placer Street Windbreak at 1x Height to Target

This scenario models wind if the Placer trees were cut in a gradient below heights capable of striking buildings along Placer Street. The canopy geometry modeled is based on a selection of vegetation volume that does not account for actual tree structure and is strictly based on a 45-degree angle from the base of occupied buildings on Placer Street.

This scenario (9A) produces subtle changes from current conditions (9B). Those differences within the cluster zone are best viewed in Figure 10 below.

Figure 9A Vertical Wind Profile with 1x Height to Target Scenario

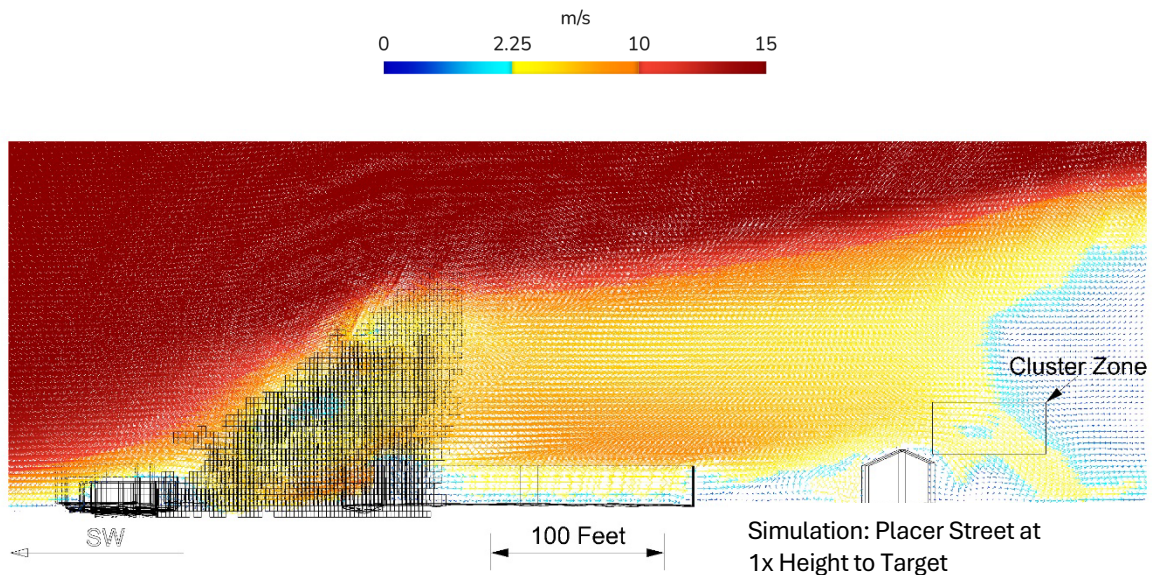


Figure 9B Vertical Wind Profile Current Conditions (same as Figure 5A)

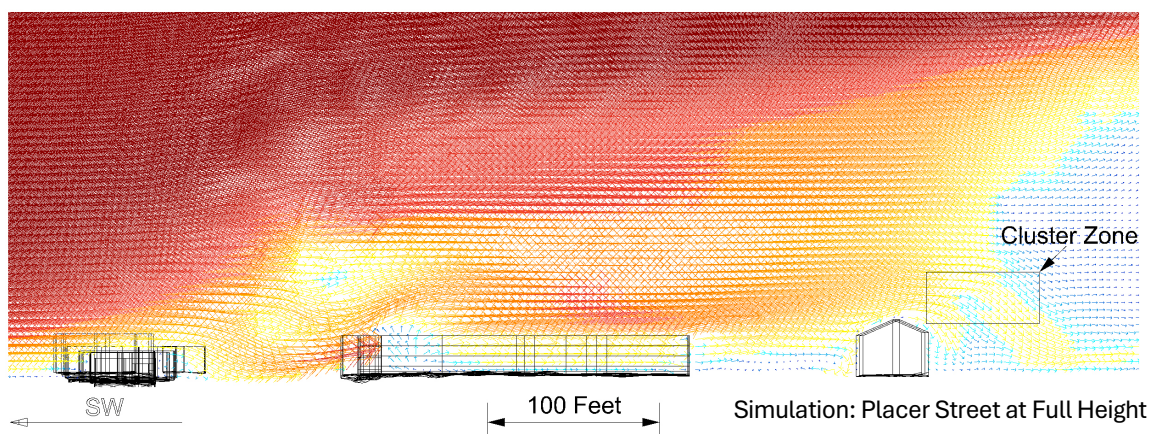
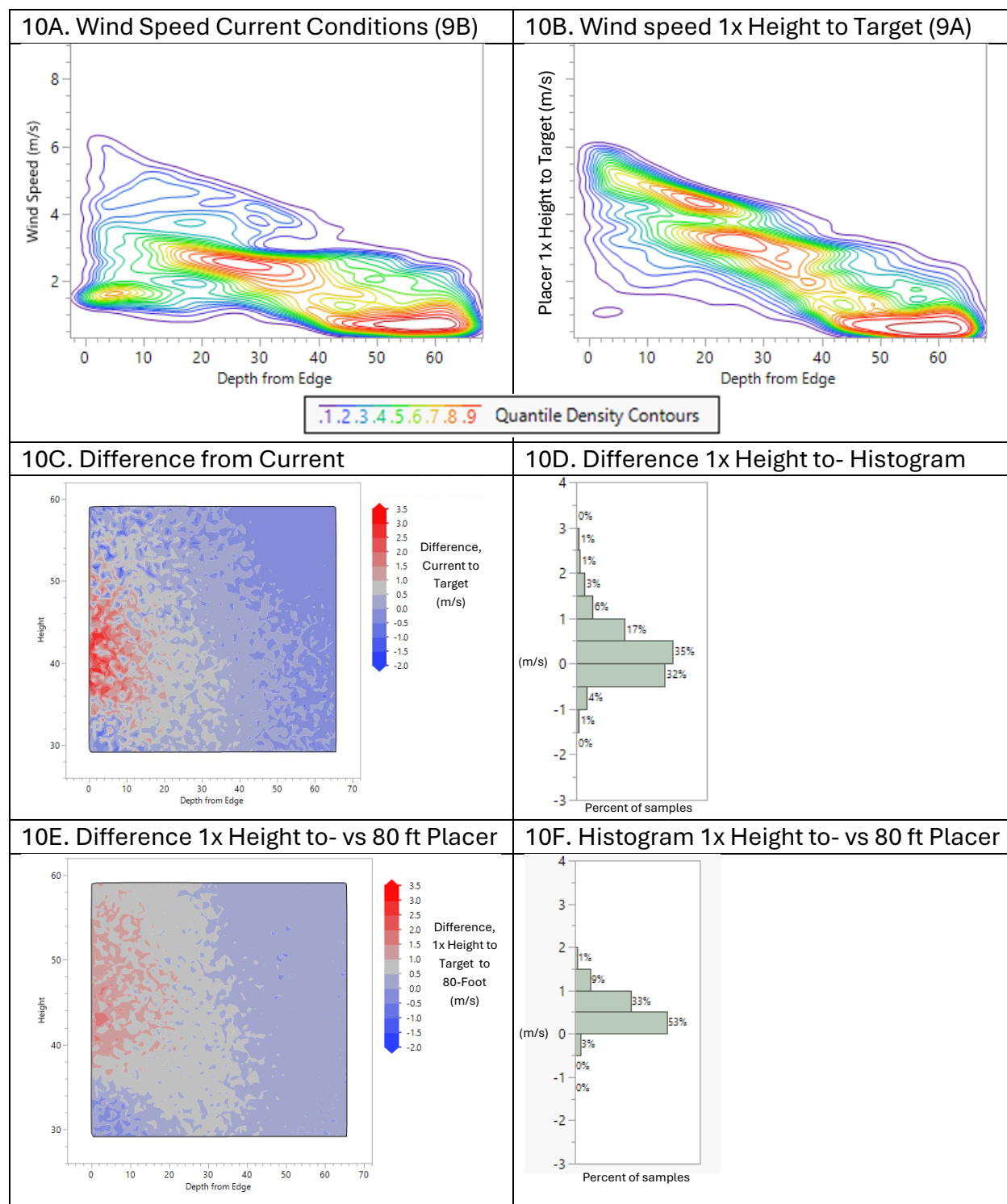


Figure 10. 1x Height to Target Scenario Statistics



In the 1x Height to Target scenario, the only areas with wind below 2 m/s are greater than 40 ft depth (10B). The main impacts are within 20 ft of the edge, between heights of 35 to 50 ft (10C). The sites beyond 40 ft from the edge are little affected Compared with the 80 ft Placer scenario, 1x Height to Target mainly changes in that same zone by ~1.5 m/s (10E).

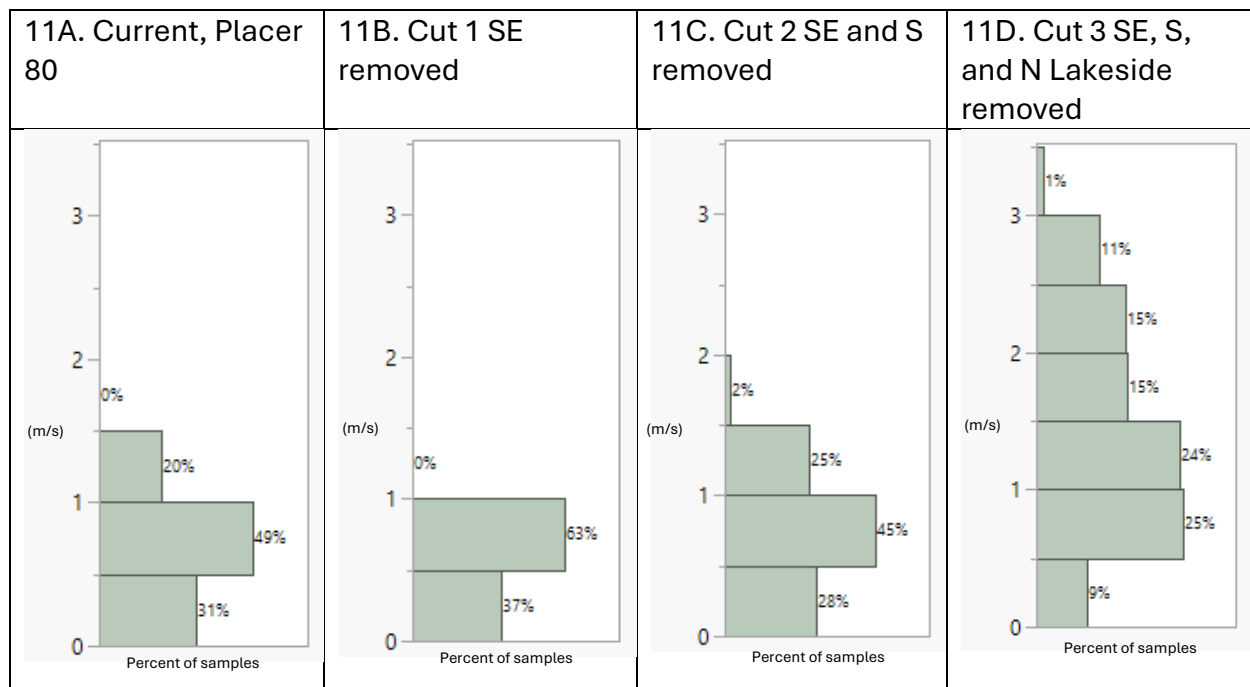
Scenario 3 & 4: Complete Removal of Southern Groves

The set of scenarios referred to as 3&4 includes the complete removal of groves south of the trees immediately surrounding the sanitation yard. This includes the Southeast Groves, South Lakeside, and North Lakeside. In the simulations we iterated through removing the groves in the order mentioned above.

The effect of these changes was tested using an incoming 10 m/s wind direction of 200°. This wind direction puts the southern groves directly in line with the main cluster site. This allows us to establish the maximum amount of protection provided by the southern groves. We set the Placer trees at the critical 80 ft height.

The current conditions of the North Lakeside, South Lakeside, and Southeast groves provide excellent 200° (SSW) wind protection for the cluster zone, with only 20% of the volume greater than 1 m/s and none greater than 2 m/s. Removal of the SE and S groves does not create areas of higher winds. The only scenario that creates wind speeds greater than 2 m/s is complete removal of the three groves in question, an extreme scenario; 27% of the cluster zone volume has wind speeds greater than 2 m/s.

Figure 11. Histograms of Absolute Wind Speed in Cluster Zone for 200° 10m/s Wind.



Scenario 5: 70-foot Canopy Height at Southern Groves

This scenario is designed to test the effects of reducing the southern groves to a height of approximately 70 ft. These are the same groves as discussed in scenarios 3&4 – North Lakeside, South Lakeside, and Southeast Groves.

Conditions in this scenario do not result in excessive wind for monarchs in the cluster zone. In the vertical wind profile below the majority of the cluster zone are estimated to stay below 2.25 m/s.

Fall roosting sites

Fall roosting sites are not limiting for monarchs. When monarchs arrive at an overwintering site in October and early November, the weather is usually mild prior to the first storms of the season. During these mild periods, the butterflies may roost in a wide variety of sunny sites and are not constrained by winds. Many options are available, and the use of any particular microsite is largely a matter of chance, as some butterflies start roosting and attracting others. When the first strong winds occur, from any direction, they abandon wind-exposed microsites and start to concentrate in wind-sheltered areas that receive full or dappled sunlight.

At Moran Lake, the numerous trees around the lagoon (North Lakeside, South Lakeside, Southeast Groves) can serve as fall roosting sites at a height of 70 ft. The linear stands of trees also serve to “gather” monarchs as they pass by. As winds occur with the first storm fronts of the year, the monarchs then tend to move to sunny Creekside cluster sites, until SE winds drive them to the main cluster zone NE of the yard. But strong northerly winds can penetrate through the gap along the access road/trail and drive the butterflies back to Creekside, or into more sheltered microsites within the main cluster zone.

Figure 12. Vertical Wind Profile with Scenario 5 Height Reduced to 70 Feet

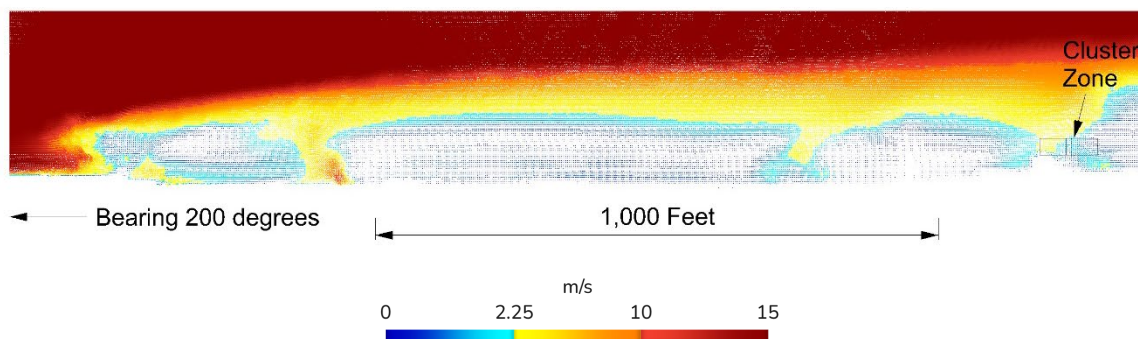


Figure 13. Overhead View of Scenario 5, Sampled 30 Feet Above Ground

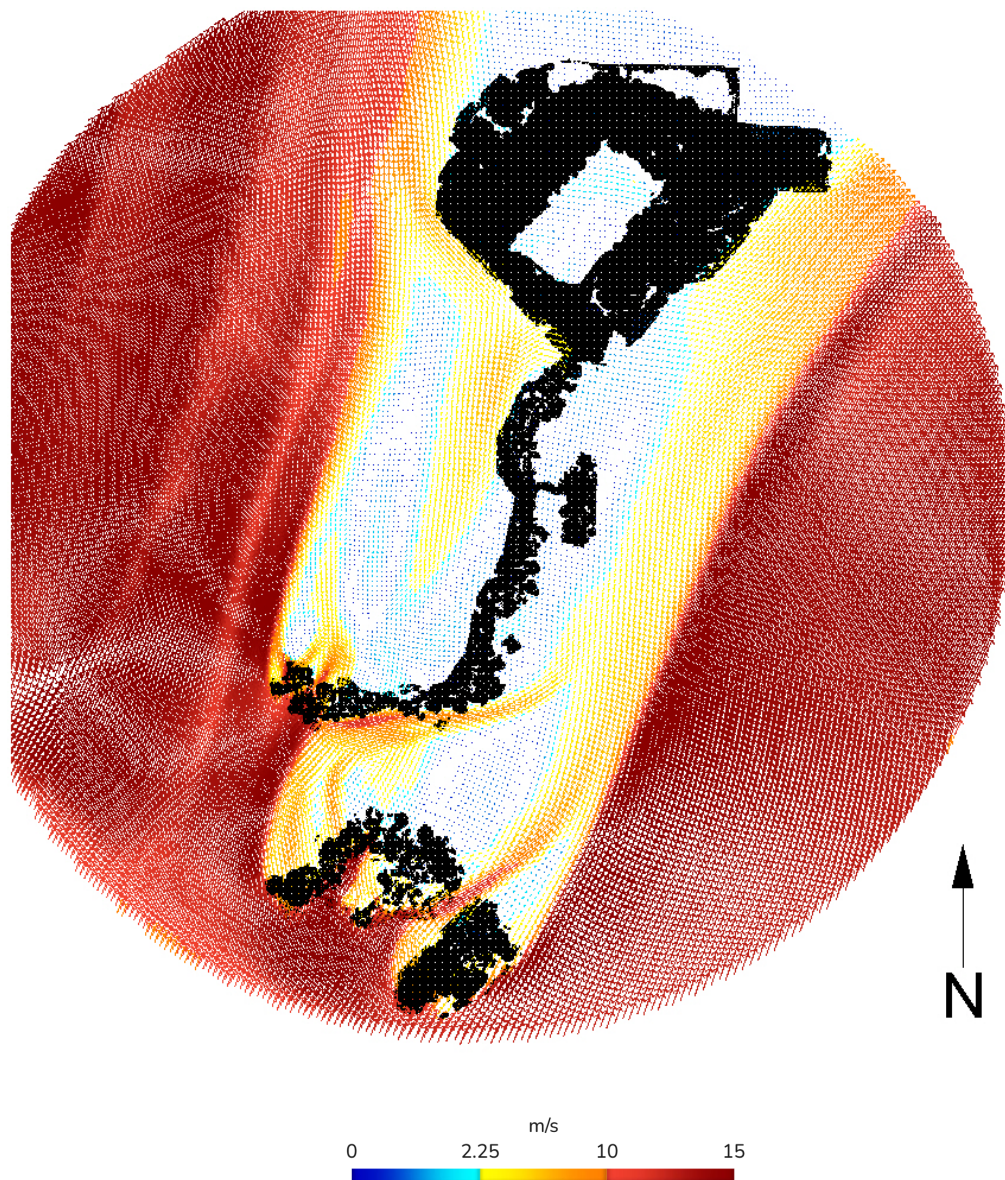
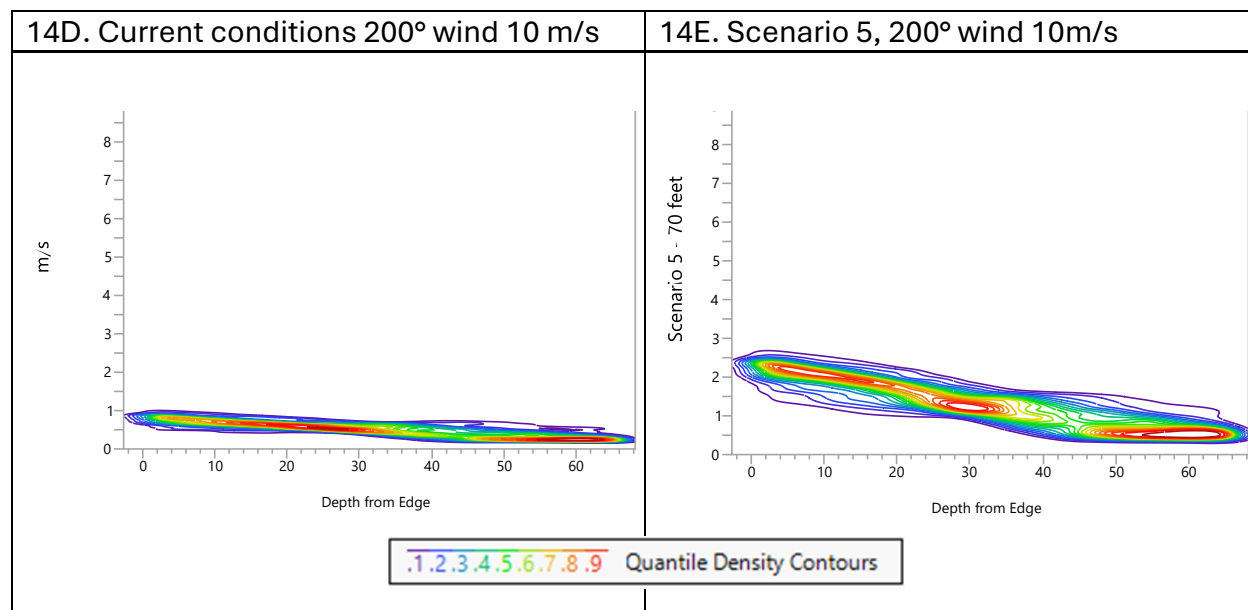
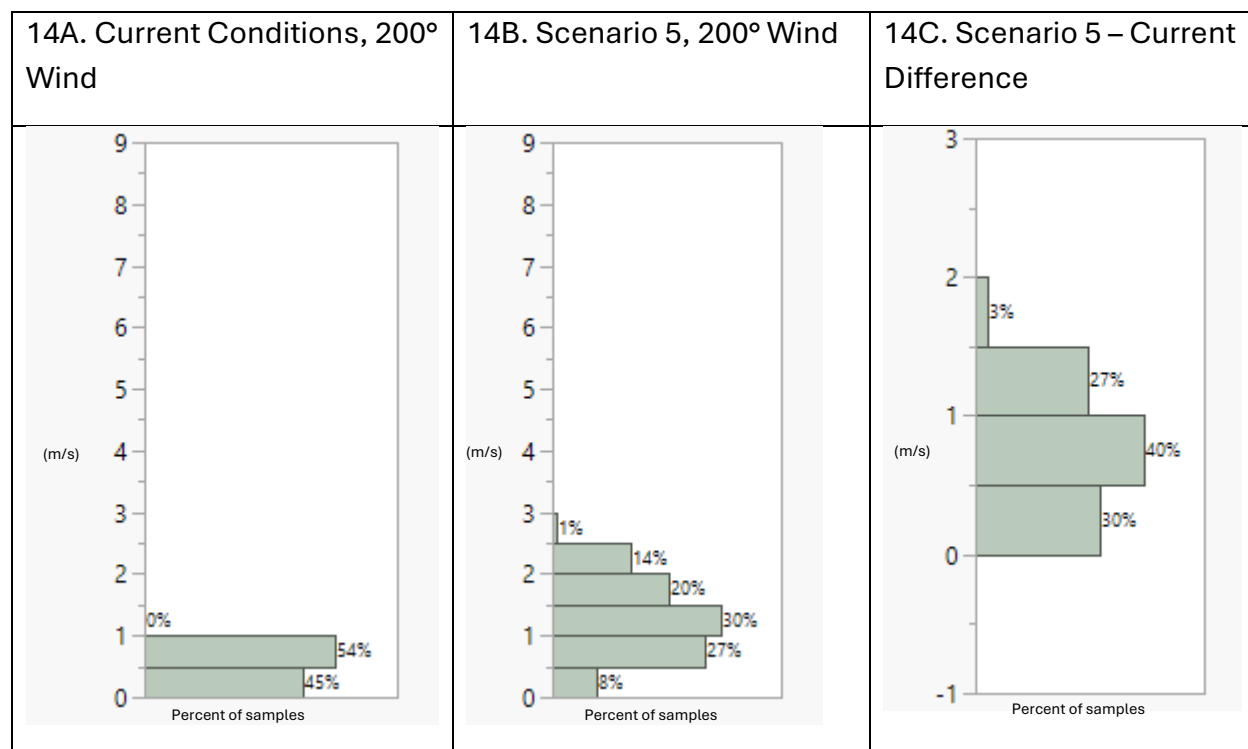
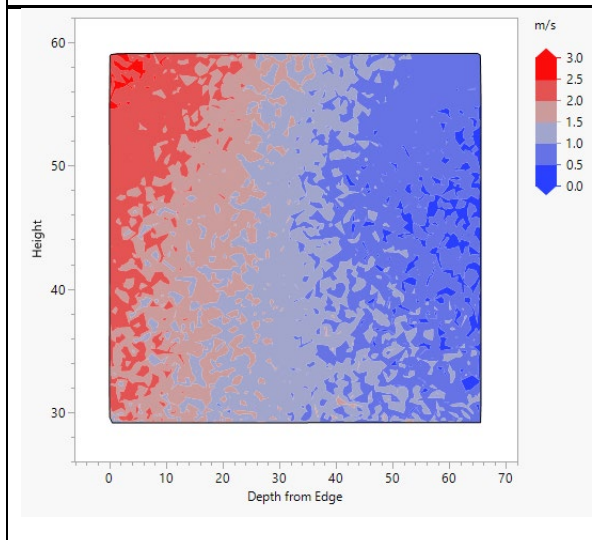


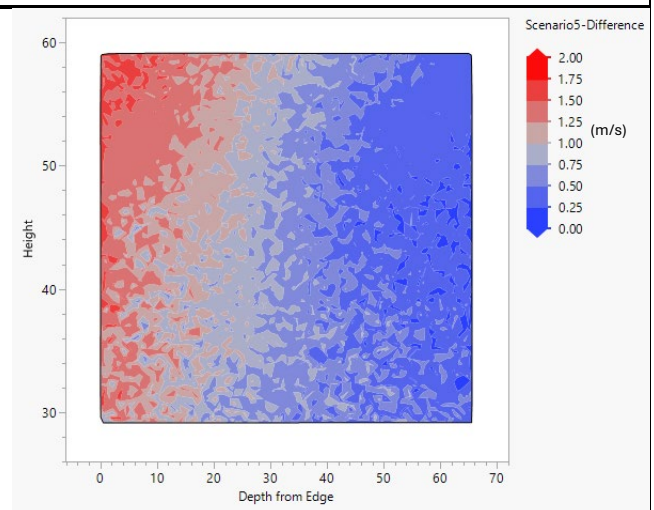
Figure 14. Scenario 5 Windspeed Distribution Graphs



14F. Scenario 5 Absolute Wind Speed – note that scale is different from other scenarios



14G. Scenario 5 Difference – note that scale is different from other scenarios



Scenario 6: North Edge 1x Height to Target

This scenario uses the same approach as scenario 2, except for with buildings nearest to the North Edge grove. The buildings on this northern side of the groves are farther from the North Edge grove than those buildings along Placer Street, with the “Boneyard” occupying most of the space between buildings and North Edge trees. The modifications result in minor changes to the canopy of the North Edge. Cutting would be limited to the highest sections of the trees.

