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7 July 2020

Assessment and proposed management activities Monarch Grove Sanctuary and George Washington Park for 2020

The following recommendations and assessments are based on site visits and consultations with City Arborist Albert Weisfuss and Caleb Schneider in spring 2020. They are addressed in the context of the 2011 Management Plan (Weiss 2011) and subsequent consultations with City staff and residents, including annual recommendations from 2014-2019 (Weiss 2014-2019). The recommendations are based on previous scientific work, professional judgment, and detailed field assessments. They carefully balance monarch habitat needs, hazard reduction, and forest health, based on both short-term and long-term perspectives.

City Arborist Albert Weisfuss completed a detailed report with his recommendations, and those are considered in this report (Weisfuss 2020).

Background data on monarch numbers at Monarch Grove Sanctuary (Xerces Society Thanksgiving Counts and New Year's Counts) provide context of the entire California monarch population. We have incorporated butterfly monitoring data from the Pacific Grove Museum since 2013 to document habitat suitability and monarch use patterns relative to weather and time of season. This reporting on monarch abundance and distribution provide a long-term accessible record for the local community.

Summary of recommended actions (see below for detailed exposition)

Minimal on the ground actions are recommended this year

1. The tree that was re-staked west of the nectar beds may not be viable in the long run. Its health and prospects should be assessed by the City Arborist

2. Removal of dead eucalyptus in the SE corner of the Sanctuary
3. Establish a cypress tree in the open area east of the viewing area, as a potential cluster tree in a dappled light area. Plant at least two cypress, but be prepared to thin down to a single tree once establishment is assured.
4. Filling gaps the southern boundary eucalyptus row with different eucalyptus species, especially E. as recommended
5. Planting cypress east of the nectar beds from the acacia stand to the bend in the trail.
6. Establish low growing native fall nectar species in the sunny borders of the main trail as it winds through the established nectar beds.
7. Tend the yellow Buddleia and tree daisies to produce new growth by selective pruning.
8. Oak understory plantings: procurement of acorns and trees, and planning for appropriate sites
9. Toyon and ceanothus understory plantings: procurement of shrubs and planning for appropriate sites

Planning for future actions in 2020 and beyond include:

1. Formal delineation of management zones for native pine /oak forest, including understory species.

History

Current status of monarchs in California:

The western monarch population that overwinters in California has been declining for decades (Schultz et al 2017), and the Thanksgiving Counts reached their lowest level (~21,000) ever in 2019 (Table 1), following the previous record low in 2018 (~30,000). The fall 2019 population had suffered an 84% (six-fold) reduction from fall 2017 (~190,000). The prior historical low was ~60,000 in 2009, with a bounce back to 300,000 in 2016.

The long-term decline is likely the result of conditions in the breeding areas, and the short-term fluctuations the result of annual weather. This recent collapse has garnered much attention, and there are numerous efforts at national, state, and local levels to address the causes and consequences (Pelton et al. 2019). Among the likely causes discussed are (Crone 2019):

1. Loss of milkweeds across the breeding range, or in key areas, is a long-term driver. For example, in the 1980s and 1990s, milkweed abundance in the Central Valley plummeted with increased intensity of “clean farming.”
2. Deterioration of overwintering sites that is increasing mortality. The lack of management at many sites has led to too much wind exposure and other deleterious microclimate conditions.
3. “Climate whiplash” whereby warm mid-winter conditions stimulate the butterflies to break diapause and leave prematurely. In winter 2018, monarchs

left the overwintering grounds in February, only to encounter one of the coldest and rainiest March periods in recent history. Much of the reproductive potential of that generation in spring 2018 was lost. Monarchs never made it parts of the Pacific Northwest, indicating a break in the multi-generational like cycle in spring and early summer.

4. A gap in milkweed availability in early spring when butterflies leave the overwintering grounds, related to 3 (climate whiplash) but also related to the rarity of three milkweed species (*Asclepias californica*, *A. cordifolia*, and *A. eriocarpa*) that emerge earlier than the more common *A. fascicularis*.
5. Pesticide use whereby milkweeds in agricultural areas become mortality sinks. Neonicotinoid insecticides are mobile, persistent, and absorbed by plant tissues (systemic). In particular, milkweeds in the Central Valley have accumulated lethal and sublethal levels of several pesticides, even outside intensive agricultural areas (Halsch et al 2020).
6. Increased infection rates with *Ophryocystis elektroscirrha* (O.e.) a protozoan parasite that can build up in populations where tropical milkweed allows nearly year round breeding.
7. The cumulative effects of all the above, “death by a thousand cuts” is the most likely explanation.