Figure 15 shows a vertical slice for current and 1x Height to Target. The wind is N (0°) at 10 m/s. In the current configuration, there is a “wind tunnel” along the road opening (the jet of yellow/red near the ground). This opening can be seen in Photo 2, 949 as the near-horizon gap to the NE. This wind vulnerability, which drives the monarchs away from the NE cluster zone during strong northerly winds, was confirmed with actual wind measurements in the habitat assessment (Weiss 2022). Sealing this gap with new cypress trees in the Boneyard across from the opening was a key recommendation in that report.

The 1x Height to Target modification results in minimal changes to wind conditions in the cluster zone - in fact they are almost indistinguishable both visually (Figure 15) and in the histograms (Figures 16 A, B). The slight differences are captured in a difference histogram (Figure 16C). The distribution of wind with height along the NW-SE canopy edge (Figures 16 D, E) shows the wind tunnel along the road opening clearly in the lower left corner between 0 and 20 ft and below 40 ft height.

The actual trimming would be high in the canopy, well above the cluster zone, with several rows of trees to provide wind shelter. Combined with sealing up the wind tunnel with Boneyard cypress plantings, the north edge of the grove will be more secure for both monarchs and building safety.

Figure 15A. North-Edge Current Conditions

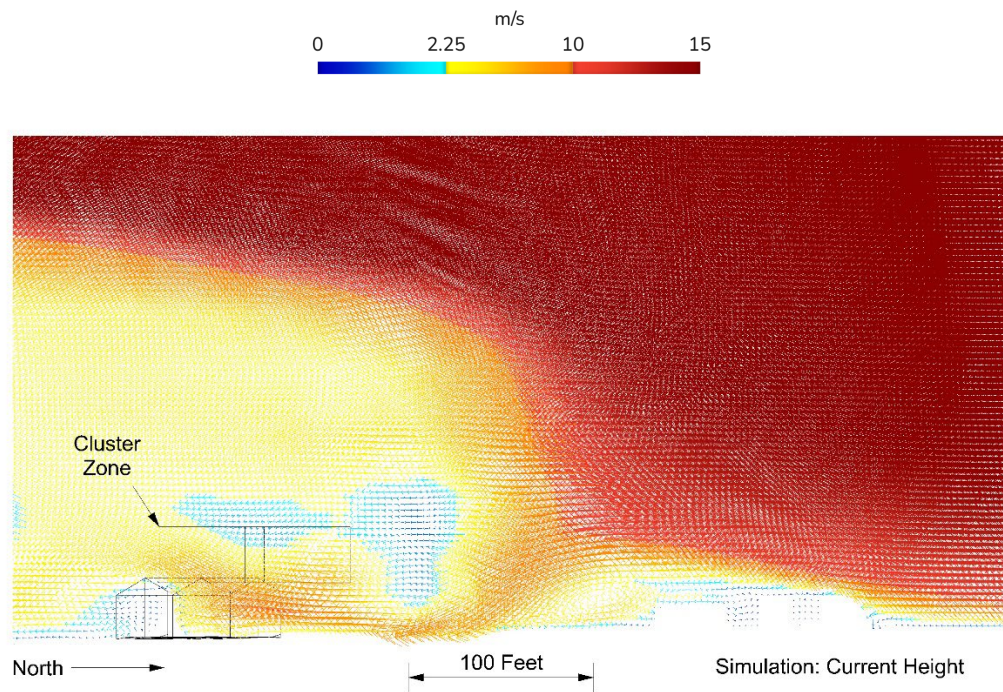


Figure 15B. North-Edge 1x Height to Target

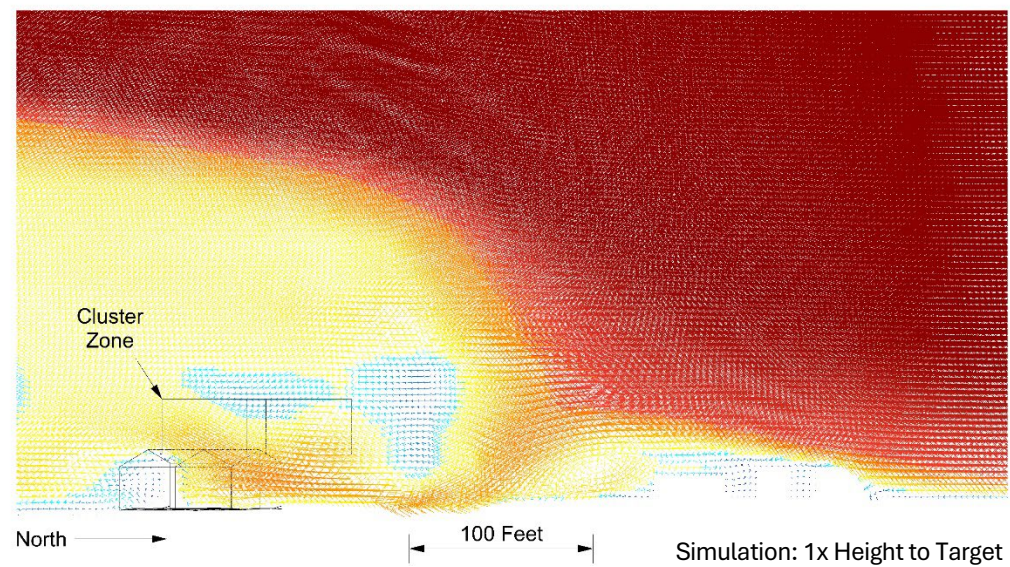
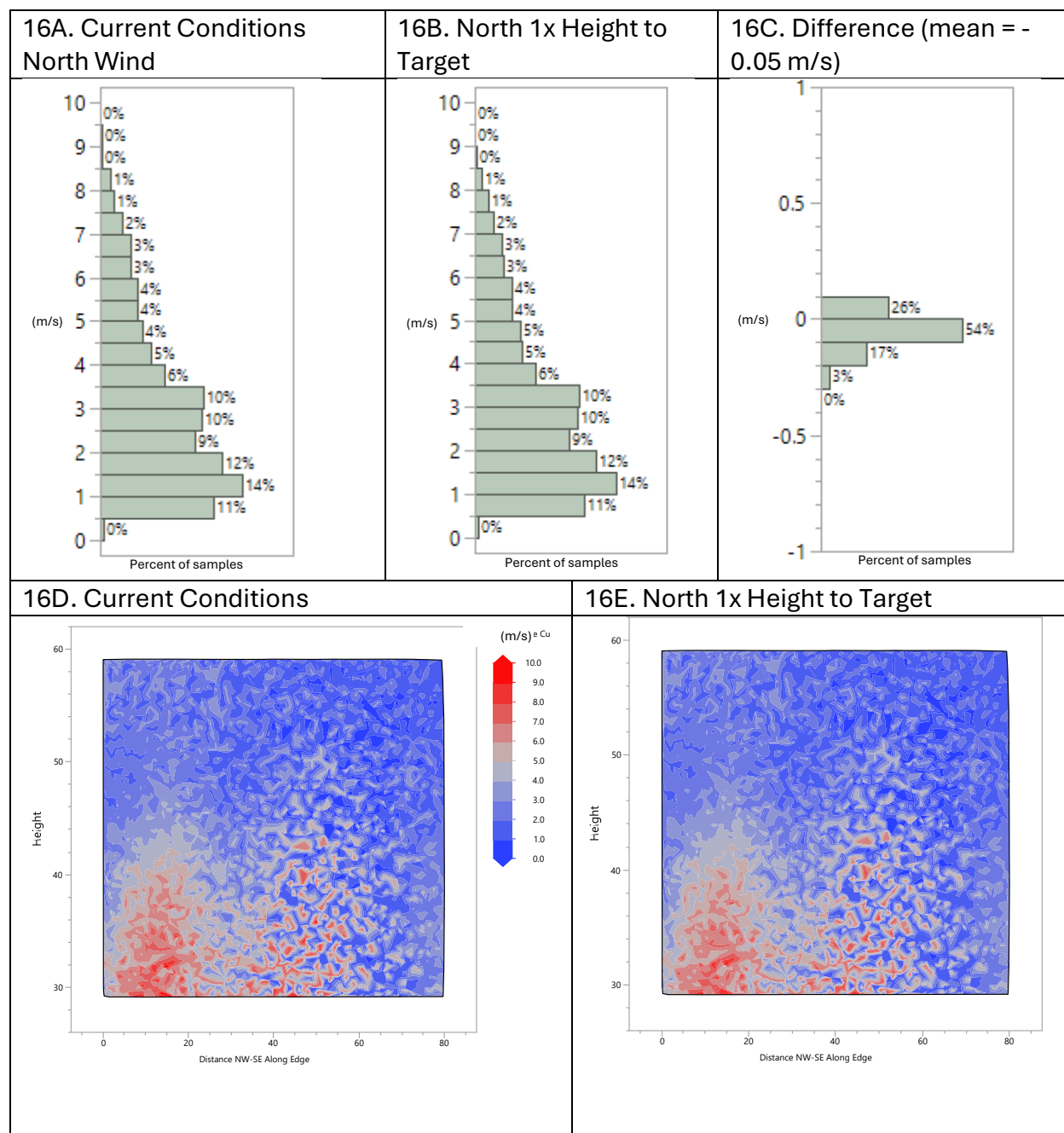
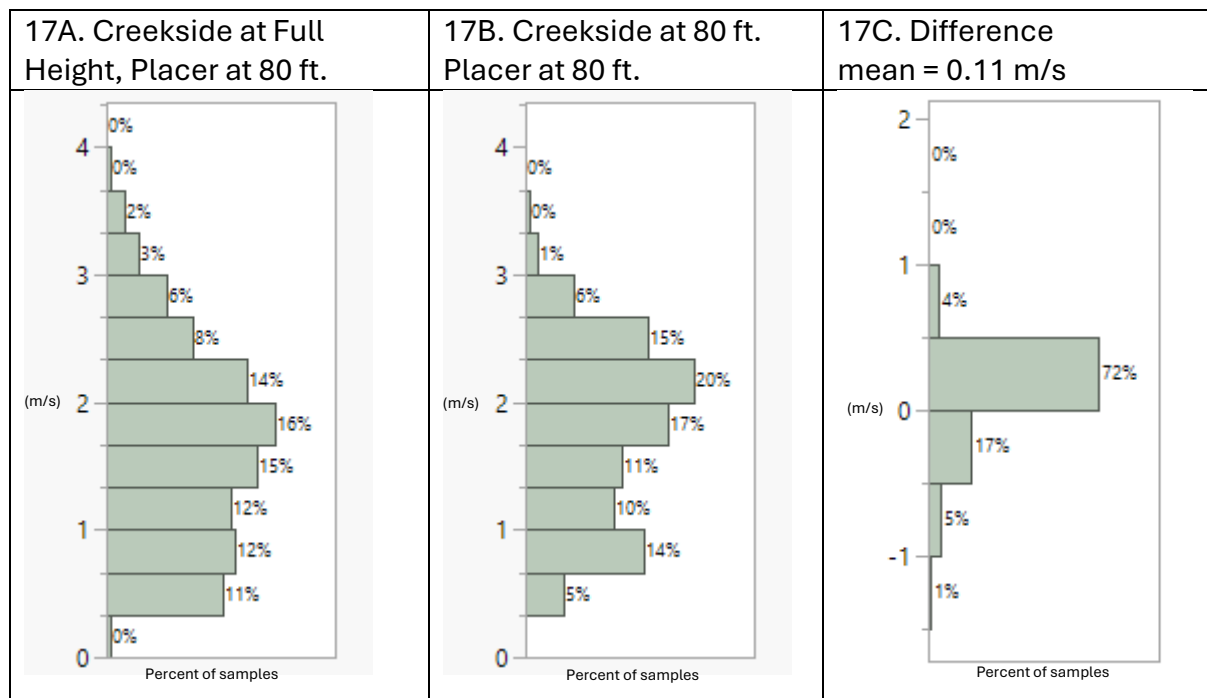


Figure 16. 1x Height to Target on North Edge Histograms



Scenario 7: South Creekside at Critical Height

Figure 17 Histograms of Wind Speed for Creekside Height Reduction



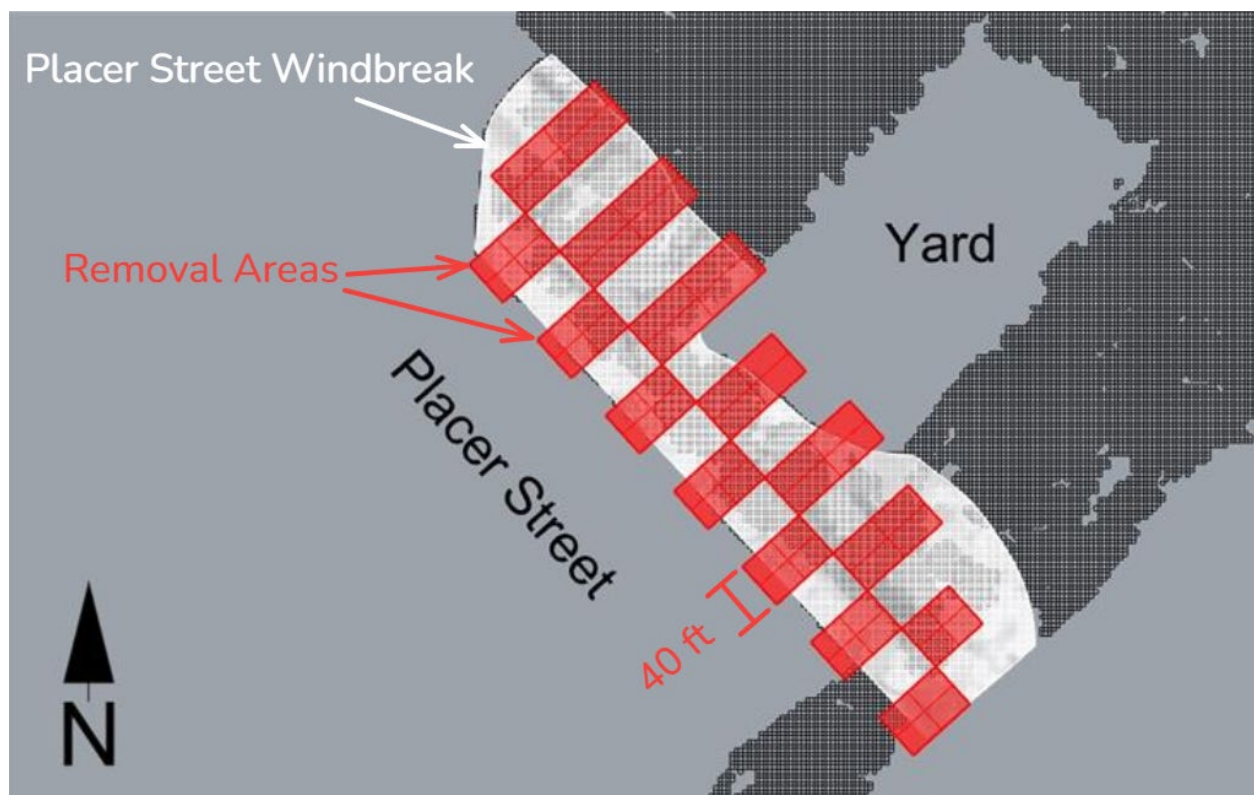
Reducing the height of the Creekside trees to 80 ft has a small effect on the cluster zone, a mean increase of 0.11 m/s. It actually decreases the very maximum wind speeds (> 3 m/s) slightly.

This treatment is not a realistic option for monarchs because of the presence of consistent cluster trees in this area. Those cluster sites would likely be disrupted by height reduction.

Appendix A. Scenario 8: Sectional Removal of Placer Street Windbreak

This scenario models the Placer Street Windbreak with sections of canopy removed. Roughly half of the Placer Street Windbreak is modeled as being removed, in order to approximate conditions in a long-term plan to replace the eucalyptus trees. The sections of removal are designed to allow for tree plantings to grow in the areas of removal. The removal areas are also placed in such a way that they alternate between removing the southwest edge (closest to Placer Street) and the northeast edge (closest to the yard). The axis on which the removal zones alternate runs northwest to southeast, splitting the thinnest part of the Placer Street Windbreak roughly in half. This is an attempt to maintain the greatest minimum canopy width at the thinnest section of the Placer Street Windbreak given the canopy removal scenario. The removal sections are all 40 ft wide, with varying depths from canopy edge. The remaining canopy of the Placer Street Windbreak is modeled at the previously established critical height, 80 ft.

Figure 18. Scenario 8 Removal Areas

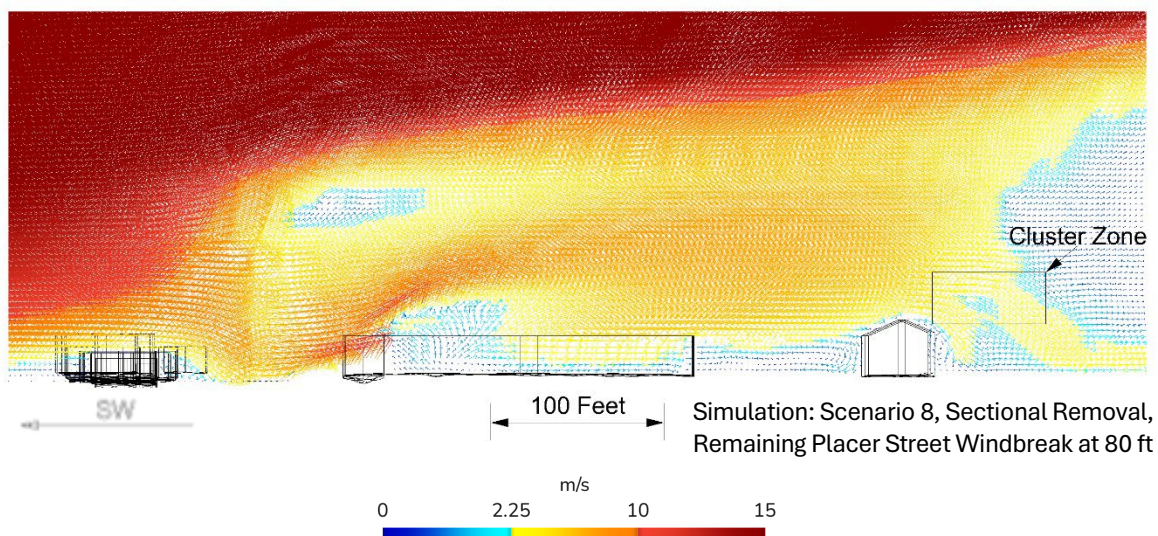


This approach is limited in how well it can approximate a realistic execution of a tree replacement plan because the LiDAR data available does not identify individual trees. So a less precise approach in which larger sections of canopy are removed is designed to approximate a similar practice. The actual tree removal would likely differ from the exact

areas of removal established in this scenario. The general approach of removing approximately half of the canopy is still achieved.

The results of modeling scenario 8 suggest an average increase of 0.3 m/s when compared to the results of the placer street windbreak at 80 ft tall (critical height) without sectional removal. The figure 19 below shows that the southwest edge of the cluster zone has windspeeds greater than 2.25 meters per second, but the protection offered by the Placer Street Windbreak provides enough of a barrier to allow the canopy directly around the cluster zone to slow windspeeds and maintain pockets of windspeeds slower than 2.25 m/s deeper in the canopy. These calm pockets are more concentrated in the northeast sections of the cluster zone.

Figure 19. Scenario 8 Vertical Slice Side Profile

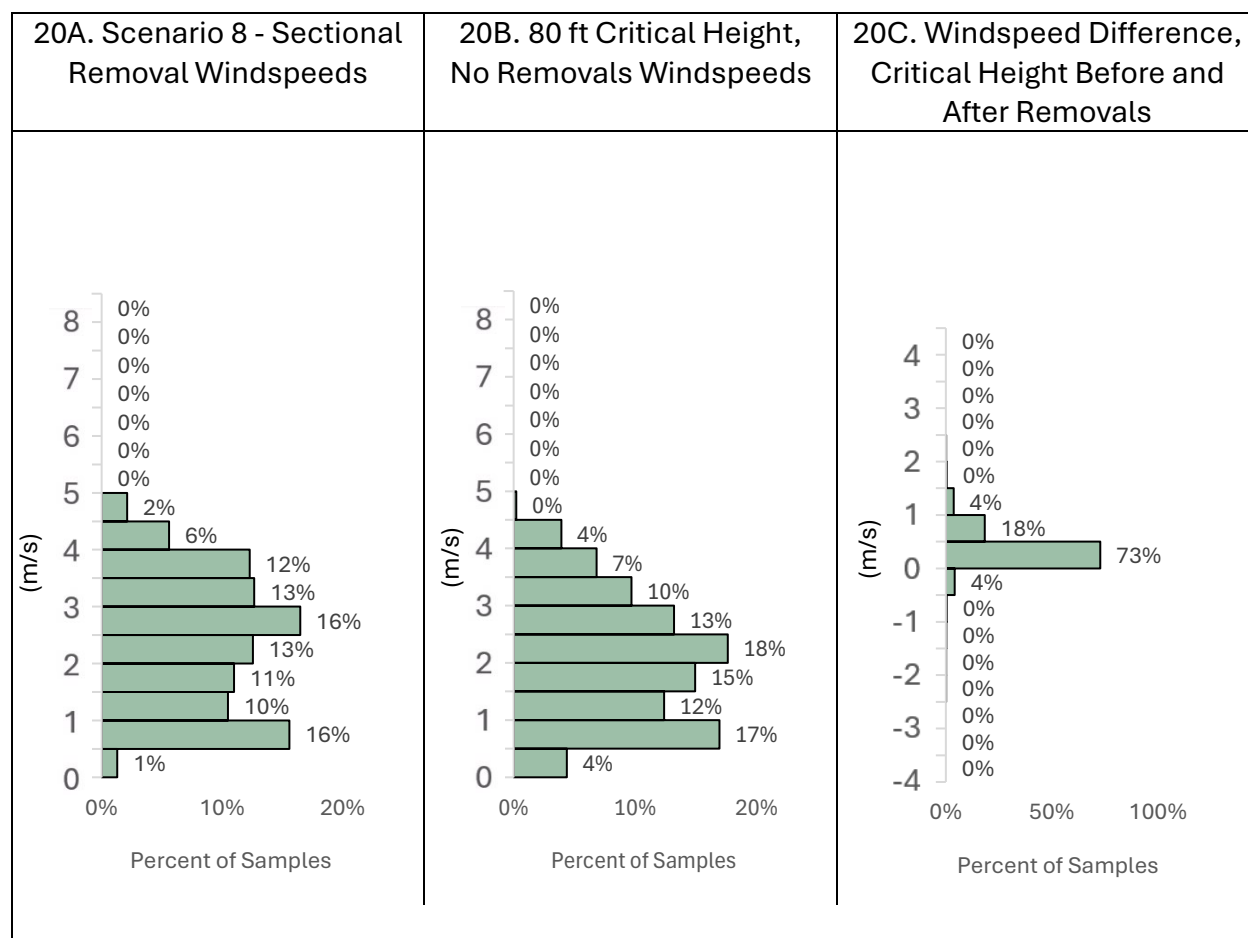


Examining the figure 20 histograms shows that scenario 8 is suggested to result in a similar histogram structure as placer street at critical height. 91% of sample points in the cluster zone show an increase in wind speed of 0 to 1 meter per second. Which, while showing a trend toward higher windspeeds, 96% of sample locations still predict speeds lower than 4 m/s, while in the critical height scenario, 98% of samples predict speeds less than 4 m/s. The 90th percentile wind speed in scenario 8 is 3.9 meters per second, which is most similar to the 50 ft tall Placer Street windbreak condition previously estimated, which also had a 90th percentile value of about 3.9 meters per second. The 50 ft scenario of the Placer Street on figure 8 is at the base of a steep slope that indicates rapid increase in windspeed starting at that canopy height as canopy height decreases. Seeing a similar 90th percentile value in scenario 8 suggests that the scenario is on a threshold that is vulnerable to further increase to windspeeds given further reduction of wind protection. However, the plastic

epicormic response of the eucalyptus canopy would likely fill in gaps relatively quickly, leading to increased protection.

One potential challenge with the removal scenario is the increased amount of canopy edge, which increases the exposure of previously protected trees to increased windspeeds and will present increased stresses on those trees.

Figure 20. Scenario 8 Histograms



References

Leong, K.L.H. 1990. Microenvironmental factors associated with the winter habitat of the monarch butterfly (Lepidoptera:Danaidae) in central California. *Annals of the Entomological Society of America* 83:906-910

Leong, K.L.H. 1991. Use of multivariate analyses to characterize the monarch butterfly (Lepidoptera:Danaidae) winter habitat. *Annals of the Entomological Society of America* 84:263-267.

OCM Partners, 2025. 2020 San Mateo RCD Lidar: Santa Cruz County, CA, <https://www.fisheries.noaa.gov/inport/item/63258>.

Weiss, S.B. 2022. Assessment of Moran Lake Monarch Overwintering Habitat. Report by Creekside Science for Santa Cruz County Parks.



Addendum to Management Recommendations from Moran Lake Habitat Assessment



Monarchs clustering on blue gum eucalyptus in Creekside Area

Stuart B. Weiss, Ph.D.

January 2024

Introduction

This document is an addendum to the “Assessment of Moran Lake Overwintering Monarch Habitat” produced in October 2022. It modifies the management recommendations based on feedback from various stakeholders, especially Dr. John Dayton.

Management recommendations

The management recommendations are modified as follows:

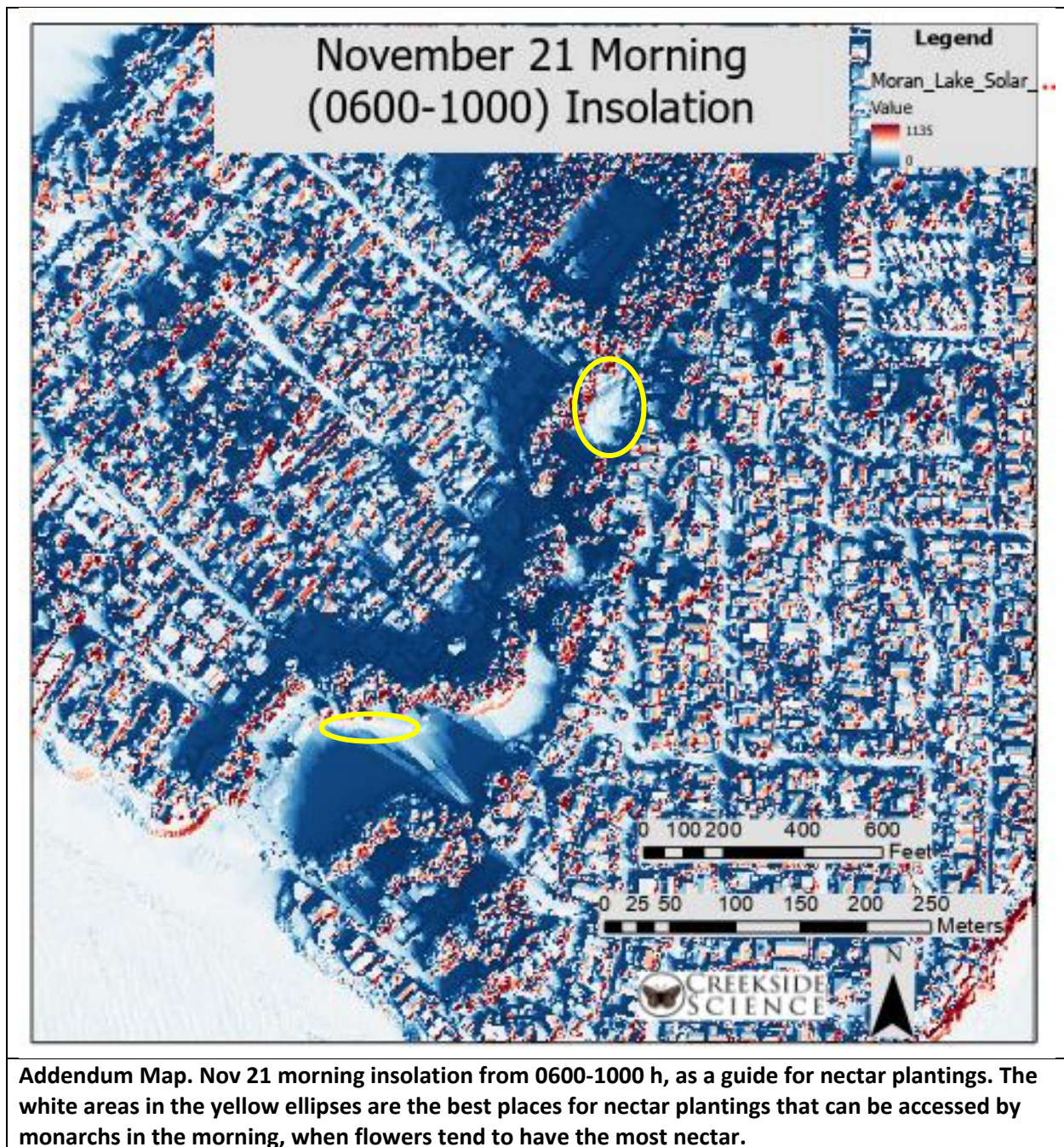
1. Seal up the outer NE and NW edges of the grove surrounding the pump station yard, using Monterey cypress planted to fill the gaps between eucalyptus rows. Originally, California bay and coast live oak trees were recommended, but they have not done well in these shady locations. There is some concern about maintaining sightlines into the grove to detect occupancy by unhoused people so close coordination with public safety agencies is important.
2. Plant a small stand of Monterey cypress at the SW side of the Boneyard opposite the trail opening to seal against northerly winds that penetrate into the grove along the trail and drive the monarchs away from the interior cluster site.
3. Encourage blue gum saplings within the main stand when they serve to seal up the open row spaces.
4. Maintain a partially open canopy south of the main cluster area NE of the Yard so that direct insolation can penetrate from the Yard edge.
5. The SW side of the main grove poses issues with tree hazards to the neighbors. Maintaining wind shelter along this edge is crucial for the monarchs clustering on the opposite side of the yard. Topping trees and removing hazard branches in this area may be necessary and should be done with a light touch. Reinforcing the wind shelter with plantings on the Yard side of the drainage ditch – currently there are several redwoods that are not doing well - is important. Eucalyptus and cypress may be better choices than redwoods here.
6. In the Creekside Zone, maintain and fill in the row of trees SE of the creek. The public property is dominated by shrubs including blackberries and other shrubs – interplanting trees such as redwoods will reinforce existing wind shelter. However, care should be taken over the long run to not deeply shade the cluster sites along the creek.
7. The private property S of the public parcel has had trees trimmed, but new plantings and other management here depend on a cooperative landowner, so there are no guarantees of implementation.
8. Upon closer examination, the SE gap at the Yard does not require new trees – existing trees appear to be filling in the gap. Monitoring their progress is recommended.
9. Trees south of the pump station complex provide early season roosting but are abandoned once storms bring substantial winds. The viability of the site is much less dependent on trees in these areas, which are used opportunistically. The upper canopies do provide some shelter for the pump station complex, but the under- and mid-stories are of lesser importance.
10. Nectar plants of various species (listed in 2010 draft plan, and in the Xerces Society lists) should be planted primarily in areas that receive morning sun (Addendum Map), or in spots with dappled light. The prime area for nectar is just S of the main grove, in the sunny grassy area at the head of the lagoon (larger yellow ellipse). The moist soil here allows for many species to thrive, and on a microscale, the variety of habitats available including marshy areas, creekbanks, and open grassy fields. Other narrow zones between the trail and water on the W side of the

lagoon should be considered. Monarchs are less likely to use nectar plants in deep shade, so the forest understory near the main clustering sites are poor places for nectar plants. The most important nectar plants are those that bloom in the fall (Oct-Nov) because they help retain monarchs at the site, which in turn attracts more butterflies that are passing by. A concentrated pollinator garden for many species besides monarchs, should be considered in various areas, even those that do not receive morning insolation.

11. Management of hazard trees and branches is essential in publicly accessible areas. If hazards are identified on the NE side of the Yard, near the cluster zone, then special care should be taken in assessing urgency and targets of falling trees/branches, as well as potential for opening the cluster sites to wind. In other parts of the habitat, removal of single branches and individual trees should be routine if hazards are identified.
12. Keeping the future option of selective surgical thinning of parts of the main grove is important. Maintaining individual tree health in the face of aridification may require reduction of basal area. The remaining trees will fill in the canopy as water and light availability allow.



Close up of monarchs clustering in the interior of the main grove, NE of the Yard, December 2023.





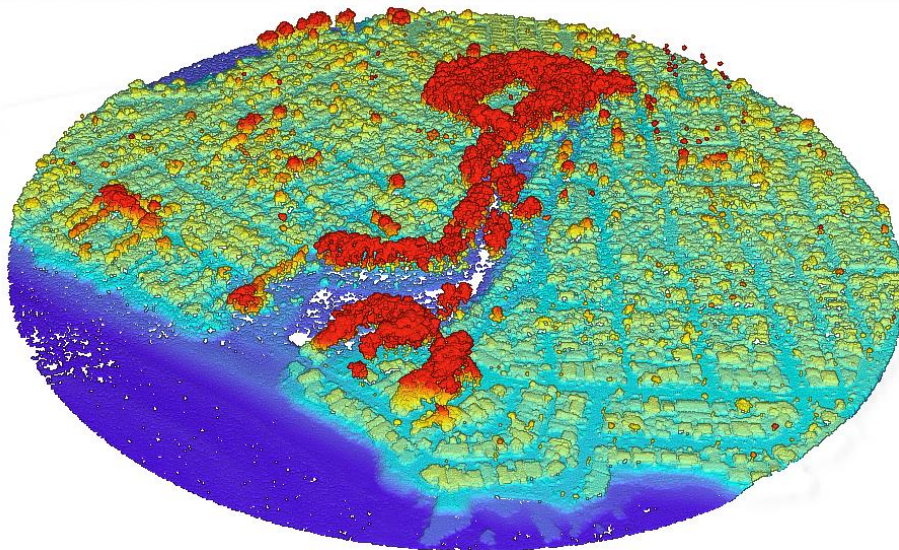
Assessment of Moran Lake Monarch Overwintering Habitat



Hemispherical photo at main cluster site



Monarchs clustering on blue gum eucalyptus



Oblique LiDAR view from South

Stuart B. Weiss, Ph.D. October 2022

Moran Lake Monarch Assessment October 2022

Executive Summary

Monarch butterflies overwinter in groves of trees, primarily blue gum eucalyptus, near Moran Lake, Santa Cruz County. This assessment provides a structural analysis of the microclimate of the groves, using hemispherical photography, LiDAR, and wind measurements, that documents wind and insolation patterns that provide the conditions that allow monarchs to successfully overwinter. The assessment includes the following elements:

1. A site map with LiDAR-based elevation to delineate key zones for monarchs
2. Oblique LiDAR views that identify key structures and vulnerabilities
3. An explanation of how to interpret a hemispherical photograph (hemiphoto).
4. Sixteen example hemiphotos showing key sites and exposure from different directions
5. A map of ISFU (Visible Sky) in the habitat surrounding the pump station Yard.
6. A series of maps of direct insolation below the canopy derived from hemiphotos
7. Insolation at the outer canopy envelope derived from LiDAR and insolation modeling in GIS.
8. A map of hemiphoto exposure in eight directions, and a close-up map of the cluster areas NE of the Yard.
9. Relative wind exposure at the outer canopy envelope, at a 10-meter scale across the Yard and across the entire site and surrounding urban areas, derived from LiDAR and wind modeling using the program WindNinja.
10. A series of wind measurements near ground level (1.75 m) on three days with differing wind directions, and a standardized wind attenuation map at the sample points.
11. A section on detailed methods of processing LiDAR and hemiphotos.

Monarch Habitat and Vulnerabilities

Monarchs seek sites with wind shelter and some direct and dappled light. These conditions are met in certain parts of the grove surrounding the Yard, especially the NE and NW sectors. The tall trees provide wind shelter, and the Yard opening provides high insolation forest edges, where canopy gaps allow dappled light into the forest interior. The tall trees across the Yard provide wind shelter, especially at cluster heights. But the open NE and NW edges of the grove allow wind to penetrate along rows and through openings.

Monarchs will shift distributions according to wind, particularly. The main NE cluster site is consistently used, but monarchs will temporarily abandon it when northerly winds penetrate through the opening. At those times, the wind-shadowed SE zone can be heavily used by flying monarchs, and some clusters may form on the SE edge of the grove until the wind shifts again.

Major vulnerabilities that decrease habitat suitability include:

- 1) Northerly wind penetration into the cluster area NE of the Yard, from the open NE edge.
- 2) Southerly wind penetration into the NE cluster area, a combination of penetration over the Yard, and around the corner from the creek.
- 3) Northerly wind penetration into the NW side of the grove along the rows of trees and the access road.
- 4) The inside edges of the Yard are generally well sheltered from wind by the tall trees on opposite sides. But the SE gap produces a wind tunnel that allow some wind to penetrate the Yard.

Moran Lake Monarch Assessment October 2022

Management recommendations

A series of management recommendations based on the above analyses includes:

1. Seal up the outer NE edge of the grove surrounding the pump station Yard, using bay trees, live oaks, and/or Monterey cypress planted to fill the gaps between eucalyptus rows.
2. Seal up the NW edge of the grove by planting more bay and live oak trees
3. Encourage blue gum saplings within the main stand when they serve to seal up the open row spaces.
4. Maintain a partially open canopy south of the main cluster area NE of the Yard so that direct insolation can penetrate from the Yard edge.
5. Plant a small stand of Monterey cypress at the SW side of the Boneyard opposite the trail opening to seal against northerly winds.
6. Maintain and fill in the row of trees SE of the creek. Property boundaries here will require consideration.
7. Plant a tall-growing eucalyptus tree (species TBD) to eventually fill in the SE gap at the Yard.
8. Trees south of the pump station complex provide early season roosting but are abandoned once storms bring substantial winds. The viability of the site is much less dependent on trees in these areas, which are used opportunistically.
9. Nectar plants of various species (listed in 2010 draft plan, and in the Xerces Society lists) should be planted primarily in sunny areas, or in spots with dappled light. Monarchs will fly hundreds of meters to use nectar plants, so there are a variety of habitats available including marshy areas, creekbanks, and open grassy fields. A concentrated pollinator garden could be considered in various areas. Monarchs are less likely to use nectar plants in deep shade, so the forest understory near the main clustering sites are poor places for nectar plants. The most important nectar plants are those that bloom in the fall (Oct-Nov) because they help retain monarchs at the site, which in turn attracts more butterflies that are passing by.
10. Management of hazard trees and branches is essential in publicly accessible areas. If hazards are identified on the NE side of the Yard, near the cluster zone, then special care should be taken in assessing urgency and targets of falling trees/branches, as well as potential for opening up the cluster sites to wind. In other parts of the habitat, removal of single branches and individual trees should be routine if hazards are identified.

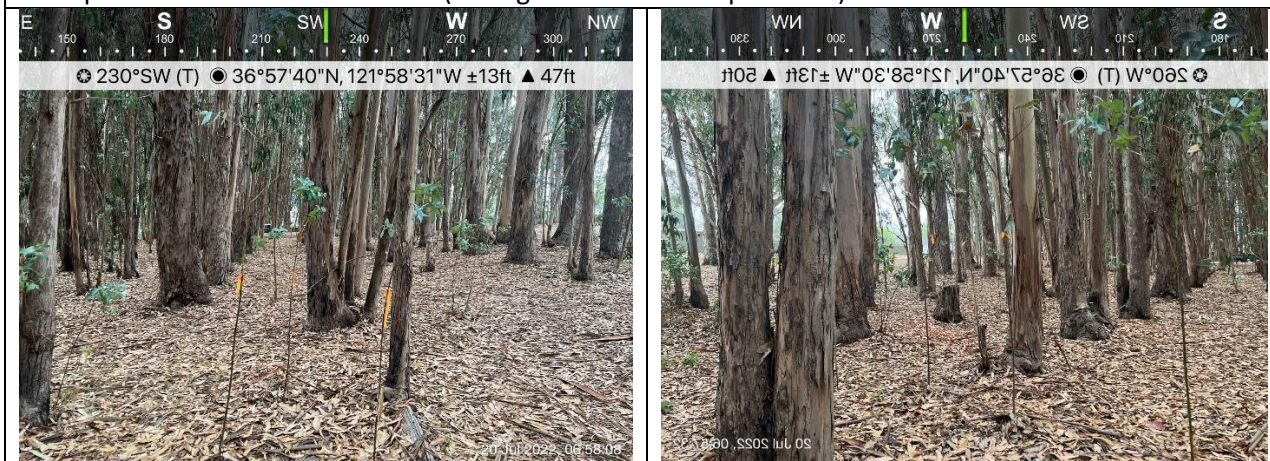
Moran Lake Monarch Assessment October 2022

Georeferenced Photographs of Recent Plantings and Retained Saplings

NW Edge of grove, with bay trees planted. Recommended to increase the number of bay trees and live oaks to better seal this edge



Interior blue gum saplings flagged for retention NW of Yard. Recommend using saplings to seal up the row spaces here and in other areas (SE edge of Yard and slope below).

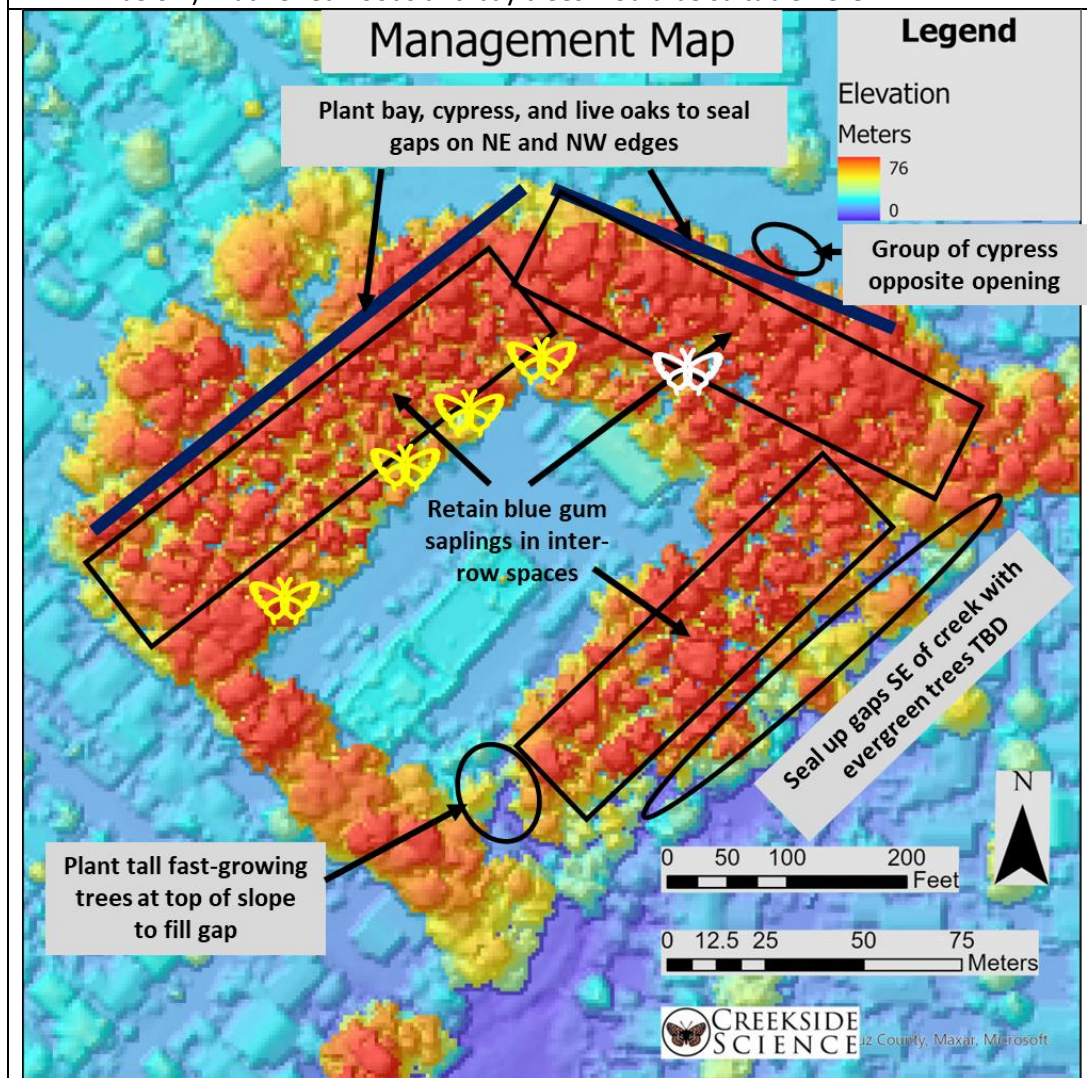


Moran Lake Monarch Assessment October 2022

Management Summary Map

Major management actions, primarily planting trees of various species to provide more wind shelter. Key areas include the open NE and NW edges, the SE gap, and the creek.

- 1) The 2021-2022 cluster site is the white butterfly outline, historical sites described by S. Marcum are in yellow.
- 2) Some bay trees and live oaks are already planted along the NW edge, add more for a complete seal (see photo above).
- 3) Plant additional bay, oaks, and cypress to seal NE edge
- 4) Retain blue gum saplings in the interior in inter-row spaces to seal against wind, on NW, NE, and SE sides
- 5) The gap along the NE edge at the trail into the grove sealed up with a small grove of cypress planted across the fence in the Boneyard.
- 6) The S gap around the Yard sealed up with a fast-growing tree (eucalyptus of some species TBD) planted at the top of the slope
- 7) Seal up gaps in the trees SE of the creek. Some of the SE creek bank is on private property and arrangements need to be made for access (see property maps below). Native redwoods and bay trees would be suitable here.



Moran Lake Monarch Assessment October 2022

Property Parcel Maps (from Santa Cruz County GIS)

Parcel map SE of creek. This parcel 02829157 is County-owned.



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Assessor's Office

Search Parcel List Assessed Value & Taxes Parcel Addresses Splits & Combos Transfers Characteristics

No Assessed Value found for the selected APN.