Monarch Grove Sanctuary History in Context:

Monarch Grove Sanctuary (MGS) continues to support one of the largest overwintering aggregations in California (Table 1). The ultimate size of the MGS aggregation is dependent on range-wide breeding success the previous summer, and the ability of the site to attract butterflies in the fall and provide suitable temperature, light, and wind conditions through the fall and winter. An abbreviated history here provides some context.

Since 1998, MGS supported between 1% and 14% of the Thanksgiving Count estimates for the entire state. From 2001 on, MGS supported between 17% and 58% of the Monterey County population.

The severe drop in 2009 to 800 butterflies reflected a sharp decline rangewide from 220,000 to 55,000, likely driven by a three year drought across the Western United States. The low numbers at MGS in 2009-2010 also followed hazard branch trimming (summer 2009) along the southern boundary where monarchs had clustered in most years. The relative contributions of low overall California numbers and branch trimming to the sharp decline compared to other aggregations are difficult to quantify. MGS had supported as few as 20% of the Monterey County population (in 2004) compared with 17% in 2009.

Numbers and ranking recovered in 2010 and 2011 with the end of the drought. In fall 2010, potted trees were placed along the southern edge to fill in low wind gaps. Adventitious branches filled the mid-level gaps created by the trimming, and wind

shelter improved on the southern boundary. Importantly, the blue gum trees planted in 1999 achieved heights (50-60') and crown volume that provided critical NW wind shelter, as envisioned in the 1998 management plan. In 2011-2012, butterflies moved from the southern edge into the grove interior for much of the season. Since then they have regularly used those interior trees for substantial parts of many seasons. But in recent years, they have more frequently used the trees on the southern boundary and in the neighbors' yards, especially the pine tree that has served as a major cluster tree since the 1990s (and even before).

Recent Monitoring Results

Creekside staff mapped the location of trees that have been tagged by monitoring crews from the Museum (Figure 1) green triangles. Note the two distinct areas for monarch clustering; the southern and far southeast boundary and the Monterey Pine on the adjacent property (*southern boundary and neighbors yards* [208, 210, and 212 Ridge Road]), and the interior stretching from the hotel driveway to 30-40 m west into the grove (*interior*). The numbers of monarchs and their distribution within seasons have been monitored by the Museum since 2013-14 by the (Figure 3a). The combination of these maps paint a dynamic picture of monarch distribution and abundance in the Sanctuary for 2013-2019. From 2016 to 2019 a simplified map was used by monitors to document monarch distributions, along with tree tags. Discussions of the 2013-2019 seasons are in Appendix A.

The general pattern for each season is a rise in numbers in October/early November, a peak in late-November and December, and a decline, sometime abrupt, through the remainder of the season which usually ends in February, but sometimes extends into March. Overall movements of butterflies between the southern boundary and interior can be tracked as a measure of habitat suitability and response to weather. Wind data from Monterey Airport provide context for local shifts in distribution.

2019-2020 season summary

Weather:

The Monterey Airport data are used to characterize the seasons, especially wind events. There are no accessible weather stations near the Sanctuary that can provide the long-term quality data collected at Monterey Airport. Conditions at the Sanctuary do differ, but no analysis and descriptions require more than an understanding of the overall weather pattern, especially wind events. The utility of a more local weather station is discussed below.

The 2019-2020 season was relatively mild with only 6 wind events with maximum hourly speed >20 mph (Figure 2a). Three occurred from mid-November to early December, followed by relative calm through mid-January, with 2 final events in early-February. The wind events were mostly associated with rainstorms (Fig. 2b); note the stormy period in late November-early December but the February events were not accompanied by rainfall. Maximum daily temperatures remained in the high 50s/mid-

60s from mid-December into late-January, when a brief spike hit 71°F. Low temperatures fell below 40 °F only 6 times during the season – frost and freeze risks were minimal.

Butterfly numbers through the season:

The steep declines in numbers are apparent in the seasonal graph (Figure 3a). For clarity, only 2018-2019 and 2019-2020 are shown in Figure 3b.