Parcel Info	APN	Site Address	Class
	02829157	Address Unavailable	830-TOKEN VALUE PROPERTY

Taxes*	
Year	2021/2022
First installment	\$0.00
Second installment	\$0.00
Total	\$0.00

* This is regular tax information. Please refer to the Tax Collector for more information on taxes.

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Parcel map SE of creek. This parcel 02829161 is private and arrangements would need to be made with the owners for tree plantings



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Assessor's Office

Search Parcel List Assessed Value & Taxes Parcel Addresses Splits & Combos Transfers Characteristics

Parcel Info		
APN	Site Address	Class
02829161	541 PALMDES AVENUE, SANTA CRUZ - 95062	020 SINGLE RESIDENCE

Assessed Value	
Year	2021/2022
Land	\$384,209
Improvement	\$523,668
Gross Total	\$907,878
Homesowners Exemption	\$7,000
Net Assessment	\$900,878

Taxes*	
Year	2021/2022
First installment	\$5,524.64
Second installment	\$5,524.64
Total	\$11,049.28

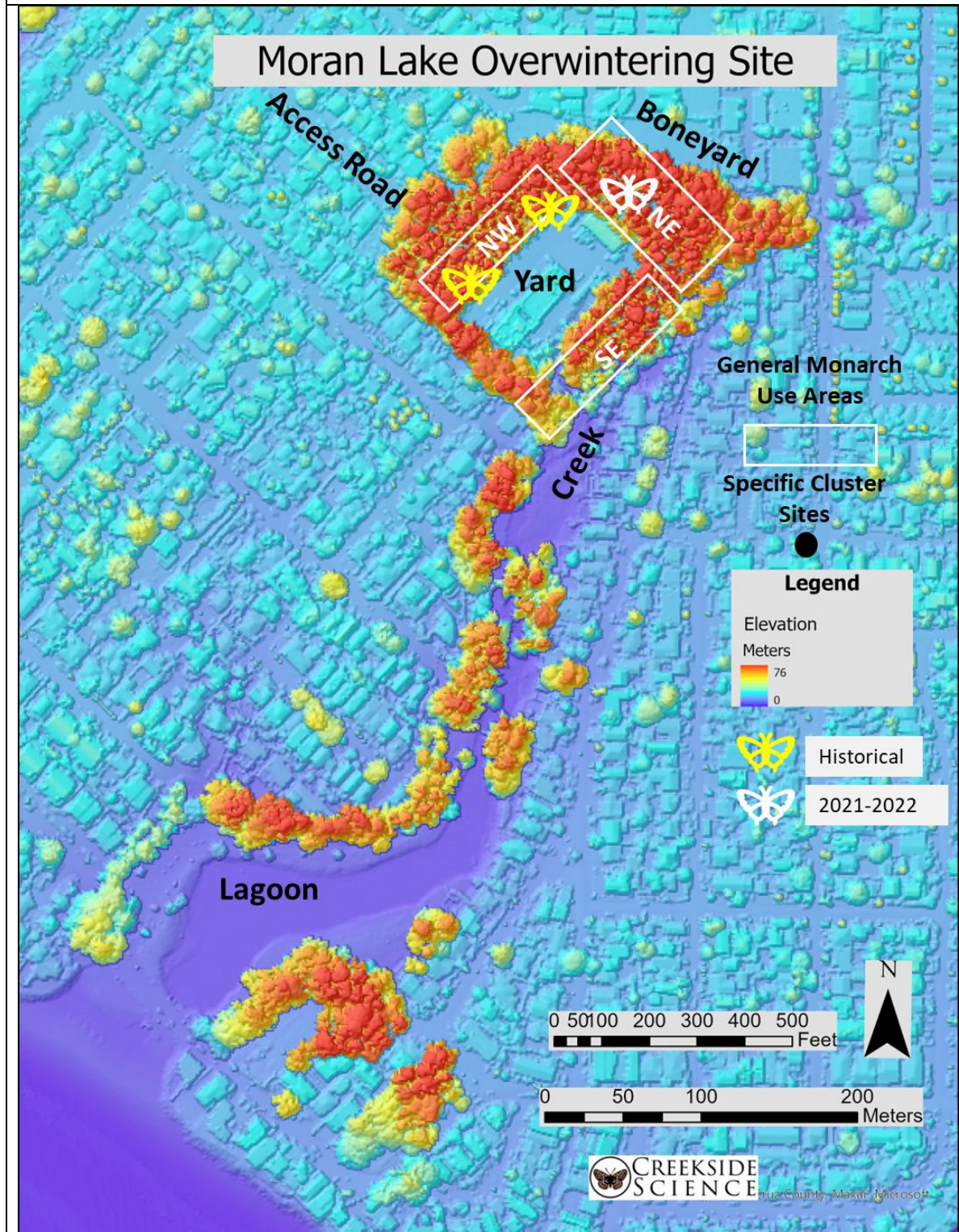
* This is regular tax information. Please refer to the Tax Collector for more information on taxes.

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Moran Lake Monarch Assessment October 2022

Site Map

This map shows the forest canopy (red and yellow, and other features of the overwintering site. The primary cluster sites (observed in 2021-22 and pointed out by S. Marcum) and activity areas are around the “Yard” (the pump station facility). Most of the detailed analyses focus on this area around the Yard.

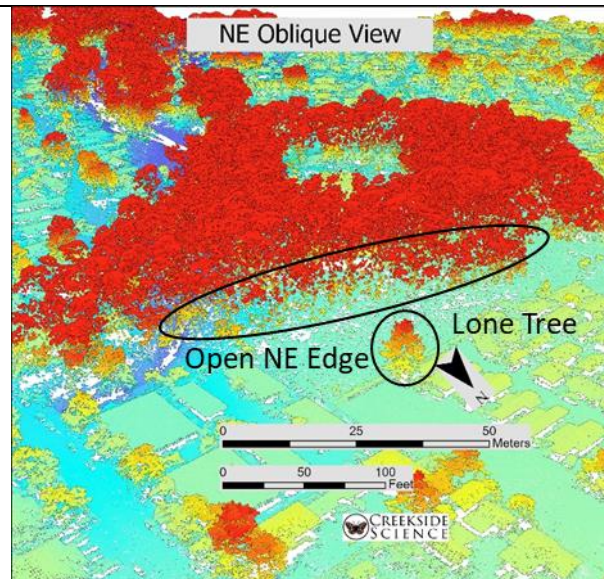


Moran Lake Monarch Assessment October 2022

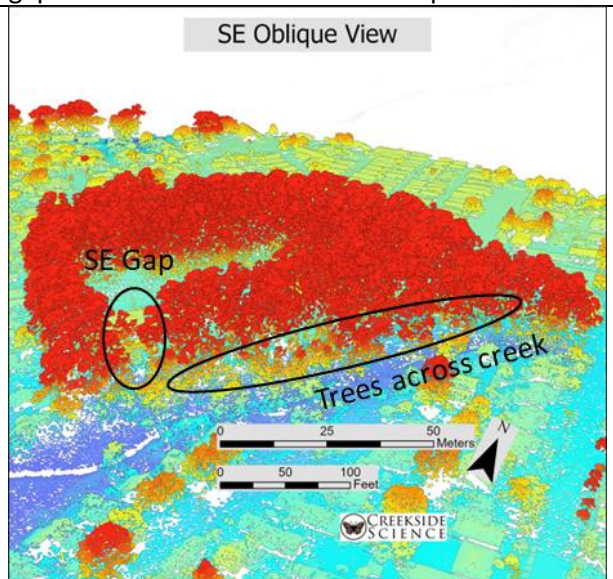
Oblique Views of Monarch Habitat Around the Yard

These oblique views show key features mentioned in various maps below. Views are **from** the direction in title.

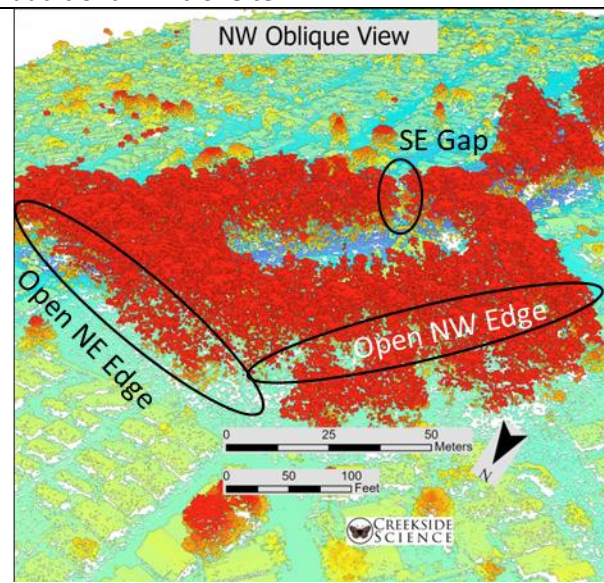
The view from the NE shows the open canopy edge along the “Boneyard” fence, and the lone tree observed in Photo 909 below.



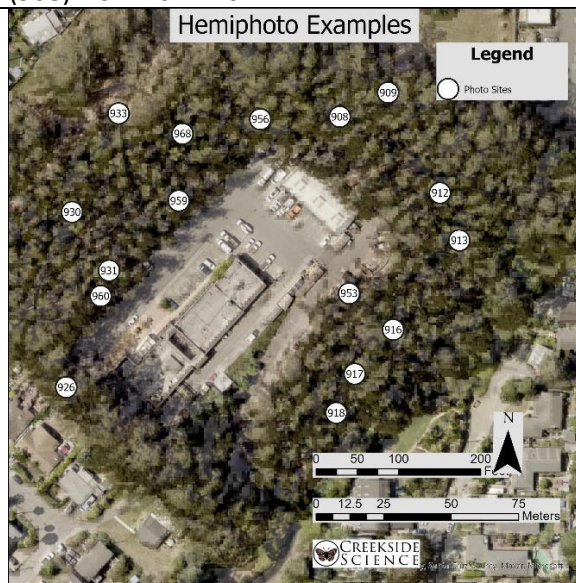
The view from the SE shows the row of trees across the creek from the main grove, and the SE gap at the S corner of the Yard complex.



The view from the NW shows the open NW and NW canopy edges and the SE gap. A row of trees farther NW from the open edge provides some additional wind shelter.

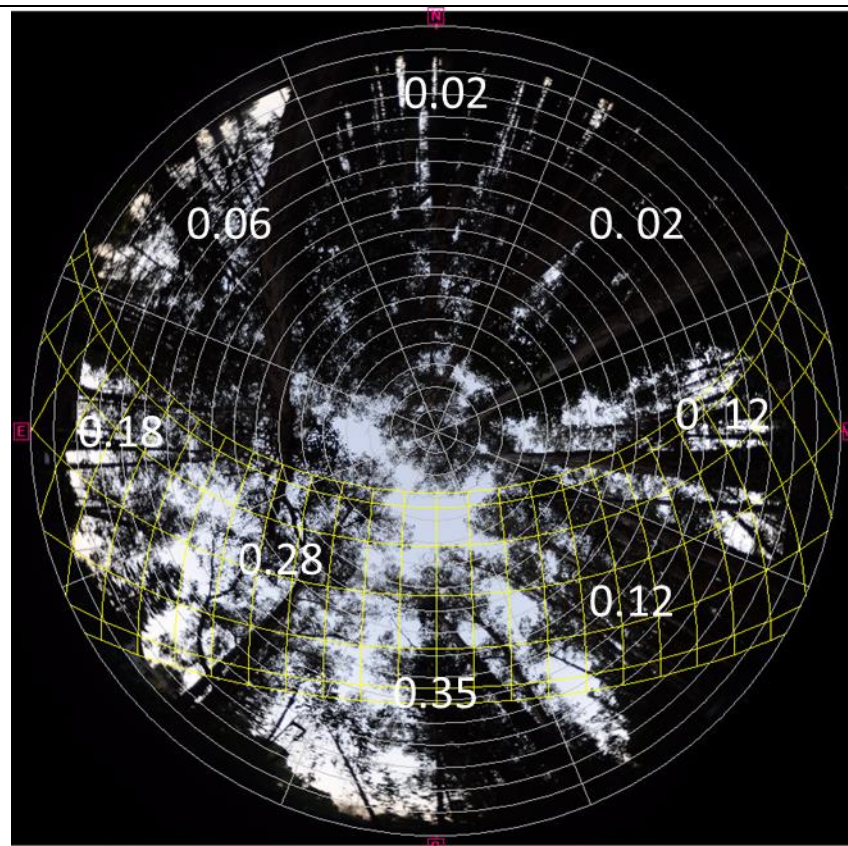


Example Hemiphoto Locations. Hemiphoto examples were chosen to represent a range of situations and include observed cluster location (908) from 2021-2022



Moran Lake Monarch Assessment October 2022

How to interpret a Hemispherical Photograph (Hemiphoto)



The hemiphoto is overlain with a sky grid, with 45° azimuth wedges and 5° increments of zenith angle. The sun grid consists of monthly sunpaths (Dec 21 is the lowest arc, Mar 21 is the center arc, and Jun 21 is the highest arc), divided into half hour increments from E (left) to W (right) [E and W are reversed in upward looking hemiphotos].

ISFU	0.14
DSFU	0.26
October	295 MJ m ⁻² month ⁻¹
November	192 MJ m ⁻² month ⁻¹
December	205 MJ m ⁻² month ⁻¹

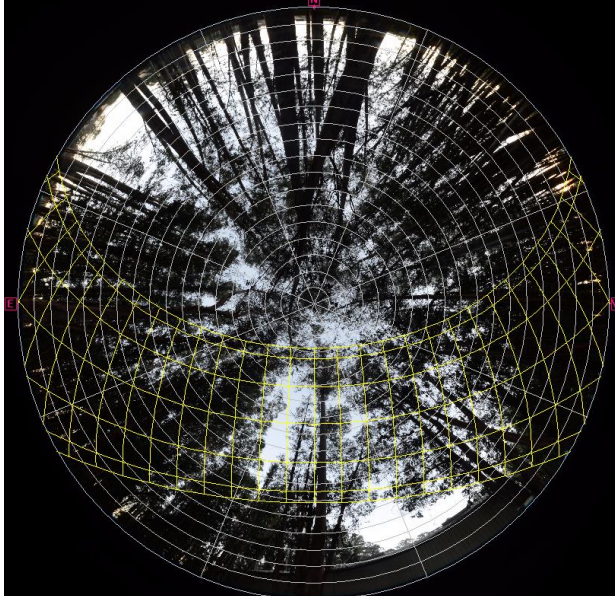
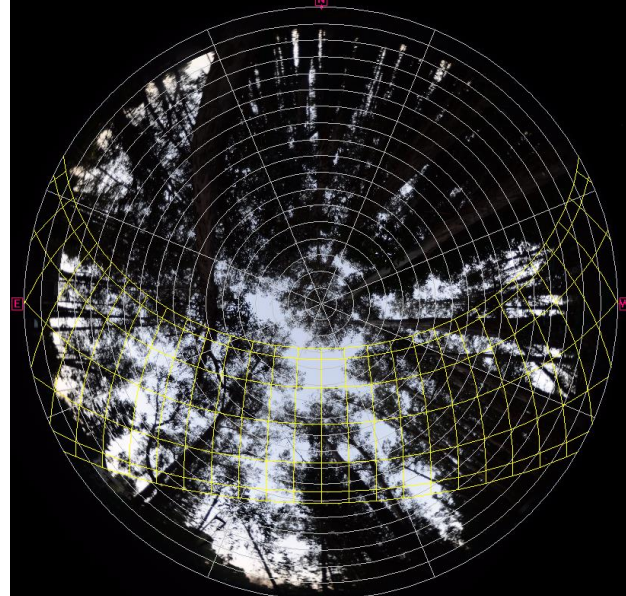
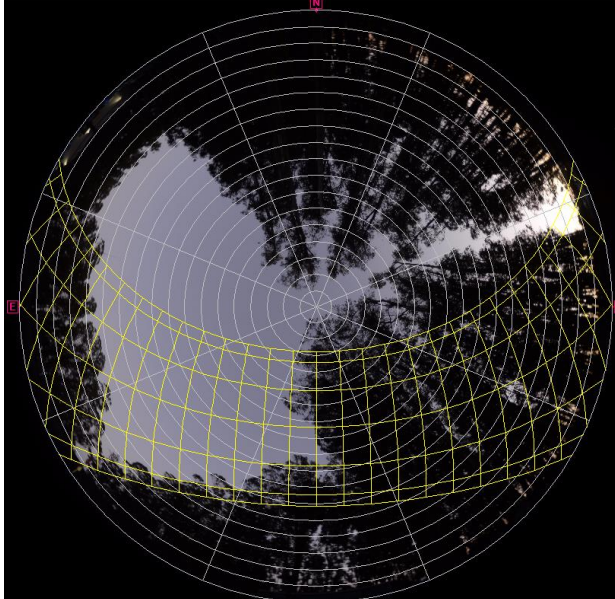
This photograph (913) is from the E corner of the main stand. ISFU (Visible Sky in all directions) is concentrated in the southern half of the image. Insolation is concentrated in the morning, mainly dappled. Little direct insolation is received after ~ 1400 h.



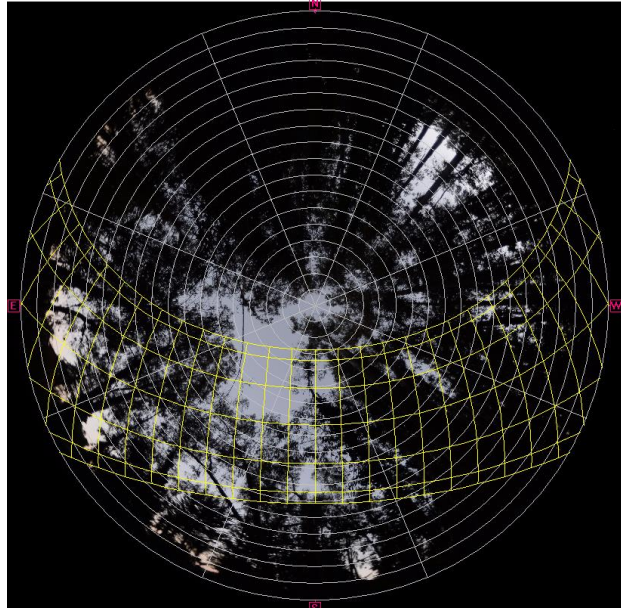
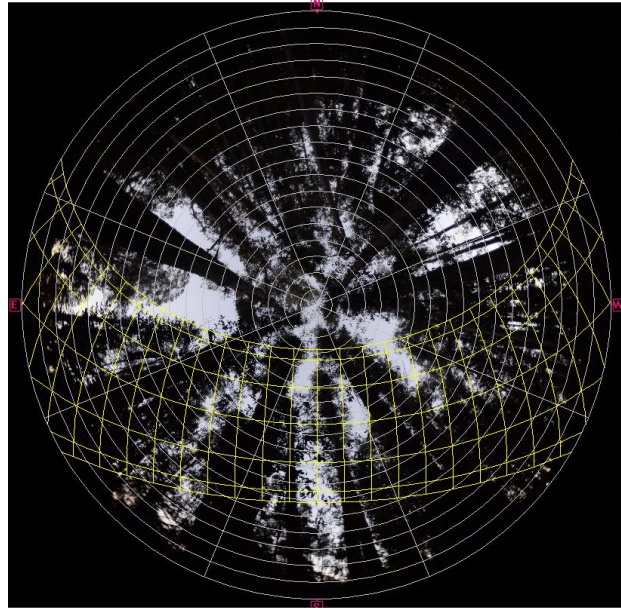
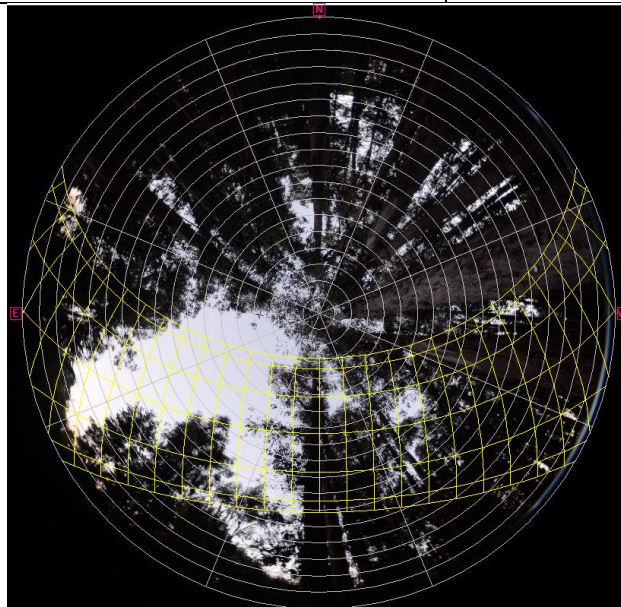
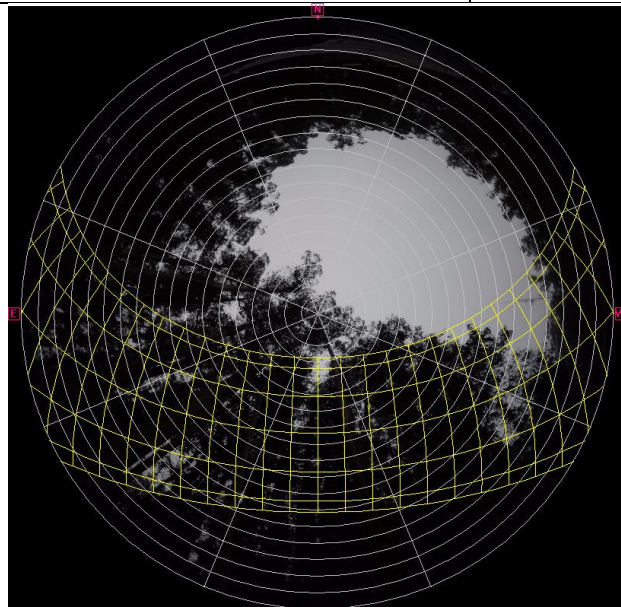
Directional exposure is greatest S (0.35) and SE (0.28) looking across the creek, and lowest N and NE looking back into the dense forest. The openings near the horizon to the NW are across the Yard opening. The "Wind Rose" is a graphical representation of the directional exposure, size of arrows proportional to value, and color coded (aqua = <0.20, yellow 0.20-0.30, red >0.30)

Moran Lake Monarch Assessment October 2022

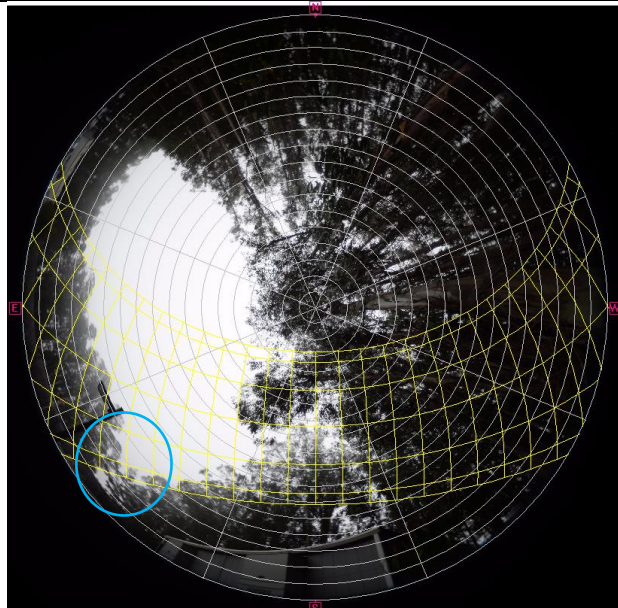
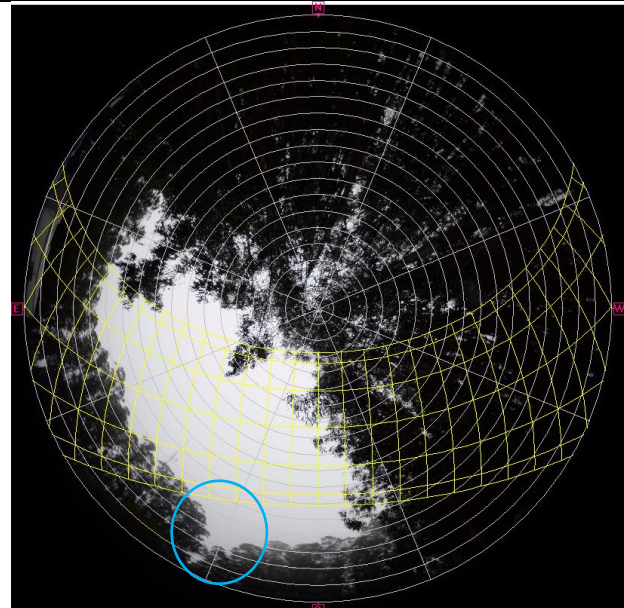
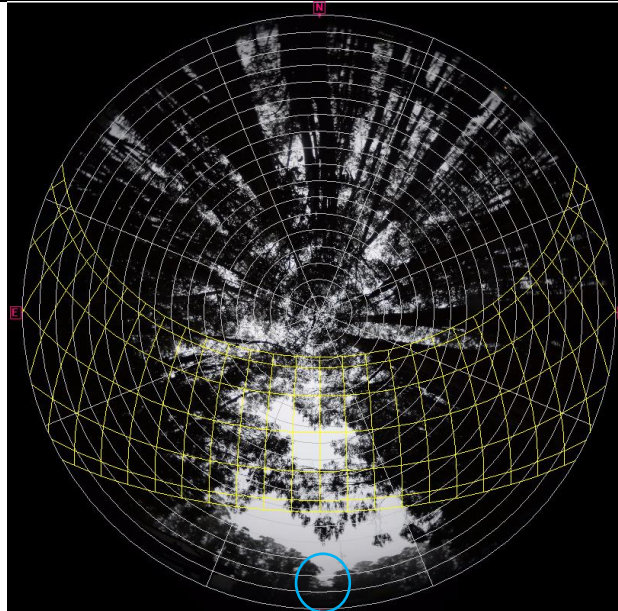
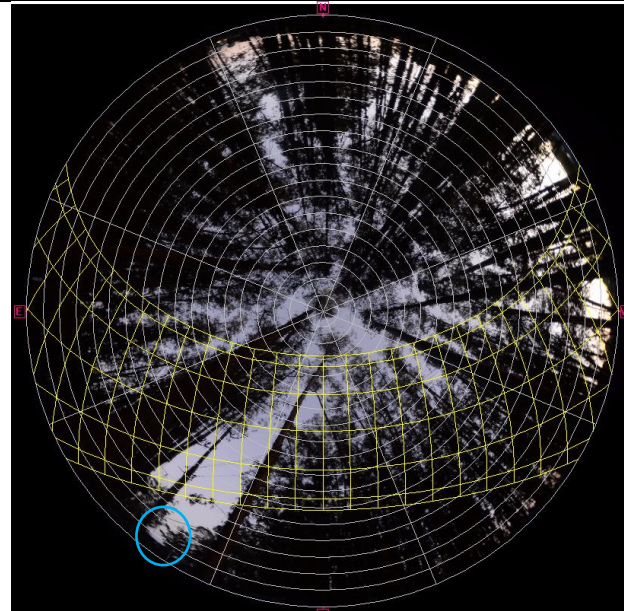
Example Hemiphotos (with wind roses showing exposure)

Photo 908. Cluster Site N-side. Openings to S and SW across Yard, and moderate shelter from N and NE. Dappled insolation from late morning through mid-afternoon ISFU = 0.16 DSFU = 0.16		Photo 913. Wind Site with S SE opening, toward SE end of the “mesa” before descending toward creek. Dappled morning insolation ISFU = 0.14 DSFU = 0.26	
			
Photo 931. Wind Site near cluster site along access road (vertical gap toward WNW). Large opening over Yard, SE gap (see NW and SE Oblique views) visible. ISFU = 0.28 DSFU = 0.37		Photo 909. Wind Site at edge of grove at N end of trail, (note irregular opening along trail to SW) open to Boneyard to NE with the Lone Tree to NNE (see NE Oblique View). ISFU = 0.25 DSFU = 0.09	
			

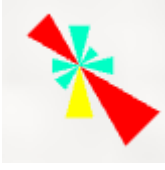
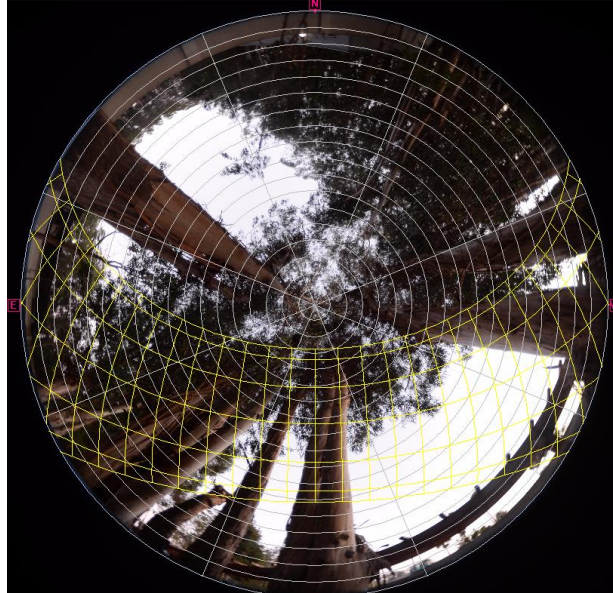
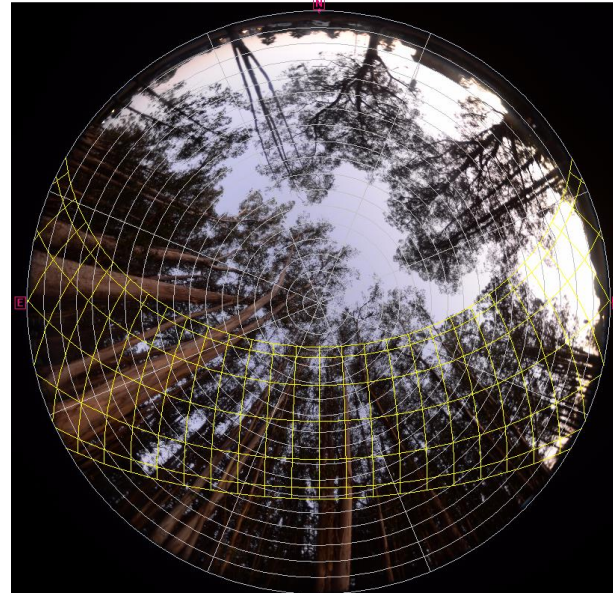
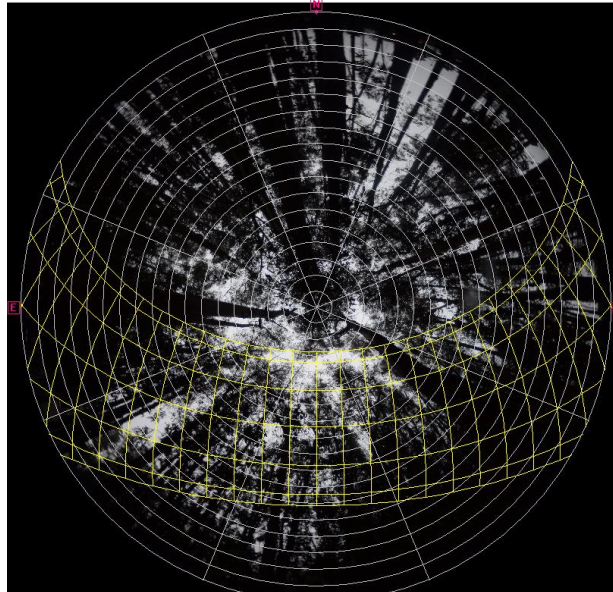
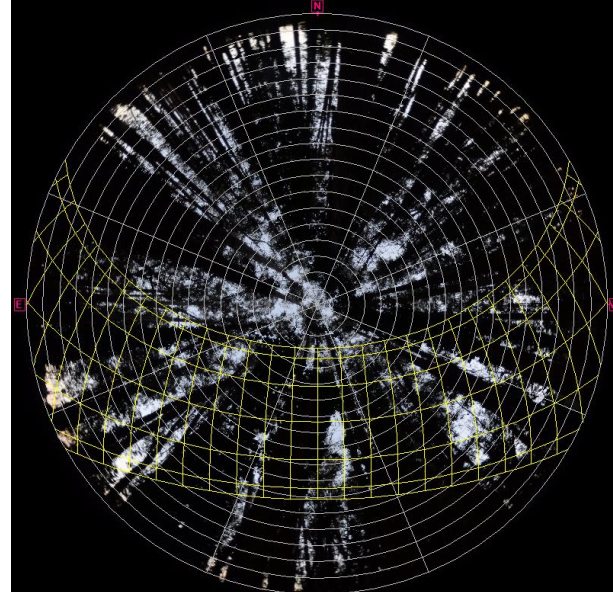
Moran Lake Monarch Assessment October 2022

Photo 916. Wind Site SE Edge, just NW of trail. One gap in trees across the creek to SE (see SE Oblique view). Dappled morning insolation. ISFU = 0.12, DSFU = 0.20		Photo 917. Wind Site SE edge just NW of trail. Trees across creek show few gaps. Largely shaded except for short periods of dappled insolation. ISFU = 0.11, DSFU = 0.15	
			
Photo 918. Wind Site SE Edge just NW of trail. Gap to SE and E across the creek. ISFU = 0.14 DSFU = 0.27		Photo 953. SE edge of Yard. Dense canopy from NE to SW, opening over the Yard from N to W. Dense shade for most of the day. ISFU = 0.20 DSFU = 0.10	
			

Moran Lake Monarch Assessment October 2022

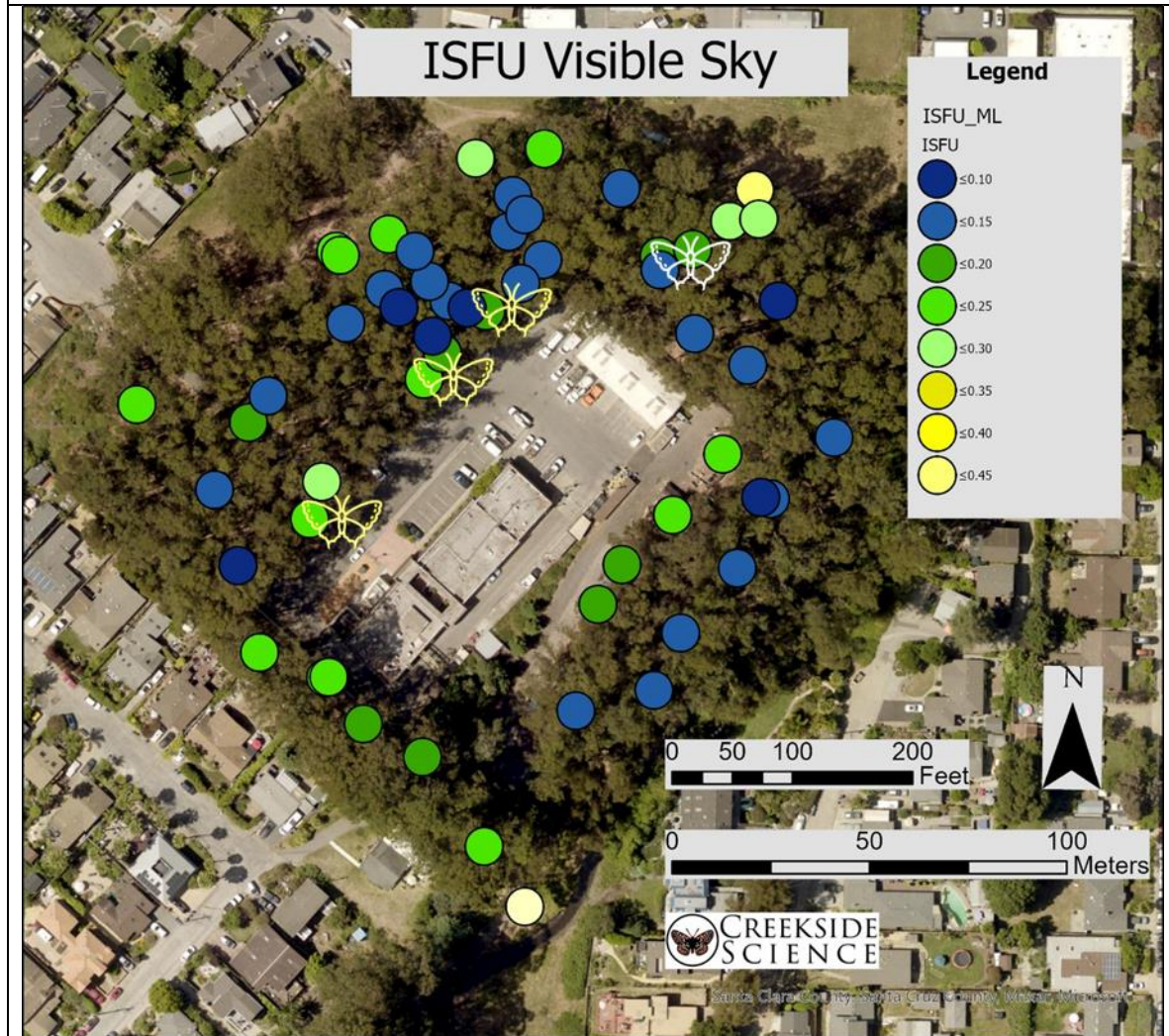
Photo 960. Historical cluster site on NW fence line of Yard. Note vertical gap to SE (circled). Exposed to SE, E and NE winds across Yard. Morning insolation. ISFU = 0.24 DSFU = 0.36		Photo 959 Historical cluster site along NW fence line of Yard, 46 m (150') NE of 960. The vertical gap noted in Photo 960 has shifted to S. ISFU = 0.21 DSFU = 0.43	
			
Photo 956. N corner of Yard. Gap over Yard to S, note the vertical gap (circled) from Photos 960 and 959 due south ISFU = 0.12 DFSFU = 0.18		Photo 930. 26 m (84') NW of Yard. Vertical gap to SE is between the tree rows, with gap on opposite side of Yard still visible. ISFU = 0.15 DSFU = 0.21	
			

Moran Lake Monarch Assessment October 2022

Photo 926. Gap along SW edge, penetrating from SW to NE through the stand. ISFU = 0.21 DSFU = 0.25		Photo 933. NW edge of grove. The row of trees 25 m (85') to the NW help shelter the edge. ISFU = 0.22 DSFU = 0.11	
			
Photo 968. Interior of NW stand. Well-sheltered from all directions. Low insolation. ISFU = 0.10 DSFU = 0.15.		Photo 912. Interior site near E corner of Yard. Dense canopy, well sheltered from all directions Low insolation, ISFU = 0.10 DSFU = 0.07	
			

Moran Lake Monarch Assessment October 2022

ISFU (Visible Sky) The vast majority of monarch cluster sites have ISFU between 0.15 and 0.30, which are shown in green. The blue sites are too closed, and the yellow sites are too open. The observed cluster sites (white circle) on the NE side of the Yard are in that range, as are the sites on the NW side.

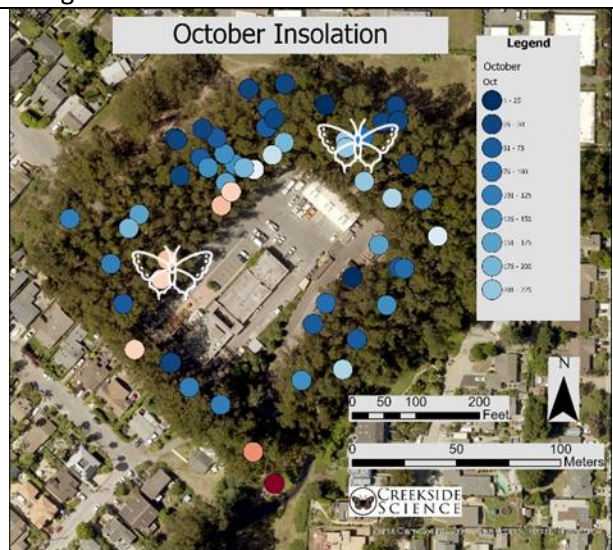
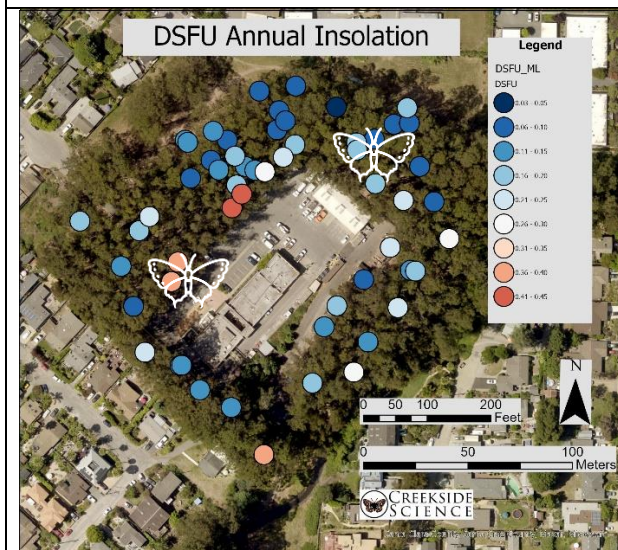


Moran Lake Monarch Assessment October 2022

Direct Below Canopy (1.75 m) Insolation from Hemiphotos

DSFU is the fraction of potential annual insolation, and includes sunpaths for all months, and can approximate insolation exposure higher in the canopy Cluster sites are white circles.

October insolation shows the relatively brighter conditions at the NE cluster site (Photo 908), where direct sun penetrates through the forest from the S. High insolation also at the NW site along the access road.



November insolation has a similar pattern to October, but values are lower because the sun tracks lower in the sky. Cluster sites still relatively brighter than surrounding forest,

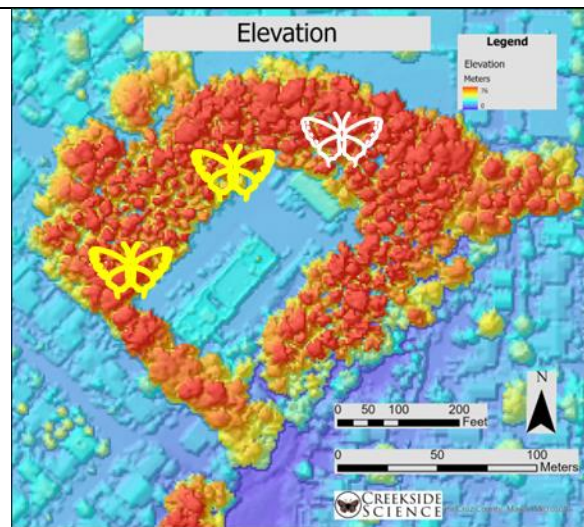
December insolation still shows relatively brighter cluster sites than surrounding forest. Sites along the creek trail SE of Yard are brighter than sites farther up the hill.



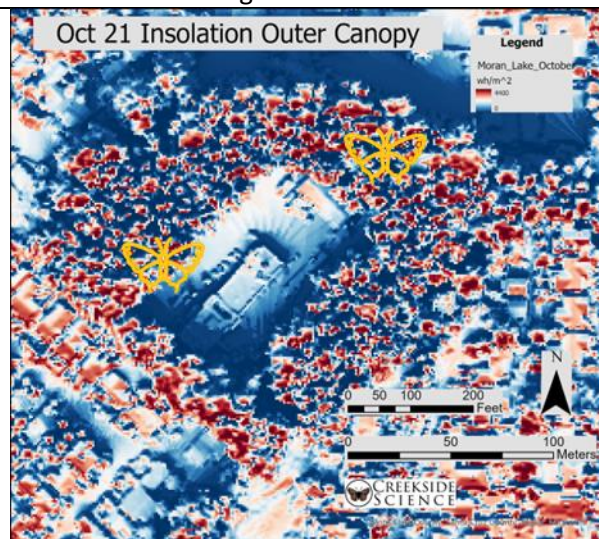
Moran Lake Monarch Assessment October 2022

Outer Canopy Insolation from ARCGIS Solar Radiation Calculator

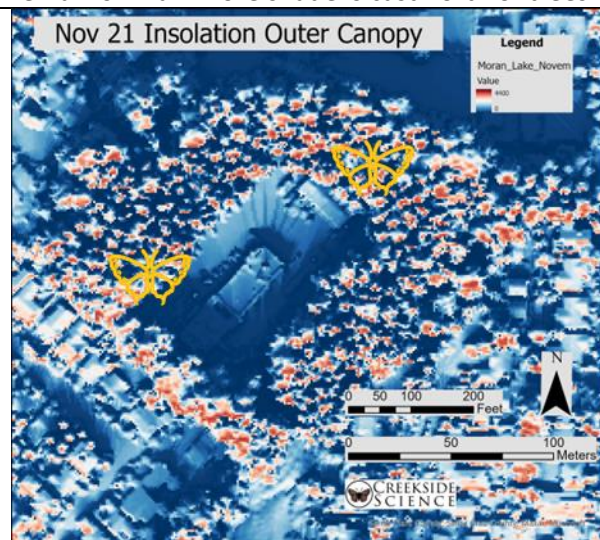
Digital Surface Model (DSM) of the grove surrounding the Yard, with current and some historical cluster sites shown.



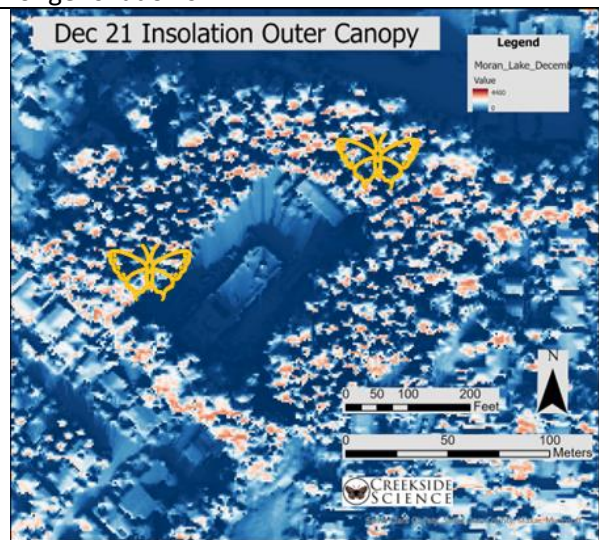
October 21 insolation at outer canopy surface. The south-sides of trees receive the highest insolation. Canopy gaps in the high insolation (red) areas allow penetration to potential cluster sites. Note the shade cast into the open Yard and to the north of the grove.



November 21 insolation at outer canopy surface. Values are lower than in October, but patterns remain similar. More shade is cast north of trees.