The peak numbers observed at MGS in 2019-2020 (642) were 70% of those observed in 2018-2019 (919). The Monterey County population overall was the same in 2019-2020 and 2018-2019. MGS contained 2.9% of the California population, and 25% of the Monterey County population

In fall 2019, butterflies arrived as usual in October with 24 counted on October 18, rising to 101 on November 1, and reaching 642 for the official Thanksgiving count on November 21. In December, numbers fluctuated between ~300 and ~400. In early January, numbers dropped to 130. The mid-January storm scattered the butterflies (down to 65 on January 16), but they had reassembled back to ~130 by January 23. ~100 butterflies were observed in late-January and early-February, and the last significant numbers were observed on Feb. 13.

The peak in 2019-2020 was much shorter than the sustained peak in 2019-2020 (and in other years), and was most similar to 2016-2017. MGS retained 49% of its butterflies through the New Year's count, one of the better performances (third) of 11 sites in Northern California (Table 2). The drop following Thanksgiving was likely the result of the stormy weather in late November-early December (Figure 2a).

Tree species usage:

The monarchs primarily used eucalyptus in 2019-2020 (Figure 4a). There were small shifts to cypress early in the season, and to pine mid-season. This pattern greatly contrasts with other recent years: in 2018-2019 they started in eucalyptus and moved to pines (4b); in 2017-2018 they started on eucalyptus and moved to cypress (4c); and in 2016-2017 they started on pines and moved to cypress (4d).

Butterfly distribution:

The butterflies primarily stayed on the south boundary (Figure 5a, Figure 1). There was minimal use recorded on the pine south of the fence at 210 Ridge Road, in contrast with many previous years. Small numbers were observed in the interior and along the driveway, and small clusters were observed west of the nectar beds on several occasions. The consistent use of the south boundary eucalyptus reflects the lack of strong wind events for most of the season.

Long-term Management Considerations

Management of Monarch Grove Sanctuary is a long-term process. This section looks ahead to anticipated changes and issues over the next decades, so that current management recommendations can be put into context. Much of this section is reiterated from previous reports, with a few updates

- 1) **NW Windbreak:** The 1999 blue gum plantings are now 60-70' tall and provide critical NW wind shelter and allow monarchs to remain in the interior of the grove following storms that drive them from the wind-exposed southern boundary. *These eucalyptus trees are the anchor of a multi-species windbreak, and are absolutely necessary to maintain long-term windbreak functions* because pines may succumb to pitch canker and cypress will lose lower branches. The mid-story of pines and cypress currently contributes to windbreak function, as the foliage on the blue gums is concentrated in the upper canopy.
- 2) **Eucalyptus threat?:** The ground along narrow zone below the NW windbreak eucalyptus is being affected by leaf and litter fall, but less than 0.1 acres are affected. The comments on page 2 in the arborist report (“potential catastrophic effects”) greatly exaggerate the threat to native forest, especially since the eucalyptus will not be allowed to spread, and the ground deposits can be occasionally raked up. The remainder of the interior and northern reaches is available for native forest management.
- 3) **Southern Boundary:** The 2011 blue gum plantings inside the southern boundary, authorized by the City, have grown to heights of 25-30' and are beginning to provide additional wind shelter. Monarchs used some of these trees in November and December 2019, with a peak of 53 (~15% of the population) on December 5 (Figure 4e). As these trees continue to grow, eventually monarchs can cluster in a wind sheltered dappled light environment as envisioned in the 2011 Assessment and Management plan. These trees will provide redundancy for the large southern windbreak trees, and will eventually replace them decades from now. These trees are in a tough environment for rapid growth, with shade and root competition from the large southern boundary trees, so they will continue to grow relatively slowly, but will be healthy. Planting some additional trees, *Callistemon viminalis* and *Eucalyptus ficifolia* as recommended by the arborist report in key locations would fill gaps, diversify the windbreak, and provide a multi-age structure (see below).
- 4) **SE Corner:** The densely planted blue gums (2013) in the SE corner are showing signs of overcrowding (some were planted 3' apart), with poor growth relative to more widely spaced trees. There has been a consistent recommendation over the years to thin these trees back to a more appropriate density, but it has never been implemented. The Weisfuss arborist report also recommends thinning these trees. Thinning will increase the health of the remaining trees, and their canopies will expand to fill in the available space. Several of them are now dead, and should be removed (see below). These trees will continue to grow poorly in