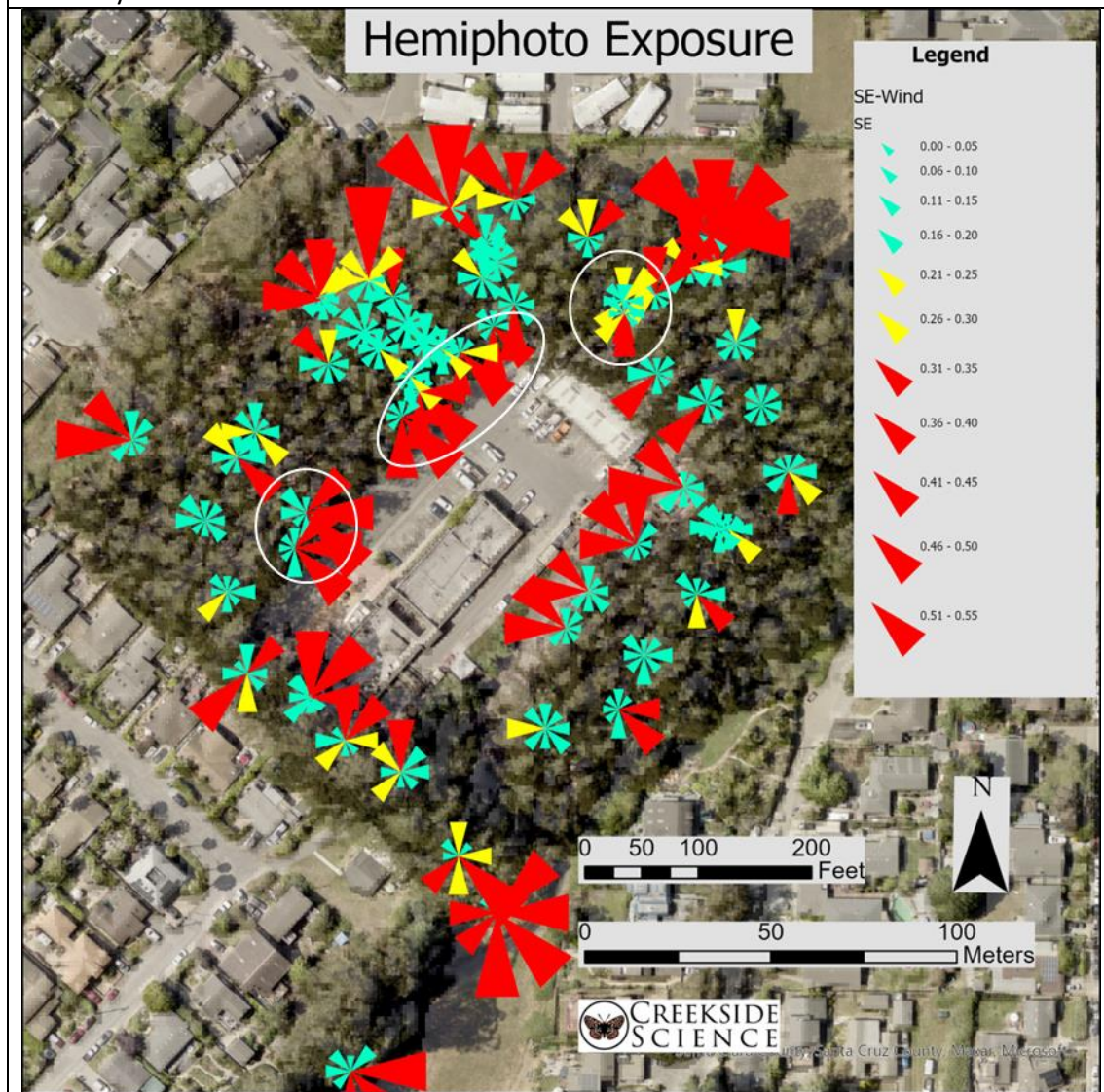
December 21 insolation at outer canopy surface. Similar to November 21, but lower values and longer shadows



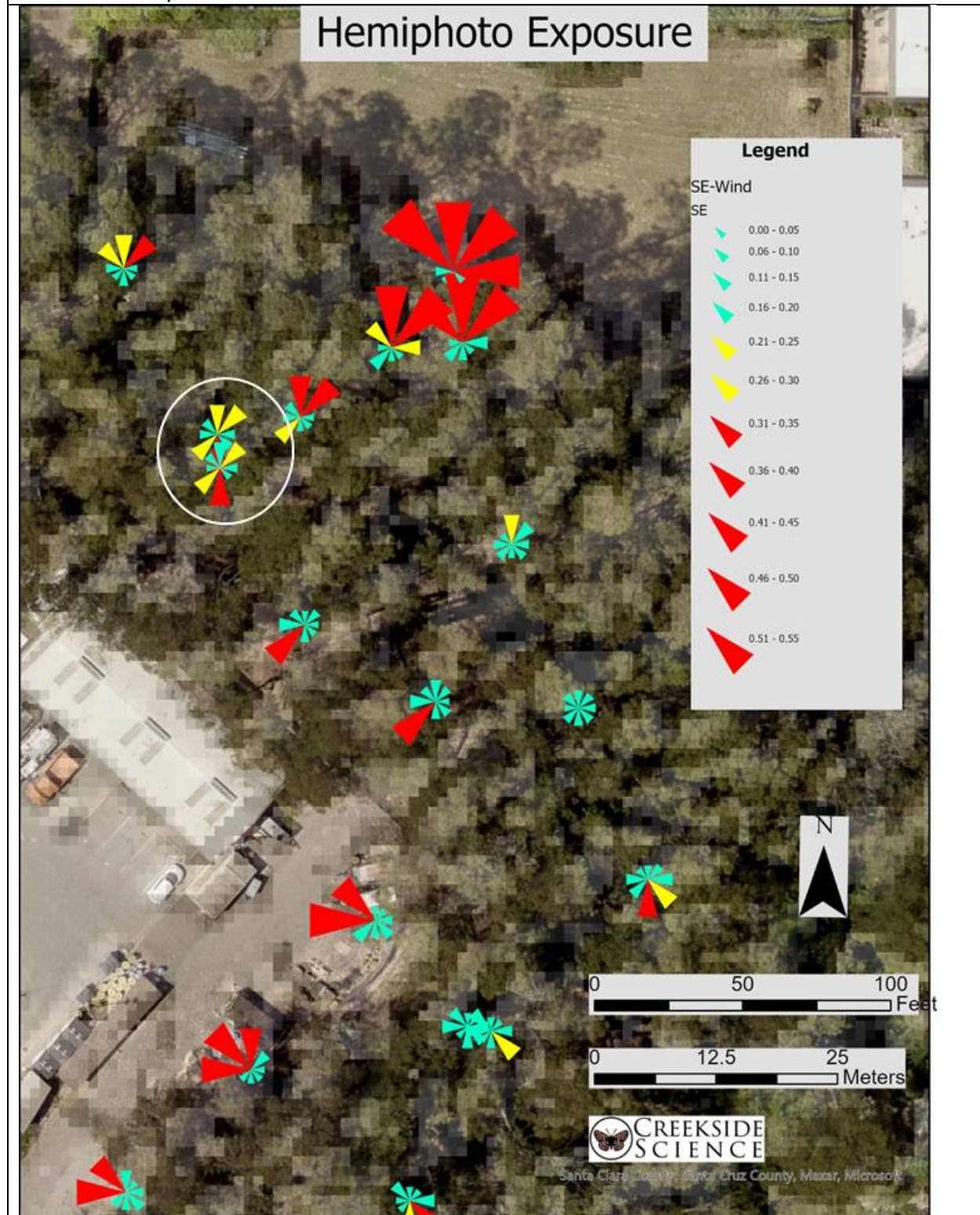
Moran Lake Monarch Assessment October 2022

Hemiphoto Exposure in Eight Directions

The exposure (proportion of visible sky) in each direction is represented by the size of the arrows. Cyan are < 0.20 , yellow are $0.20-0.30$, and red are > 0.30 . The “exposure roses” are shown in the example photos above, so one can see what different values mean visually. Forest interior sites are generally well sheltered, but open edges and roads/trails expose more sky. Current and historical cluster sites are within the circles.



Close-up of the NE cluster zone. The 2022 cluster site is circled, note the mix of cyan and yellow arrows with only one red to the S.

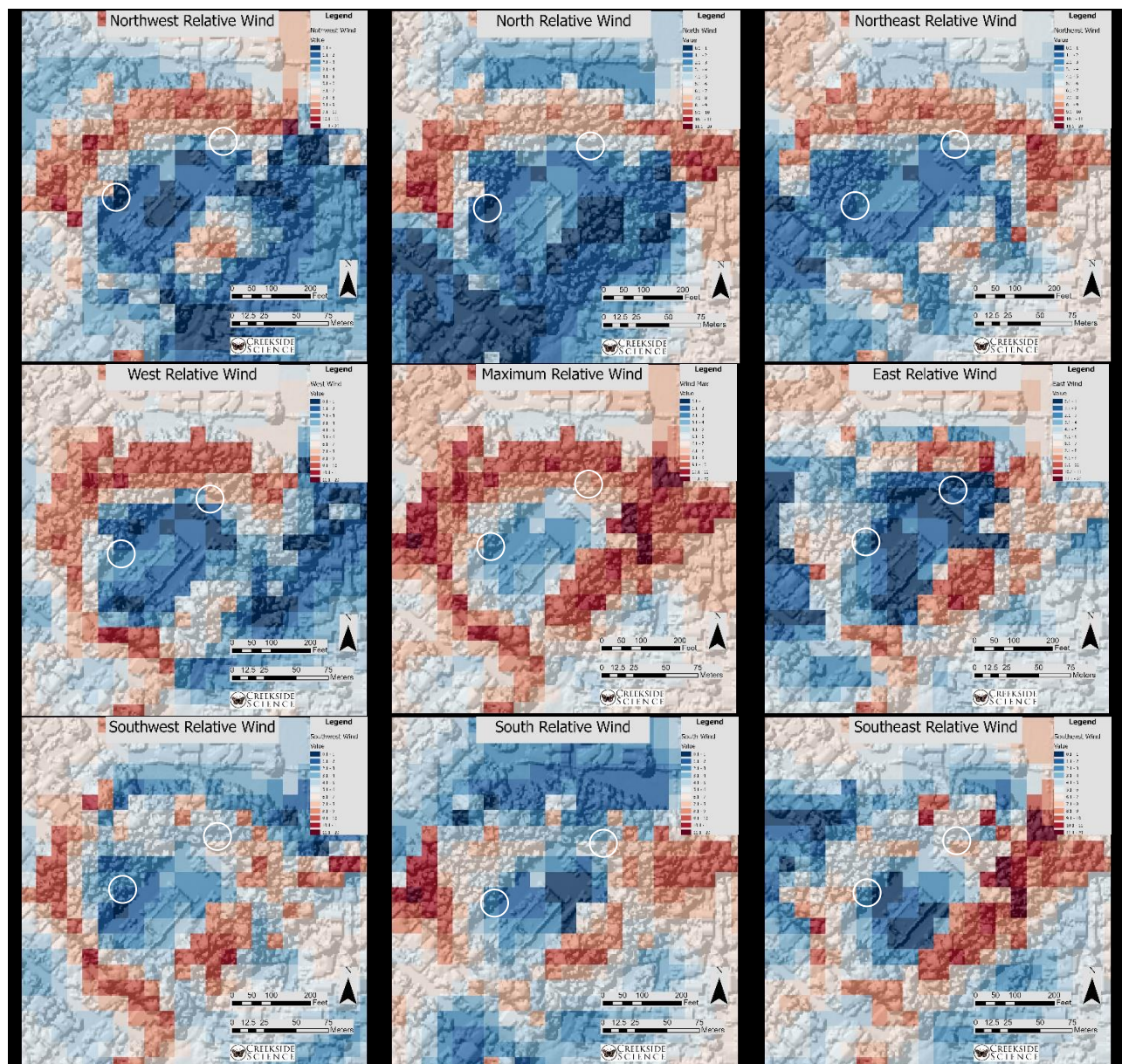


Moran Lake Monarch Assessment October 2022

Relative Wind Exposure at Canopy Surface (WindNinja)

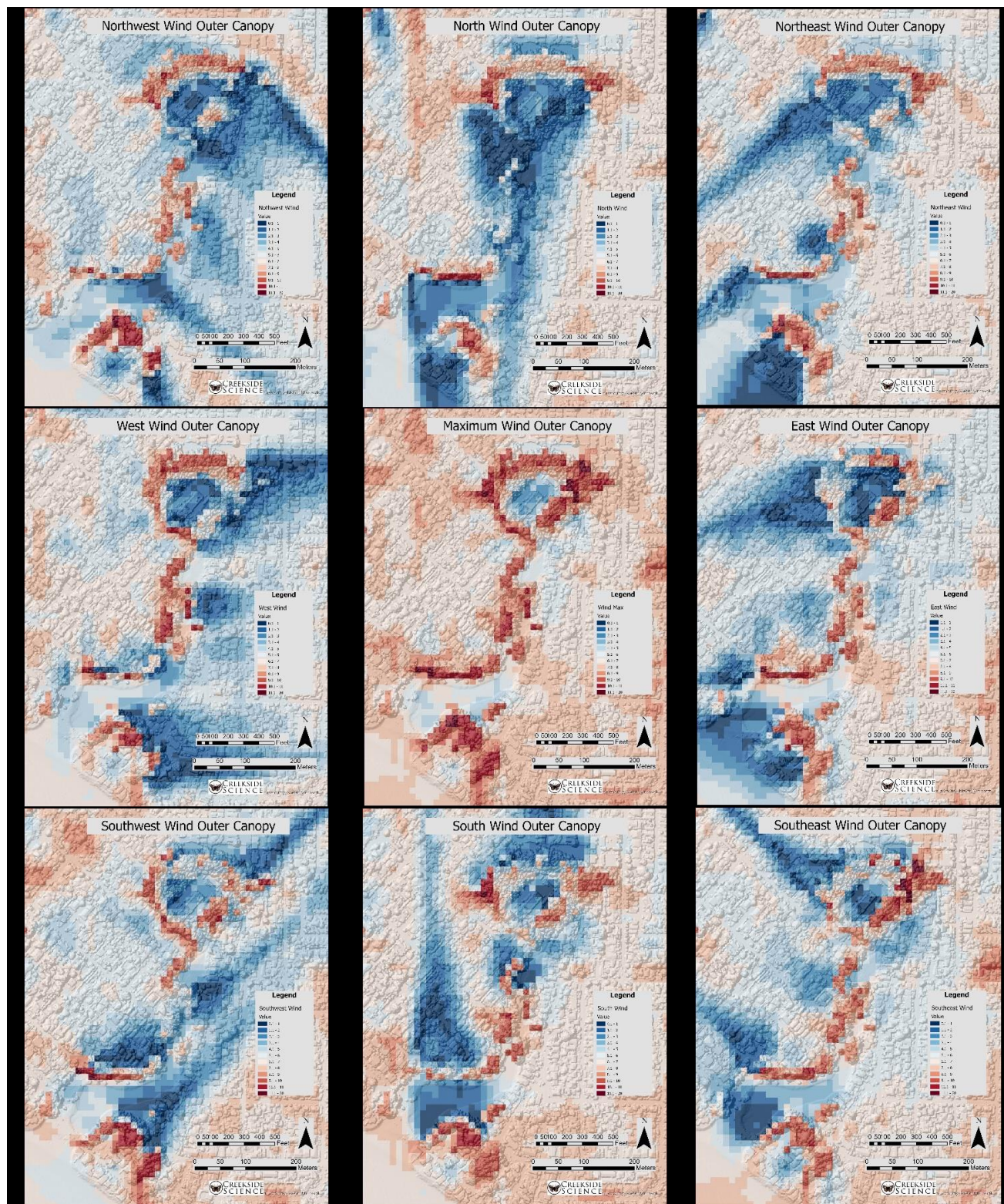
The outputs of WindNinja are at a 10-meter scale at the outer canopy surface and capture the effects of larger structures such as stands of trees or buildings. These maps assume a 10 m/s (22.4 mph) wind coming from the indicated direction and provide a measure of relative wind exposure based on features at the 10 m spatial scale. The analyses do not account for small gaps in the canopy that lead to the interior (that is the realm of hemiphotos). The tops of trees on windward edges have the highest relative wind (dark reds). The Yard interior has wind shelter from most directions (blues), but the interior edges of the Yard sometimes have moderate shelter (white or light red).

The smallest structural element that is captured is the SE gap around the Yard, which can be seen best in the Maximum map in the center, where the band of high exposure at the treetops surrounding the Yard (dark red) is interrupted by a 10 m wide band of lower wind (white).



Moran Lake Monarch Assessment October 2022

Maps of the entire site show sheltering effects of tall trees extending well downwind. But the trees extending S along the creek and lagoon appear to have minimal effects around the Yard, even with S wind. Management efforts, therefore, should concentrate on the immediate surroundings of the Yard.



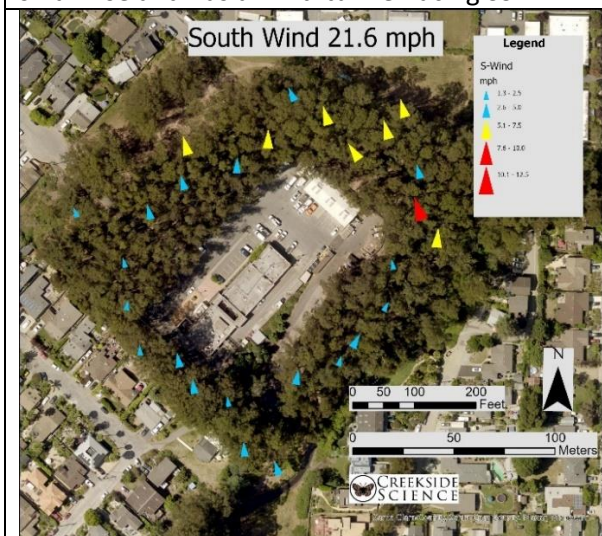
Moran Lake Monarch Assessment October 2022

Wind Measurements

Wind measurements (2-minute average at each point) on three dates demonstrate some of the vulnerabilities. The maximum wind speed among the sites is posted in the title. Arrows are sized by speed and color-coded – blue is <5 mph (~2 m/s), a threshold for site occupancy, yellow are 5-7.5 mph (marginal), and red are >7.5 mph. The direction of the arrows shows how wind directions vary from the overall wind field. Attenuation is the ratio of the wind to the maximum measured at any site.

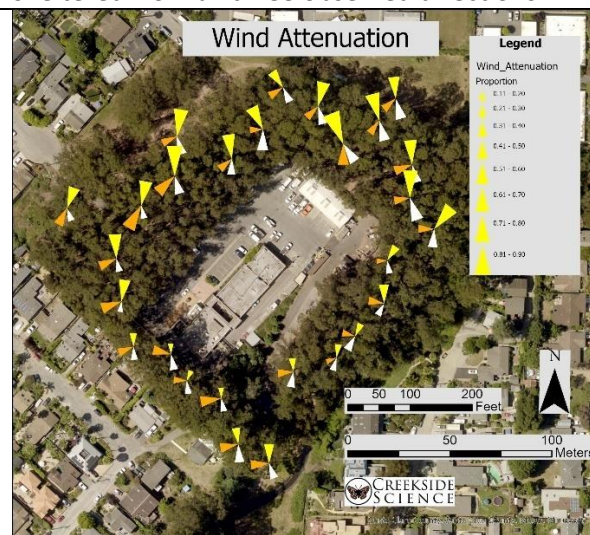
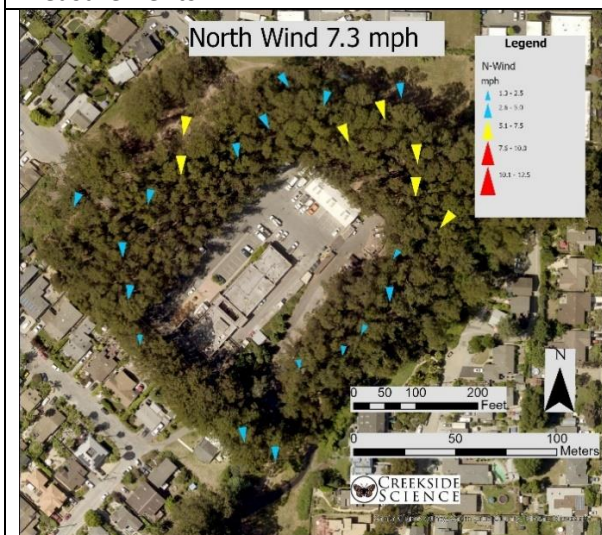
Measured wind Dec 13, 2021. Strong S winds were attenuated by the forest but penetrated into the cluster area NE of the Yard, through and around the E corner of the grove. The red site due east of the Yard (Photo 913) is at the top of a small rise and has a wind-tunnel facing SSE.

Measured wind July 7, 2022. The low speed of the maximum wind in the area (6.8 mph) meant that all sites were below the 5 mph threshold. The overall low speed around the pump station reflects the shelter provided by the urban matrix.



Measured wind Jan 21, 2022. Northerly winds penetrated into the cluster area through the open NE edge. Monarchs were active in the sheltered areas along the SE edge during these measurements.

Attenuation of maximum wind. The attenuation factors standardize wind speeds. The open NE and NW edges produce wind vulnerabilities in those sectors. The SE edge along the creek is sheltered from all three observed directions.



Moran Lake Monarch Assessment October 2022

Methods

LiDAR Analysis

LiDAR Analysis: LiDAR (Light Detection and Ranging) is an airborne laser scanner that sends pulses and measures the reflections at a density of ~12 points/square meter. Flown in 2020 for vegetation mapping and other purposes in Santa Cruz and San Mateo, Counties (OCM Partners, 2022: 2020 San Mateo RCD Lidar: Santa Cruz County, CA, <https://www.fisheries.noaa.gov/inport/item/63258>), it provides a three-dimensional “point cloud” that can characterize the structure of the forest canopy and underlying ground surface. In recent years, it has become a useful method for quantifying monarch habitat through insolation and wind modeling, and providing 3-dimensional views of sites.

The LiDAR point cloud is processed and analyzed as follows:

- 1) Creation of a Digital Surface Model (DSM) of the outer canopy by taking the average height of the first hit averaged over each square meter.
- 2) The DSM is input into ARCGIS solar radiation modeling tools to create surfaces of daily insolation for October 21, November 21, and December 21. Because insolation is virtually symmetrical around the winter solstice, November 21 is equivalent to January 21, and October 21 is equivalent to February 21. Atmospheric transmissivity is set to 0.65, and 10% of the insolation is diffuse (clear-sky conditions). Radiation units are in watt-hours/m². This analysis assumes that the canopy is solid, and is only applicable to the outer canopy surface (where monarchs often cluster) and the open ground such as the Glen center. The interior conditions with more dappled insolation are quantified by hemispherical photography (see below).
- 3) The DSM is also used as an input surface for wind analysis using WindNinja. This program (developed by the USDA Forest Service Fire Lab in Missoula, MT) distributes a specified wind speed and direction over complex surfaces. In this analysis, a wind speed of 10 m/s (22.3 mph) is specified from eight cardinal directions. The resulting maps are indicative of *relative* wind shelter caused by terrain (i.e., the ridge to the north), upwind trees, and the outer canopy of the grove itself. Like the insolation model, the results are applicable only to the outer canopy surface, not sites within the canopy. The spatial scale of the WindNinja output is 10 meters, so it captures larger structures like shelterbelts, not individual branches. Forest interior conditions and small openings in shelterbelts are quantified by hemispherical photography (see below).
- 4) To characterize the vertical distribution of canopy, height metrics are extracted on a 5-meter grid. Metrics include mean return height, standard deviation, skew, and kurtosis, which can indicate if the canopy is continuous from the ground to the top (a good wind screen), or skewed toward the top with openings lower down (allows wind to penetrate through the canopy).

Hemispherical Photography

Hemispherical photography has been a standard method for assessing forest canopy structure at monarch overwintering sites. Photographs are taken using a Nikkor 8mm lens on a Nikon D610 camera body, mounted on self-leveling gimbals so that the photograph is pointed straight up at the zenith. A compass is used to orient to north.

Photographs are analyzed with Hemiview 2.0 software (Delta-T Devices). The photographs are aligned, and a gray-scale threshold is interactively selected to differentiate sky from obstructions. Photographs

Moran Lake Monarch Assessment October 2022

are best taken under uniform overcast conditions, or at sunrise or sunset, when there is no direct illumination of the canopy (which can be brighter than the sky).

Hemiview overlays a “sky grid” (gray) that divides the upward hemisphere into 5° zenith angle increments (18 total = 90°) and 45° azimuth wedges centered on the eight cardinal directions. The fraction of open sky in each segment is calculated and weighted by the geometry of the segment depending on the analysis. Hemiview also overlays a “sun grid” (yellow) based on site latitude, with monthly increments through the year, and half-hourly increments over the day. The December 21 sunpath (winter solstice) is the lowest path, the middle path is March 21, and the highest path is June 21. The fraction of open sky in each of the segments is calculated, and the specified solar model is used to calculate insolation. The example photographs show both grids.

The following “site factors” are extracted:

- 1) ISFU – Indirect Site Factor Uncorrected, the fraction of visible sky in all directions.
- 2) DSFU – Direct Site Factor Uncorrected, the fraction of potential radiation across all months.
- 3) Nov/Feb and Dec/Jan potential direct insolation – calculated from fraction of unobstructed monthly sunpaths assuming clear skies.
- 4) Directional Exposure – the fraction of sky visible in eight compass directions, a measure of relative wind exposure.

The hemiphoto data are mapped as points because the photo grid was not dense enough to create an interpolated surface.

Appendix B

Moran Lake Restoration Project Arborist Report



Moran Lake Restoration Project

Arborist Report

prepared by

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Table of Contents

1	Project Overview	1
2	Scope of Report	3
3	Survey Methods	4
4	Survey Results	6
5	References	7

Tables

Table 1	Trees Documented by Species within the Park	6
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Figures

Figure 1	Tree Inventory Area	2
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Appendices

Appendix A	Tree Inventory Table Results Summary
Appendix B	Tree Inventory Figures

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1 Project Overview

Rincon Consultants, Inc. (Rincon) was contracted through Santa Cruz County to prepare an Arborist Report (report) to assist in the preparation of the Moran Lake Restoration Plan (Project) and the Monarch Butterfly Habitat Management Plan Update for Moran Lake County Park (Park), which is located at 22775 East Cliff Drive in Santa Cruz, California. The Project will involve the restoration and enhancement of wetland habitat to improve its functionality and the water quality within Moran Lagoon, will enhance the lagoon and the surrounding areas climate change resilience, and improve public access and urban green space for the parks neighboring communities. As shown in Figure 1, the tree inventory area is located entirely within Park parcels owned and maintained by the County of Santa Cruz and includes portions of developed land and forested undeveloped land on an approximately 18.5-acre site.