- crowded conditions and eventually self-thin, and they are competing with several of the authorized plantings from 2011.
- 5) Farther west on the southern boundary, there are several larger gaps that should be filled. The arborist report recommends *Callistemon viminalis* and *Eucalyptus ficifolia* to diversify the windbreak and provide mid-story and low windbreaks. Cypress are not recommended along the southern boundary because of sprawling growth form.
 - 6) Pines continue to succumb to pitch canker, and despite some wet years in 2017 and 2019, drought effects are still being expressed in some trees, not helped by a dry year in 2020. Continued plantings to maintain a substantial pine component in the grove is important, but pines still cannot be counted upon to provide long-term overstory. Pine plantings need to be protected from browsing and getting knocked over by deer. Removal of pines heavily infested with pitch canker can slow, but not stop the spread.
 - 7) Many of the cypress planted over the last two decades are in their period of rapid growth and will provide significant wind shelter in coming years and decades. The cypress along with blue gums will provide the backbone of the grove, given the uncertainties of pine survival in the long run. Some densely planted cypress stands have been thinned in recent years to encourage more rapid growth of remaining trees, and continued selective thinning is recommended in several spots.
 - 8) There are more than 20 potted cypress brought into the Sanctuary as temporary windbreaks, and these trees should be planted in appropriate spots described below. One particularly important area is the area east and just upslope of the nectar beds, where the death of a large sprawling acacia has opened the understory to wind. More details are provided below.
 - 9) Understory live oaks are scattered among the pines and cypress, and more plantings could fill in understory in select parts of the grove and provide good native habitat. Oaks can eventually provide low and mid-story windbreaks.
 - 10) Overall, there are many sections of the Sanctuary where management for native forest is appropriate, with an emphasis on overstory pines. The northern reaches, beyond the NW windbreak is a prime example. The old pines have died or fallen, leaving wildlife snags and an open canopy. In addition to oaks, native shrubs (toyon and ceanothus in particular but a large palette is available) can contribute to understory. Non-native cover like the calla lilies can be removed in phases, and forest floor forbs could be introduced in parts of the Sanctuary, but all native plantings need to be protected from deer browsing.
 - 11) Maintaining the irrigation system for tree establishment and for watering during droughts, as well as developing a rigorous irrigation management plan overseen by City staff and implemented by volunteers, is critical. But irrigation should only be provided for the first year (unless severe drought occurs in the second year)
 - 12) Attractive fall blooming nectar plants help to retain arriving butterflies early in October and November. *Nectar plants in sunny areas can be used far more frequently than those in the shade and sunny areas are at a premium.* Yellow

Buddleia and tree daisy are the most attractive species in the beds, and replacement of some of the other species in the beds (i.e. the mallow) should be considered. The sunny edges along the trail are perfect for planting native nectar species for fall nectar. Away from the nectar beds, butterflies nectar on the flowering red gum when it occasionally blooms in the fall. Use of bottlebrush was noted every year. Later in the season, early-blooming *Prunus* has provided winter-spring nectar in addition to the blooming blue gums.

Management Recommendations for 2019 Review

Monarch Grove Sanctuary

Needs for tree management for 2019 were minimal.

- 1) No hazard trees or branches were identified, so no action was necessary.
- 2) Removal of the completely dead pine in the pine stand west of the nectar beds - **done.**
- 3) Removal or re-staking of the cypress west of the nectar beds, depending on arborists judgement **Tree was re-staked, but the arborist suggest that it will be structurally unsound and should be removed. It does not provide critical wind shelter.**
- 4) Planning for a few additional cypress plantings in key spots, to provide back-up for pines. **Sites have been considered, but no trees planted yet.**
- 5) Removal of dead individuals in the crowded blue gums in the SE corner. **Not done**
- 6) Evaluation of needs for further plantings of *Eucalyptus* (not necessarily blue gums) in the second row to fill in gaps along the southern boundary. **Evaluation in arborists report and this document have led to more detailed plans for filling in and diversifying this critical structure using *Callistemon viminalis* and *Eucalyptus ficifolia*.**
- 7) Planning for plantings of live-oaks, either from acorns or from starters. The advantage of acorns is that the root system will be able to freely explore the soil and establish naturally, and many can be planted inexpensively to anticipate mortality. Oaks in starter tubes have truncated root systems. Sites throughout the Sanctuary should be considered to provide understory wind shelter. Live oaks are excellent wildlife habitat as well. Protection of new trees from deer is critical. **Sites have been scoped, but no plantings have been done**
- 8) Toyons can provide good understory wind shelter and are attractive and excellent wildlife habitat. The large toyon just east of the nectar beds is a good example of what the species is capable of. Blue blossom ceanothus is similar to toyon. These shrubs/small trees can complement oak plantings, but must be protected from deer browsing for many years. **No plantings done.**
- 9) Protection of the new pine saplings and volunteer seedlings. **Not done, but there was little browsing in 2019-2020.**

Management recommendations for 2020. Detailed discussion and observations.