Figure 1 Tree Inventory Area



2 Scope of Report

This report is intended to provide tree information to inform planning and design of the Project and the Monarch Butterfly Habitat Management Plan Update. More specifically, this report details the findings from the tree survey (survey), which was conducted by International Society of Arboriculture (ISA) Certified Arborist Casey Clark and Rincon Biologist Kate Ludwig on June 7 and June 8, 2022. During the survey a tree tag was assigned to each tree surveyed and the location, species, diameter at breast height (DBH), height, canopy spread, general health condition, and any relevant notes (particularly pertaining to structural integrity) were recorded for each tree.

3 Survey Methods

All newly planted native trees in the park, landscape/ornamental trees, and all naturally occurring trees with a diameter at breast height (DBH) of 4 inches or greater were surveyed if they had any portion of their canopy in the Park. All newly planted native trees and landscape/ornamental trees, regardless of size, were surveyed to collect data on their establishment success. The number of trunks, DBH, location, height, canopy spread, general health condition, and any relevant notes (particularly pertaining to their structural integrity) were recorded for each tree. DBH measurements were taken with a diameter tape or Biltmore stick and were taken in accordance with American Forests Champion Tree Measurement Guidelines (American Forests 2015). All trees with a DBH of greater than 60" were recorded as "60+" due to equipment limitations. A Global Positioning System (GPS) device with submeter capability was used to collect the location of each tree's trunk. Tree tags were affixed to the tree's trunk approximately 6 feet above the ground, primarily facing north. Each tree's unique tag number was sequential along the survey path. Numerous trees had tree tags with numbers from past surveys. To avoid confusion from previous tree inventories, tree tag numbers for this survey began at 1001 and concluded at 1348 within the main Park area. The Parks extension area, sanitation facility, and remnant landscape/ornamental trees surrounding the parking area were surveyed separately and tagged with numbers beginning at 3001 and concluding at 3095. Tree height and canopy spread were visually estimated in the field. The health condition of each tree was evaluated by using a basic visual inspection method, and the arborist assigned one of the following general condition ratings to each tree:

- **Good:** Overall good tree vigor¹, healthy foliage and cambium² with no significant defects³ or pest infestations. The location is optimal for the tree, and the tree is expected to survive long term.
- **Fair:** Overall moderate tree vigor, moderately healthy foliage and cambium with no serious defects or pest infestations. The tree's location may not be optimal for that species, but further decline is not anticipated.
- **Poor:** Overall poor tree vigor, declining foliage and cambium health due to abiotic and/or biotic factors. Notable defects or pest infestations may be present. Typically, poor vigor results when a tree is outcompeted by other plants, or the tree is in the wrong location.
- **Dead:** The tree is dead or very close to death and will not recover.

Individual tree ratings consider a variety of factors, including overall tree vigor, foliage condition, cambium condition, evidence of decay, insect or disease infestations, and any other notable structural defects. The survey was limited to visual examination of accessible parts without dissection, excavation, probing, or coring. There is no warranty or guarantee, expressed or implied, that problems or deficiencies regarding the trees discussed in this report may not arise in the future.

Hazardous structural defects and any other relevant information were recorded for each tree when detected.

¹ Vigor refers to the force of healthy growth in any living matter or organism.

² Cambium is the cellular plant tissue in woody plants from which phloem, xylem, or cork grows by division, resulting in secondary growth. Cambium is the layer just inside the tree's bark.

³ Defect refers to any physical abnormality that indicates poor tree health (e.g., exfoliating bark, epicormic growth, fire scars).

Due to time constraints, only priority trees (i.e., dead, dying/“Poor”, newly planted trees, and hazards trees) were surveyed within the sanitation facility grove (trees 3055 to 3092). Additionally, notes on the grove’s average diameter and diameter range, average height and canopy height range, average canopy spread and total canopy coverage, and overall health notes were taken.

4 Survey Results

Six different species and a total of 443 trees were documented during the survey. Table 1 lists the total number of each species documented and their origin (i.e., native or introduced).

Table 1 Trees Documented by Species within the Park

Tree Species	Origin	Count
Blue gum eucalyptus (<i>Eucalyptus globulus</i>)	Introduced	411
Coast redwood (<i>Sequoia sempervirens</i>)	Introduced	7
Mexican fan palm (<i>Washingtonia robusta</i>)	Introduced	1
Monterey Cypress (<i>Hesperocyparis macrocarpa</i>)	Introduced	21
New Zealand christmas tree (<i>Metrosideros excelsa</i>)	Introduced	2
Strawberry tree (<i>Arbutus unedo</i>)	Introduced	1

A summary of all 443 trees inventoried is provided with this report in Appendix A. Appendix A lists each tree sequentially by number and includes its species, the number of trunks, DBH, height, canopy spread, general health condition rating, and any relevant notes (particularly pertaining to their structural integrity). The summarized information of the sanitation facility grove, including its DBH range, height range, canopy spread range, overall health condition, and relevant notes are documented at the bottom of the table. A map depicting each trees location, tag number, species, health condition (Poor or Dead only), and potentially hazardous trees is presented in Appendix B.

5 References

American Forests. 2015. American Forests Champion Tree Measurement Guidelines. Available online at https://www.americanforests.org/wp-content/uploads/2014/12/AF-Tree-Measuring-Guidelines_LR.pdf. Accessed July, 2022.

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Appendix A

Tree Survey Results Summary

Tag Number	Species	Number Of Trunks	DBH (inches)	Tree Height (Feet)	Canopy Spread (Feet)	Overall Health Condition	Notes
1001	Monterey cypress (<i>Hesperocyparis macrocarpa</i>)	1	16	45	20	Good	
1002	Monterey cypress	1	34	40	35	Good	
1003	Monterey cypress	1	6	20	15	Poor	
1004	Monterey cypress	1	8	25	10	Fair	
1005	Monterey cypress	1	17	30	15	Good	
1006	Monterey cypress	1	21	35	25	Good	
1007	Monterey cypress	1	17	35	15	Good	
1008	Blue gum (<i>Eucalyptus globulus</i>)	1	35	50	30	Good	
1009	Blue gum	1	22	45	20	Good	
1010	Blue gum	1	47	60	30	Good	
1011	Blue gum	1	25	40	30	Good	
1012	Blue gum	3	14, 23, 10	35	15	Good	
1013	Blue gum	1	23	35	20	Fair	
1014	Blue gum	2	16, 12	40	25	Good	
1015	Blue gum	1	10	30	15	Fair	
1016	Blue gum	1	21	30	10	Good	
1017	Blue gum	1	27	30	10	Good	Significant amount of epicormic shoots present.
1018	Blue gum	1	17	35	15	Fair	Branch dieback.
1019	Blue gum	1	44	50	30	Good	
1020	Blue gum	1	19	30	10	Fair	
1021	Blue gum	1	29	25	15	Good	
1022	Blue gum	1	26	30	15	Good	
1023	Blue gum	1	23	40	15	Poor	Severe English ivy infestation. Branch dieback.
1024	Blue gum	1	30	50	30	Good	
1025	Blue gum	1	23	35	20	Good	

Moran Lake County Park
Moran Lake Restoration Project

Tag Number	Species	Number Of Trunks	DBH (inches)	Tree Height (Feet)	Canopy Spread (Feet)	Overall Health Condition	Notes
1026	Blue gum	1	26	50	15	Good	
1027	Blue gum	2	11, 15	40	10	Fair	
1028	Blue gum	1	18	40	15	Fair	
1029	Blue gum	1	21	50	15	Good	
1030	Blue gum	1	21	50	15	Good	
1031	Blue gum	1	42	50	15	Fair	
1032	Blue gum	1	21	55	20	Good	
1033	Blue gum	1	41	50	15	Good	
1034	Blue gum	1	36	45	10	Fair	Tree was previously topped.
1035	Blue gum	1	25	55	30	Good	
1036	Blue gum	1	17	25	15	Good	
1037	Blue gum	1	40	35	15	Good	
1038	Blue gum	1	22	35	20	Good	
1039	Blue gum	1	19	35	30	Good	
1040	Monterey cypress	1	13	30	30	Good	
1041	Monterey cypress	1	14	25	30	Good	
1042	Monterey cypress	1	15	30	35	Good	
1043	Monterey cypress	1	17	35	35	Good	
1044	Monterey cypress	1	17	35	35	Good	
1045	Blue gum	1	54	65	50	Good	Potentially hazardous tree. Long heavy branches leaning over trail.
1046	Blue gum	1	50	70	35	Good	
1047	Blue gum	1	55	100	45	Good	
1048	Blue gum	1	60+	100	40	Good	
1049	Blue gum	1	36	80	40	Good	
1050	Blue gum	1	55	90	50	Good	
1051	Blue gum	1	43	110	40	Good	

Tag Number	Species	Number Of Trunks	DBH (inches)	Tree Height (Feet)	Canopy Spread (Feet)	Overall Health Condition	Notes
1052	Blue gum	2	40, 35	90	60	Good	
1053	Blue gum	1	41	90	60	Good	
1054	Blue gum	1	38	80	20	Good	
1055	Blue gum	1	27	80	30	Good	
1056	Blue gum	1	60+	100	65	Good	
1057	Blue gum	1	60+	110	40	Good	
1058	Blue gum	1	32	100	30	Good	
1059	Blue gum	1	27	60	20	Fair	
1060	Blue gum	1	51	100	35	Good	
1061	Blue gum	1	23	80	30	Good	
1062	Blue gum	1	32	90	20	Good	
1063	Blue gum	1	36	75	15	Good	
1064	Blue gum	1	51	100	20	Good	
1065	Blue gum	1	28	100	40	Good	
1066	Blue gum	1	18	90	30	Good	
1067	Blue gum	1	13	70	20	Good	
1068	Blue gum	1	12	60	15	Good	
1069	Blue gum	1	41	100	25	Good	
1070	Blue gum	1	54	120	45	Good	
1071	Blue gum	1	56	100	40	Good	
1072	Blue gum	1	29	80	45	Good	
1073	Blue gum	1	34	90	45	Good	
1074	Blue gum	1	28	60	15	Fair	
1075	Blue gum	1	60+	100	60	Good	
1076	Blue gum	1	22	90	20	Good	
1077	Blue gum	1	47	100	20	Good	
1078	Blue gum	1	41	80	25	Good	

Moran Lake County Park
Moran Lake Restoration Project

Tag Number	Species	Number Of Trunks	DBH (inches)	Tree Height (Feet)	Canopy Spread (Feet)	Overall Health Condition	Notes
1079	Blue gum	1	48	90	25	Good	
1080	Blue gum	1	36	95	35	Good	
1081	Blue gum	1	33	115	50	Good	
1082	Blue gum	1	48	120	60	Good	
1083	Blue gum	1	24	60	15	Good	
1084	Blue gum	1	56	90	35	Good	
1085	Blue gum	1	25	75	25	Good	
1086	Blue gum	1	36	110	50	Good	
1087	Blue gum	1	60+	100	45	Good	
1088	Blue gum	1	25	70	20	Good	
1089	Blue gum	1	52	110	50	Good	
1090	Blue gum	1	18	110	50	Good	
1091	Blue gum	1	19	70	20	Good	
1092	Blue gum	1	37	110	40	Good	
1093	Blue gum	1	24	85	20	Good	
1094	Blue gum	1	60+	100	55	Good	
1095	Blue gum	1	45	110	35	Good	
1096	Blue gum	1	30	100	45	Good	
1097	Blue gum	1	34	110	55	Good	
1098	Blue gum	1	37	90	20	Good	
1099	Blue gum	1	40	95	60	Good	
1100	Blue gum	1	25	75	30	Good	
1101	Blue gum	1	43	75	45	Good	
1102	Blue gum	1	5	25	10	Good	
1103	Blue gum	1	36	75	35	Good	
1104	Blue gum	2	11, 7	65	20	Good	
1105	Blue gum	1	38	75	20	Good	

Tag Number	Species	Number Of Trunks	DBH (inches)	Tree Height (Feet)	Canopy Spread (Feet)	Overall Health Condition	Notes
1106	Blue gum	1	41	80	30	Good	
1107	Blue gum	1	9	65	15	Good	
1108	Blue gum	1	27	80	25	Good	
1109	Blue gum	1	19	80	30	Good	
1110	Blue gum	1	22	80	35	Good	
1111	Blue gum	1	24	85	15	Good	
1112	Blue gum	1	35	85	35	Good	
1113	Blue gum	1	41	95	40	Good	
1114	Blue gum	1	29	70	50	Good	
1115	Blue gum	1	23	70	20	Good	
1116	Blue gum	1	19	40	25	Good	
1117	Blue gum	1	31	90	35	Good	
1118	Blue gum	2	14, 14	70	45	Good	
1119	Blue gum	2	7, 12	60	30	Good	
1120	Blue gum	1	52	80	30	Good	
1121	Blue gum	1	31	80	40	Good	
1122	Blue gum	1	51	80	25	Good	
1123	Blue gum	1	25	85	45	Good	
1124	Blue gum	1	24	70	35	Good	
1125	Blue gum	1	28	80	35	Good	
1126	Blue gum	1	14	70	20	Good	
1127	Blue gum	1	34	80	30	Good	
1128	Blue gum	1	20	90	20	Good	
1129	Blue gum	1	38	75	50	Good	
1130	Blue gum	1	13	75	35	Good	
1131	Blue gum	1	22	70	25	Good	
1132	Blue gum	1	38	85	35	Good	

Moran Lake County Park
Moran Lake Restoration Project

Tag Number	Species	Number Of Trunks	DBH (inches)	Tree Height (Feet)	Canopy Spread (Feet)	Overall Health Condition	Notes
1133	Blue gum	1	14	70	30	Good	
1134	Blue gum	1	14	60	15	Good	
1135	Blue gum	1	17	75	15	Good	
1136	Blue gum	1	11	70	20	Good	
1137	Blue gum	1	21	80	40	Good	
1138	Blue gum	1	18	80	25	Good	
1139	Blue gum	1	23	90	30	Good	
1140	Blue gum	1	23	80	35	Good	
1141	Blue gum	1	39	40	15	Good	Tree was previously topped.
1142	Blue gum	1	44	75	35	Good	
1143	Blue gum	1	30	75	30	Good	
1144	Blue gum	1	32	70	15	Fair	Tree was previously topped.
1145	Blue gum	1	25	75	25	Good	
1146	Blue gum	2	16, 19	65	25	Good	
1147	Blue gum	1	30	80	45	Good	
1148	Blue gum	3	10, 9, 14	70	25	Fair	Three trunks are epicormic shoots from tree stump.
1149	Blue gum	1	51	90	40	Good	
1150	Blue gum	1	31	90	30	Good	
1151	Blue gum	1	22	65	26	Good	
1152	Blue gum	3	13, 19, 9	65	30	Good	
1153	Blue gum	2	9, 4	55	20	Good	
1154	Blue gum	3	7, 4, 4	60	25	Good	
1155	Blue gum	2	16, 6	55	25	Fair	
1156	Blue gum	2	10, 6	50	20	Fair	
1157	Blue gum	3	9, 9, 14	50	20	Good	
1158	Blue gum	1	37	100	35	Good	
1159	Blue gum	1	38	100	50	Good	

Tag Number	Species	Number Of Trunks	DBH (inches)	Tree Height (Feet)	Canopy Spread (Feet)	Overall Health Condition	Notes
1160	Blue gum	1	32	100	50	Good	
1161	Blue gum	1	9	40	15	Good	
1162	Blue gum	1	36	90	35	Good	
1163	Blue gum	1	51	110	40	Good	
1164	Blue gum	1	38	110	45	Good	
1165	Blue gum	1	28	90	45	Good	
1166	Blue gum	1	9	60	20	Good	
1167	Blue gum	1	28	80	50	Good	
1168	Blue gum	1	18	50	20	Good	
1169	Blue gum	1	9	50	25	Good	
1170	Blue gum	1	43	90	35	Good	
1171	Blue gum	1	55	90	45	Good	
1172	Blue gum	1	23	100	40	Good	
1173	Blue gum	1	21	70	20	Fair	Significant amount of epicormic shoots and branch dieback present.
1174	Blue gum	1	36	100	45	Good	
1175	Blue gum	1	19	45	35	Fair	
1176	Blue gum	1	52	110	45	Good	
1177	Blue gum	1	34	80	50	Good	
1178	Blue gum	1	20	75	25	Good	
1179	Blue gum	1	29	100	30	Good	
1180	Blue gum	1	20	95	25	Good	
1181	Blue gum	1	40	120	40	Good	
1182	Blue gum	1	26	100	35	Fair	Significant amount of epicormic shoots and branch dieback present.
1183	Blue gum	1	16	70	30	Fair	
1184	Blue gum	1	27	90	30	Good	

Moran Lake County Park
Moran Lake Restoration Project

Tag Number	Species	Number Of Trunks	DBH (inches)	Tree Height (Feet)	Canopy Spread (Feet)	Overall Health Condition	Notes
1185	Blue gum	1	38	110	30	Good	
1186	Blue gum	1	22	100	40	Good	
1187	Blue gum	1	24	60	30	Good	
1188	Blue gum	1	25	100	20	Good	
1189	Blue gum	1	51	110	50	Good	
1190	Blue gum	1	55	110	45	Good	
1191	Blue gum	1	28	90	35	Good	
1192	Blue gum	1	32	100	35	Good	
1193	Blue gum	1	41	100	20	Good	
1194	Blue gum	1	16	60	20	Good	
1195	Blue gum	1	28	75	30	Good	
1196	Blue gum	1	41	90	30	Good	
1197	Blue gum	1	29	100	30	Good	
1198	Blue gum	1	41	110	50	Good	
1199	Blue gum	1	36	80	10	Poor	Tree was previously topped and has a significant amount of epicormic shoots present.
1200	Blue gum	1	45	70	10	Poor	Tree was previously topped and has a significant amount of epicormic shoots present.
1201	Blue gum	1	24	75	45	Good	
1202	Blue gum	1	9	30	10	Fair	
1203	Blue gum	1	5	30	15	Good	
1204	Coast redwood (<i>Sequoia sempervirens</i>)	1	12	40	20	Good	
1205	Coast redwood	1	11	35	15	Good	
1206	Coast redwood	1	16	35	15	Good	
1207	Blue gum	1	12	40	20	Good	
1208	Blue gum	1	9	25	15	Good	

Tag Number	Species	Number Of Trunks	DBH (inches)	Tree Height (Feet)	Canopy Spread (Feet)	Overall Health Condition	Notes
1209	Coast redwood	1	12	30	15	Good	
1210	Coast redwood	1	11	35	15	Good	
1211	Coast redwood	1	6	30	15	Good	
1212	Blue gum	1	17	40	20	Good	
1213	Blue gum	1	11	25	25	Good	
1214	Blue gum	1	9	15	15	Good	
1215	Blue gum	1	9	15	15	Good	
1216	Blue gum	2	16, 18	75	35	Fair	
1217	Blue gum	3	14, 6, 8	75	40	Good	
1218	Blue gum	1	50	90	40	Good	
1219	Blue gum	1	25	80	35	Fair	
1220	Blue gum	1	45	100	45	Good	
1221	Blue gum	1	33	100	45	Good	
1222	Blue gum	1	36	100	20	Good	
1223	Blue gum	1	39	110	50	Good	
1224	Blue gum	1	31	110	20	Good	
1225	Blue gum	1	24	100	30	Good	
1226	Blue gum	1	31	100	20	Good	
1227	Blue gum	1	32	100	30	Good	
1228	Blue gum	1	39	90	20	Good	
1229	Blue gum	1	60+	80	50	Good	
1230	Blue gum	1	29	100	50	Good	
1231	Blue gum	1	11	35	15	Good	
1232	Blue gum	1	26	90	40	Good	
1233	Blue gum	1	53	110	40	Good	
1234	Blue gum	1	16	50	20	Good	Tree was previously topped.
1235	Blue gum	1	16	80	25	Good	

Moran Lake County Park
Moran Lake Restoration Project

Tag Number	Species	Number Of Trunks	DBH (inches)	Tree Height (Feet)	Canopy Spread (Feet)	Overall Health Condition	Notes
1236	Blue gum	1	37	100	40	Good	
1237	Blue gum	1	25	90	15	Good	
1238	Blue gum	1	51	110	40	Good	
1239	Blue gum	1	21	90	20	Good	
1240	Blue gum	1	20	90	40	Good	
1241	Blue gum	1	31	90	45	Good	
1242	Blue gum	1	33	90	25	Good	
1243	Blue gum	1	19	80	25	Good	
1244	Blue gum	1	32	85	35	Good	
1245	Blue gum	1	40	80	25	Good	
1246	Blue gum	1	31	80	30	Good	
1247	Blue gum	1	32	90	20	Good	
1248	Blue gum	1	36	90	25	Good	
1249	Blue gum	1	26	75	25	Good	
1250	Blue gum	1	36	100	25	Good	
1251	Blue gum	1	55	80	25	Good	
1252	Blue gum	1	41	110	35	Good	
1253	Blue gum	1	40	95	35	Good	
1254	Blue gum	2	9, 9	35	20	Good	
1255	Blue gum	1	39	110	45	Good	
1256	Blue gum	1	16	65	20	Fair	Significant amount of epicormic shoots and branch dieback present.
1257	Blue gum	1	60+	100	35	Good	
1258	Blue gum	3	9, 8, 10	45	35	Poor	Hazardous tree. Significant amount of epicormic shoots present. Broken limb over trail.
1259	Blue gum	1	10	50	40	Fair	
1260	Blue gum	1	38	80	40	Good	

Tag Number	Species	Number Of Trunks	DBH (inches)	Tree Height (Feet)	Canopy Spread (Feet)	Overall Health Condition	Notes
1261	Blue gum	1	43	90	40	Good	
1262	Blue gum	1	60+	100	55	Good	
1263	Monterey cypress	1	21	20	25	Good	
1264	Monterey cypress	1	17	15	15	Good	
1265	Monterey cypress	1	20	15	20	Good	
1266	Blue gum	1	14	35	30	Good	
1267	Blue gum	1	16	30	20	Good	
1268	Mexican fan palm (<i>Washingtonia robusta</i>)	2	22, 22	60	15	Good	
1269	Monterey cypress	1	45	70	40	Good	
1270	Monterey cypress	1	19	40	30	Good	
1271	Monterey cypress	1	14	50	30	Good	
1272	Monterey cypress	1	29	40	30	Good	
1273	Monterey cypress	6	16, 15, 20, 17, 10, 9	40	35	Good	
1274	Monterey cypress	1	21	40	30	Good	
1275	Blue gum	4	23, 27, 12, 21	120	15	Good	
1276	Blue gum	1	12	100	20	Good	
1277	Blue gum	5	33, 17, 26, 19, 29	120	50	Good	
1278	Blue gum	1	60+	120	60	Good	
1279	Blue gum	2	22, 24	120	30	Good	
1280	Blue gum	1	24	120	20	Good	
1281	Blue gum	1	28	100	35	Good	
1282	Blue gum	1	60	100	50	Good	
1283	Blue gum	1	60+	100	40	Good	

Moran Lake County Park
Moran Lake Restoration Project

Tag Number	Species	Number Of Trunks	DBH (inches)	Tree Height (Feet)	Canopy Spread (Feet)	Overall Health Condition	Notes
1284	Blue gum	1	33	100	55	Good	
1285	Blue gum	1	60	90	55	Good	Potentially hazardous tree. Heavy leaning codominant stem leaning over trail.
1286	Blue gum	1	36	90	55	Good	
1287	Blue gum	1	60	110	55	Good	
1288	Blue gum	1	27	80	60	Fair	Significant amount of epicormic shoots and branch dieback present.
1289	Blue gum	1	29	100	35	Good	
1290	Blue gum	1	19	75	40	Good	
1291	Blue gum	1	25	100	45	Good	
1292	Blue gum	1	60	120	69	Good	
1293	Blue gum	1	21	85	60	Good	Significant amount of epicormic shoots and branch dieback present.
1294	Blue gum	1	23	90	55	Good	
1295	Blue gum	1	22	75	15	Fair	Significant amount of epicormic shoots present.
1296	Blue gum	1	26	90	55	Good	
1297	Blue gum	1	40	100	60	Good	
1298	Blue gum	1	38	95	65	Good	
1299	Blue gum	1	37	110	60	Good	
1300	Blue gum	1	19	70	35	Fair	Significant amount of epicormic shoots and branch dieback present.
1301	Blue gum	1	41	120	45	Good	
1302	Blue gum	1	24	80	35	Good	
1303	Blue gum	1	52	80	35	Fair	Significant amount of epicormic shoots and branch dieback present.
1304	Blue gum	1	26	90	40	Good	

Tag Number	Species	Number Of Trunks	DBH (inches)	Tree Height (Feet)	Canopy Spread (Feet)	Overall Health Condition	Notes
1305	Blue gum	1	21	85	20	Fair	Significant amount of epicormic shoots and branch dieback present.
1306	Blue gum	2	9, 7	40	15	Fair	
1307	Blue gum	1	33	100	55	Good	
1308	Blue gum	1	29	110	40	Good	
1309	Blue gum	1	15	75	30	Good	
1310	Blue gum	1	18	80	15	Poor	Significant amount of epicormic shoots and branch dieback present.
1311	Blue gum	1	55	120	50	Good	
1312	Blue gum	1	17	75	35	Fair	
1313	Blue gum	1	40	120	45	Good	
1314	Blue gum	1	20	75	40	Fair	Significant amount of epicormic shoots and branch dieback present.
1315	Blue gum	1	26	100	60	Fair	Significant amount of epicormic shoots and branch dieback present.
1316	Blue gum	1	19	75	25	Fair	Significant amount of epicormic shoots and branch dieback present.
1317	Blue gum	1	27	110	50	Good	
1318	Blue gum	1	14	75	25	Fair	Significant amount of epicormic shoots and branch dieback present.
1319	Blue gum	1	44	120	40	Good	
1320	Blue gum	1	19	60	10	Poor	Tree has a broken trunk with a significant amount of epicormic shoots and branch dieback.
1321	Blue gum	1	33	100	40	Good	
1322	Blue gum	1	13	60	10	Dead	Significant amount of epicormic shoots and branch dieback present.
1323	Blue gum	1	9	60	5	Dead	

Moran Lake County Park
Moran Lake Restoration Project

Tag Number	Species	Number Of Trunks	DBH (inches)	Tree Height (Feet)	Canopy Spread (Feet)	Overall Health Condition	Notes
1324	Blue gum	1	34	110	35	Good	
1325	Blue gum	1	18	80	15	Poor	Significant amount of epicormic shoots and branch dieback present.
1326	Blue gum	1	21	75	15	Poor	Significant amount of epicormic shoots and branch dieback present.
1327	Blue gum	1	22	80	40	Fair	
1328	Blue gum	1	33	110	55	Good	
1329	Blue gum	1	9	55	10	Poor	Significant amount of epicormic shoots and branch dieback present. Two dead saplings adjacent to this tree.
1330	Blue gum	1	28	120	40	Good	
1331	Blue gum	1	37	110	40	Good	
1332	Blue gum	1	17	90	10	Fair	Significant amount of epicormic shoots and branch dieback present.
1333	Blue gum	1	11	70	20	Fair	Significant amount of epicormic shoots and branch dieback present.
1334	Blue gum	1	14	85	15	Fair	Significant amount of epicormic shoots and branch dieback present.
1335	Blue gum	1	8	50	0	Dead	
1336	Blue gum	1	44	85	40	Good	
1337	Blue gum	1	20	80	35	Good	
1338	Blue gum	1	20	90	40	Good	
1339	Blue gum	1	19	75	25	Fair	Significant amount of epicormic shoots and branch dieback present.
1340	Blue gum	1	10	40	20	Fair	
1341	Blue gum	1	9	25	15	Fair	

Tag Number	Species	Number Of Trunks	DBH (inches)	Tree Height (Feet)	Canopy Spread (Feet)	Overall Health Condition	Notes
1342	Blue gum	1	19	75	20	Poor	Potentially hazardous tree. Significant amount of epicormic shoots and branch dieback present. Dead branches over trail.
1343	Blue gum	1	14	70	25	Good	
1344	Blue gum	1	28	75	45	Good	
1345	Blue gum	2	15, 14	65	45	Good	
1346	Blue gum	1	26	90	45	Good	
1347	Blue gum	1	21	70	35	Good	
1348	Blue gum	1	32	85	35	Good	
3001	Blue gum	10	12 to 30	40	60	Good	
3002	Blue gum	3	9, 6, 7	30	15	Fair	
3003	Blue gum	2	16, 21	50	15	Good	
3004	Blue gum	1	30	50	20	Good	
3005	Blue gum	1	19	50	20	Good	
3006	Blue gum	1	25	50	25	Good	
3007	Blue gum	1	18	60	15	Good	
3008	Blue gum	2	5, 5	70	20	Good	
3009	Blue gum	1	23	70	15	Good	
3010	Blue gum	1	14	50	15	Good	
3011	Blue gum	2	12, 6	70	25	Fair	
3012	Blue gum	4	13, 13, 25, 32	70	50	Good	
3013	Blue gum	2	60+	70	50	Good	
3014	Blue gum	3	17, 19, 25	60	40	Good	
3015	Blue gum	1	60+	70	50	Good	
3016	Blue gum	2	9, 12	50	30	Good	
3017	Blue gum	2	8, 4	40	20	Good	
3018	Blue gum	1	14	70	20	Good	

Moran Lake County Park
Moran Lake Restoration Project

Tag Number	Species	Number Of Trunks	DBH (inches)	Tree Height (Feet)	Canopy Spread (Feet)	Overall Health Condition	Notes
3019	Blue gum	1	10	70	15	Good	
3020	Blue gum	1	24	70	20	Good	
3021	Blue gum	1	17	70	20	Good	
3022	Blue gum	2	25, 29	70	30	Good	
3023	Blue gum	1	29	80	35	Good	
3024	Blue gum	3	41, 13, 20	80	40	Good	
3025	Blue gum	1	6	55	15	Fair	
3026	Blue gum	2	5, 14	70	30	Good	
3027	Blue gum	2	27, 11	80	20	Good	
3028	Blue gum	2	9, 4	80	20	Good	
3029	Blue gum	2	21, 28	90	25	Good	
3030	Blue gum	2	6	60	15	Good	
3031	Blue gum	4	11, 24, 6, 5	85	40	Good	
3032	Blue gum	1	11	80	15	Good	
3033	Blue gum	1	12	70	30	Good	
3034	Blue gum	1	6	60	20	Good	
3035	Blue gum	1	16	85	20	Good	
3036	Blue gum	2	23, 13	90	25	Good	
3037	Blue gum	2	60+	100	40	Good	
3038	Blue gum	2	11	70	25	Good	
3039	Blue gum	5	41, 30, 17, 9, 7	100	50	Good	
3040	Blue gum	2	22	80	20	Good	
3041	Blue gum	2	28	80	20	Good	
3042	Blue gum	3	9, 24, 17	80	25	Good	
3043	Blue gum	2	30, 23	90	30	Good	
3044	Blue gum	2	17, 9	25	25	Good	

Tag Number	Species	Number Of Trunks	DBH (inches)	Tree Height (Feet)	Canopy Spread (Feet)	Overall Health Condition	Notes
3045	Blue gum	3	11, 9, 9	50	25	Good	
3046	Blue gum	2	22, 24	100	40	Good	
3047	Blue gum	1	23	90	35	Good	
3048	Blue gum	1	9	50	30	Good	
3049	Blue gum	1	15	75	35	Good	
3050	Blue gum	2	18, 11	75	35	Good	
3051	Blue gum	1	11	40	40	Good	
3052	Blue gum	3	9, 6, 14	80	30	Good	
3053	Blue gum	1	29	90	35	Good	
3054	Blue gum	1	31	85	35	Good	
3055	Blue gum	1	31	35	0	Dead	Tree was previously topped.
3056	Blue gum	1	26			Dead	Exfoliating bark. Leaning over sanitation facility.
3057	Blue gum	1	29	30	0	Dead	
3058	Blue gum	1	12	60	0	Dead	Potentially hazardous tree. Tree is significantly leaning
3059	Blue gum	1	4	55	0	Dead	
3060	Blue gum	1	15	55	15	Poor	
3061	Blue gum	1	9	70	0	Dead	
3062	Blue gum	1	8	40	0	Dead	
3063	Blue gum	1	36	100	40	Fair	Potentially hazardous tree. Large heavy overhanging branch with included bark.
3064	Blue gum	1	16	80	10	Poor	Exfoliating bark. Significant amount of epicormic shoots and branch dieback present.
3065	Blue gum	1	6	20	0	Dead	
3066	Blue gum	1	21	75	50	Poor	Trunk is broken and leaning half way up the tree.
3067	Blue gum	1		50	0	Dead	Large leaning and broken trunk half way up the tree.
3068	Blue gum	1	13	55	0	Dead	
3069	Blue gum	1	16	75	15	Poor	

Moran Lake County Park
Moran Lake Restoration Project

Tag Number	Species	Number Of Trunks	DBH (inches)	Tree Height (Feet)	Canopy Spread (Feet)	Overall Health Condition	Notes
3070	Blue gum	1	9	50	10	Poor	Significant amount of epicormic shoots and branch dieback present.
3071	Blue gum	1	8	40	0	Dead	
3072	Blue gum	1	11	50	0	Dead	
3073	Blue gum	1	7	20	0	Dead	
3074	Blue gum	1	10	55	0	Dead	
3075	Blue gum	1	10	25	5	Poor	Significant amount of epicormic shoots and branch dieback present.
3076	Blue gum	1	10	55	40	Good	Hazardous tree. Tree is significantly leaning over trail (60 degree angle). Will likely topple eventually.
3077	Blue gum	1	11	50	5	Poor	Significant amount of epicormic shoots and branch dieback present.
3078	Blue gum	2	9, 9	70	0	Dead	
3079	Blue gum	2	8, 7	55	0	Dead	
3080	Blue gum	1	7	55	0	Dead	
3081	Blue gum	1	21	90	5	Poor	Significant amount of epicormic shoots and branch dieback present.
3082	Blue gum	1	12	35	5	Poor	Significant amount of epicormic shoots and branch dieback present. Tree previously topped.
3083	Blue gum	1	14	55	5	Poor	Significant amount of epicormic shoots and branch dieback present.
3084	Blue gum	1	9	40	0	Dead	
3085	Blue gum	1	14	15	0	Poor	
3086	Blue gum	2	10, 12	75	20	Poor	Significant amount of epicormic shoots and branch dieback present.
3087	Blue gum	1	12	80	0	Dead	
3088	Blue gum	2	15, 11	80	20	Poor	Trunk is broken and the tree has toppled.

Tag Number	Species	Number Of Trunks	DBH (inches)	Tree Height (Feet)	Canopy Spread (Feet)	Overall Health Condition	Notes
3089	Blue gum	1	5	40	0	Dead	The tree has toppled.
3090	Blue gum	1	14	15	0	Dead	
3091	Coast redwood	1	2	10	0	Dead	Dead mitigation tree. Outcompeted by blue gums.
3092	Blue gum	1	10	10	5	Poor	Tree previously topped. Significant amount of epicormic shoots and branch dieback present.
3093	New Zealand christmas tree (<i>Metrosideros excelsa</i>)	1	3	10	5	Good	
3094	Strawberry tree (<i>Arbutus unedo</i>)	1	2	10	0	Dead	
3095	New Zealand christmas tree	1	5	10	10	Good	
Sanitation Facility Grove	Blue gums	Typically one trunk per tree	4-60"+ Average DBH of 18"	Peak grove canopy height ranging from 100 to 140 feet.	Average canopy spread 30 feet. Total grove canopy spread area is ~4.75 acres.	Overall fair to poor besides the NE portion of the grove, which is good.	Trees over a 40-inch DBH have a Good overall health condition. Trees with less than a 40-inch DBH generally have a Fair to Poor overall health condition. The >40-inch DBH trees are generally healthier due to their established nature. Smaller trees are generally being outcompeted for resources by the larger trees. Selective thinning would improve grove health. The largest and healthiest trees are within the northeastern portion of the grove. Most blue gums adjacent to the hiking trail that travels along the southeastern portion of the grove have been topped. Vast amounts of epicormic shoots are present. Hazardous trees and dead and dying trees were surveyed and are included in the results table above (i.e., trees 3055 to 3092).

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Appendix B

Tree Inventory Figures

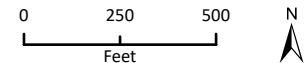
Tree Inventory Figures

Page 1 of 8

-  Tree Inventory Area
-  Poor Health Trees
-  Dead Trees
-  Potentially Hazardous Trees

Tree Species

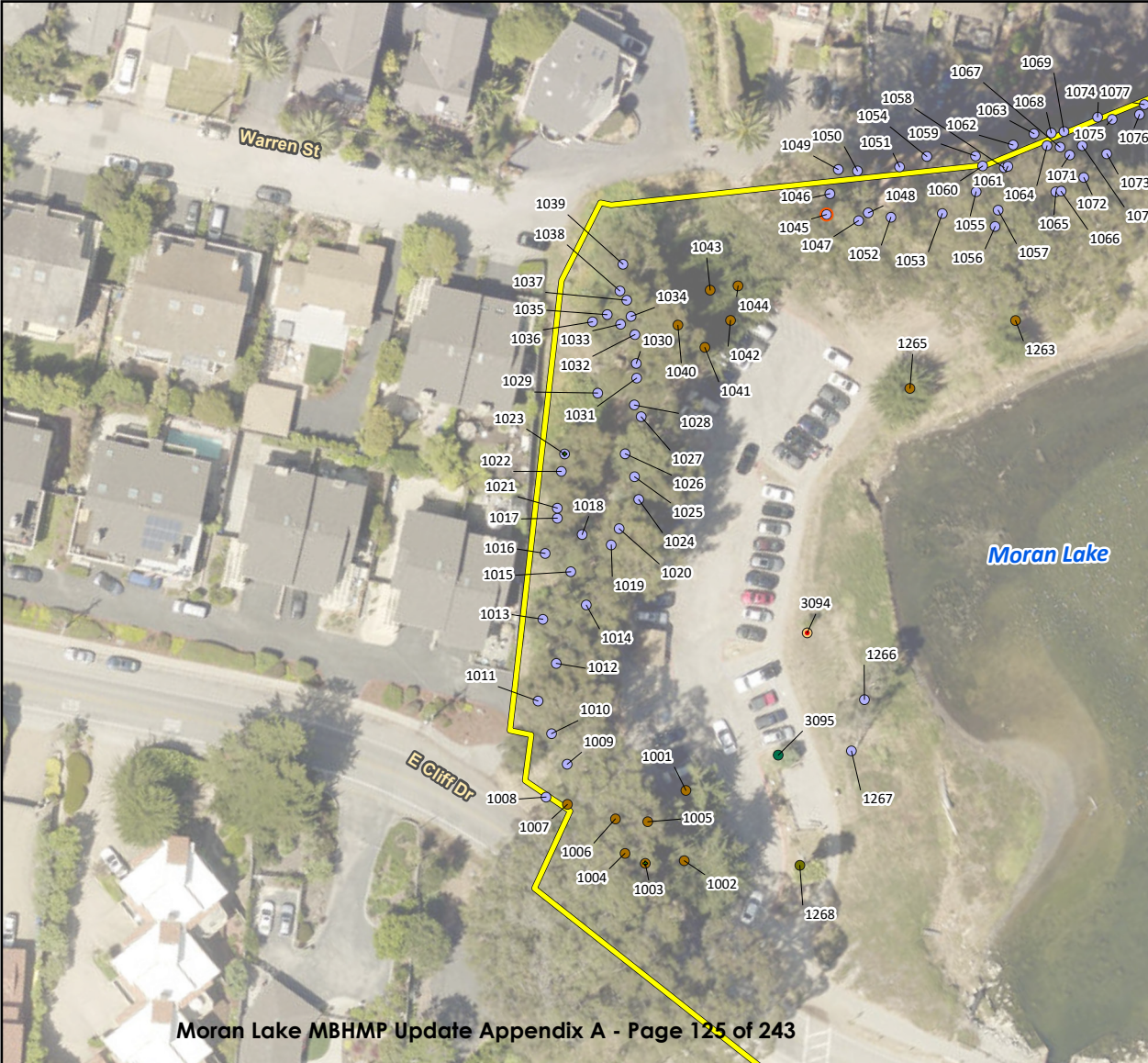
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(*Eucalyptus globulus*)
-  Monterey cypress
(*Hesperocyparis macrocarpa*)
-  New Zealand Christmas tree
(*Metrosideros excelsa*)
-  Coast redwood
(*Sequoia sempervirens*)
-  Strawberry tree
(*Arbutus unedo*)
-  Mexican fan palm
(*Washingtonia robusta*)



Moran Lake MBHMP Update Appendix A - Page 124 of 243

Tree Inventory Figures

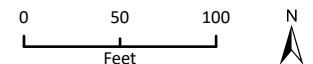
Page 2 of 8



- Tree Inventory Area
- ◆ Poor Health Trees
 - Dead Trees
 - Potentially Hazardous Trees

Tree Species

- Blue gum
(*Eucalyptus globulus*)
- Mexican fan palm
(*Washingtonia robusta*)
- Monterey cypress
(*Hesperocyparis macrocarpa*)
- New Zealand Christmas tree
(*Metrosideros excelsa*)
- Strawberry tree
(*Arbutus unedo*)



Moran Lake MBHMP Update Appendix A - Page 125 of 243

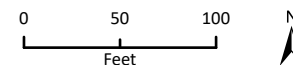
Tree Inventory Figures

Page 3 of 8

 Tree Inventory Area

Tree Species

-  Blue gum
(*Eucalyptus globulus*)
-  Monterey cypress
(*Hesperocyparis macrocarpa*)
-  New Zealand Christmas tree
(*Metrosideros excelsa*)



Moran Lake MBHMP Update Appendix A - Page 126 of 243

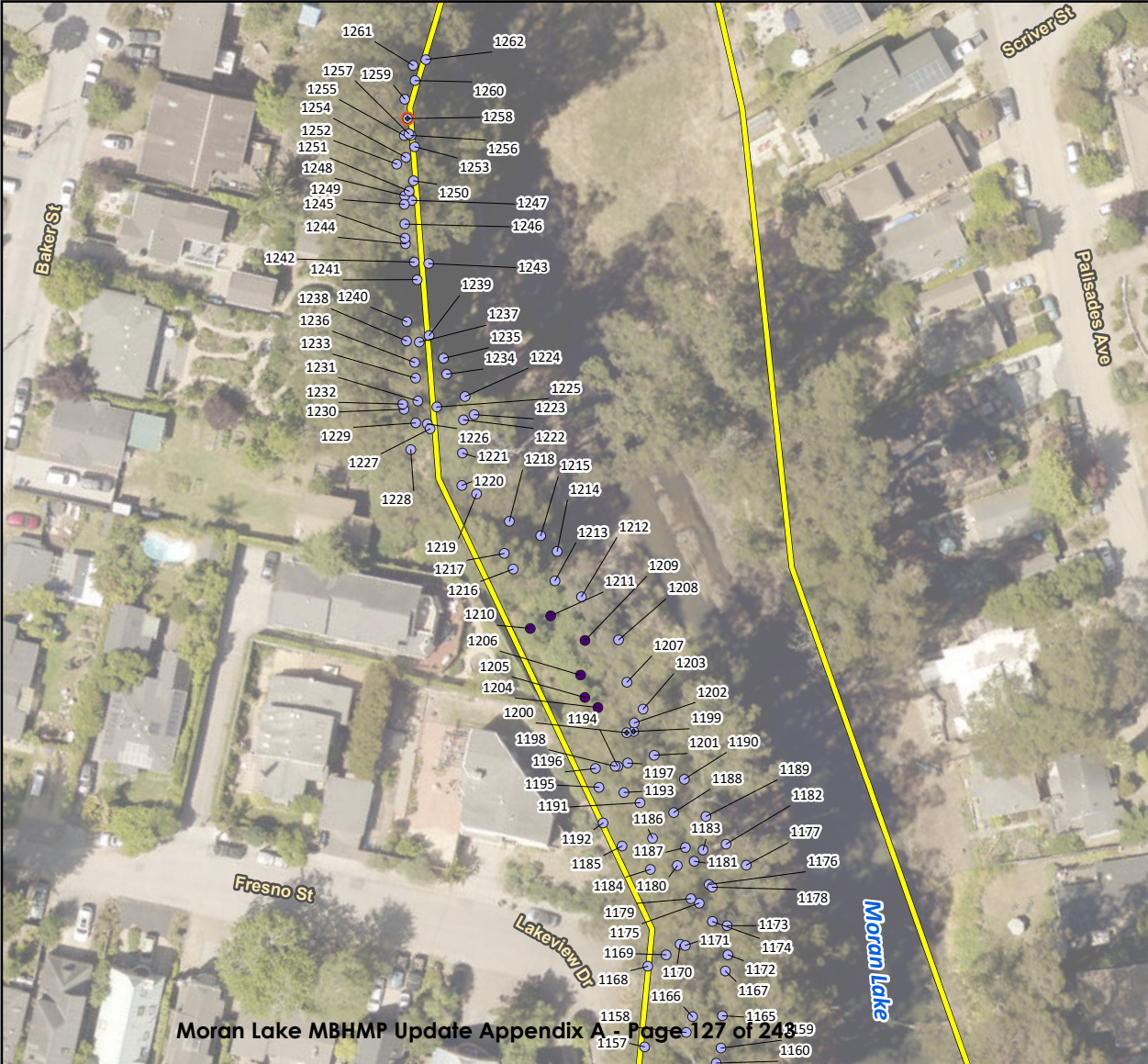
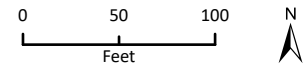
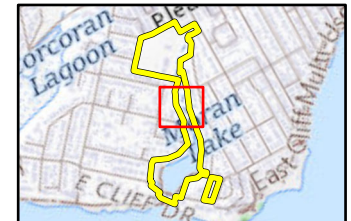
Tree Inventory Figures

Page 4 of 8

- Tree Inventory Area
- ◆ Poor Health Trees
- Potentially Hazardous Trees

Tree Species

- Blue gum
(*Eucalyptus globulus*)
- Coast redwood
(*Sequoia sempervirens*)



Tree Inventory Figures

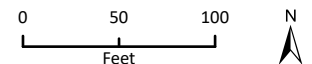
Page 5 of 8



- Tree Inventory Area
- ◆ Poor Health Trees
- Dead Trees
- Potentially Hazardous Trees

Tree Species

- Blue gum
(*Eucalyptus globulus*)
- Monterey cypress
(*Hesperocyparis macrocarpa*)



Moran Lake MBHMP Update Appendix A - Page 128 of 243

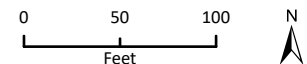
Tree Inventory Figures

Page 6 of 8

- Tree Inventory Area
- ◆ Poor Health Trees
- Dead Trees
- Potentially Hazardous Trees

Tree Species

- Blue gum
(*Eucalyptus globulus*)

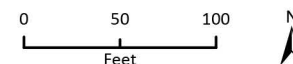
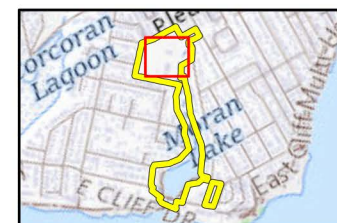


Moran Lake MBHMP Update Appendix A - Page 129 of 243

Tree Inventory Figures

Page 7 of 8

-  Tree Inventory Area
-  Poor Health Trees
-  Dead Trees
-  Potentially Hazardous Trees
- Tree Species**
 -  Blue gum (*Eucalyptus globulus*)



Moran Lake MBHMP Update Appendix A - Page 130 of 243

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Only priority trees (i.e., dead, dying [i.e., Poor Health trees], newly planted trees, and hazard trees) were surveyed within the sanitation facility grove (trees 3055 to 3092). However, notes on the grove's average DBH and DBH range, average height and height range, average canopy spread, total canopy coverage, and health condition were taken and are included in Appendix A.

Tree Inventory Figures

Page 8 of 8

 Tree Inventory Area

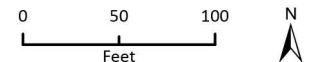
 Poor Health Trees

 Dead Trees

Tree Species

 Blue gum
(*Eucalyptus globulus*)

 Coast redwood
(*Sequoia sempervirens*)



Moran Lake MBHMP Update Appendix A - Page 131 of 243

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Only priority trees (i.e., dead, dying [i.e., Poor Health trees], newly planted trees, and hazard trees) were surveyed within the sanitation facility grove (trees 3055 to 3092). However, notes on the grove's average DBH and DBH range, average height and height range, average canopy spread, total canopy coverage, and health condition were taken and are included in Appendix A.

Appendix C

Moran Lake County Park Improvement Project Biological Resources Assessment



Moran Lake County Park Improvement Project

Biological Resources Assessment

prepared for

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Santa Cruz, California 95060

and

Santa Cruz County Department of Parks, Open Space, and Cultural Services
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