Note that the arborist report (Weisfuss 2020) designates 4 quadrants in the Sanctuary. These can be mapped onto the zones in Figures 1 and 6, and the correspondence is as follows:

Zone (Weiss)	Quadrant (Weisfuss)	Monarch Cluster Zone (Figure 5a,b).
1	Q4	West Nectar Beds
2	Q2	Interior, Driveway
3	Q1	Southern Boundary
4	Q1	
5	Q1	
6	Q3	
7	Q3-Q2	

- 1) **Zone 1 Removing re-staked tree.** This tree will be structurally deficient and should be removed. Replanting may not be necessary because of the other trees to the west. Maintaining the open sun for monarch access to the nectar beds and bottlebrush is a priority in this zone.
- 2) **Zone 6 Large dead standing pine.** This tree is leaning away from the trail and does not pose direct threat to people, but when it falls it could take out important wind shelter trees to its east. It is recommended that it be carefully removed in the near future, and an irregularly-topped wildlife snag created from the trunk.
- 3) **Zone 2 Plant cypress in the west side shelterbelt (Photo 1 Panorama).** The west facing side of Zone 2, just east and upslope from the nectar beds has an open understory that allows wind into the interior cluster zone. In recent years, wind exposure has increased with the death of the large acacia. The skeleton of the large acacia should be retained for now. There is one acacia that is fenced that will fill in some of the space, but a combination of cypress, oaks, toyons, and ceanothus is recommended to fill in the gaps here. Several volunteer pines have established and should be protected, but cannot be relied upon in the long-term (pitch canker). High priority site for potted cypress planted in a well-spaced (10' minimum) row extending from the remaining cypress in the north to nearly the bend in the trail, and consider a second row to the east staggered to fill gaps in the first row.
- 4) **Zone 1 and 6 redwood management (Photo 2 Panorama).** The redwood trees have been struggling since they were planted. They are water-stressed in many years; many have been growing poorly and have dead tops and branches. The wet years in 2017 and 2019, and a wet spring in 2018 made for decent redwood growth, and the trees are looking better for now. But redwoods are not well suited for Pacific Grove close to the ocean because of salt spray, and will cease height growth once exposed directly to ocean winds. Irrigation has not kept up

- with tree water demand. We recommend phasing out the redwoods over a few years and planting cypress and pine as replacements. There is currently sufficient wind shelter in this area that the lack of the short redwoods will not diminish the butterfly habitat.
- 5) **Zone 2 Understory Pines:** New pine plantings have survived their second season and are a few feet tall. Any volunteer pines are also noted and should be protected from deer.
 - 6) **Zone 2 Dead Acacia.** This acacia died a few years ago, but removal of the skeleton is not recommended until better wind shelter is established in this area by the cypress plantings described above in 2.
 - 7) **Zone 3 Plant isolated cypress for eventual cluster tree.** The large open space to the east of the viewing area has a nice wind-sheltered and dappled light environment. Occupying a small part of this with a lone cypress tree would provide a cluster site that might end up heavily used once the tree grows tall enough (10+ years). Planting at least 2 trees and planning on thinning back to 1 will ensure that a healthy tree is established here.
 - 8) **Zone 3 Dense blue gum plantings (2013) status (Photo 3):** Several trees here have died and should be removed. Thinning of the overplanted trees back to a more appropriate spacing is still recommended, a few trees each year. The dead potted trees should be removed.
 - 9) **Zone 3 South Fenceline (Photo 4).** One or more of these trees have died and should be removed. The trees planted next to the fence will eventually damage the fence as they grow in girth. No immediate actions are suggested other than removing dead trees, but monitoring the situation is important. At some point in the future (several decades) realignment of the fence will be necessary
 - 10) **Zone 3 Eucalyptus plantings (2011) and ground plantings (Photo 10).** The trees planted in 2011 are now growing taller (some are close to 35'). The planting of Douglas iris and strawberry as groundcover is a welcome diversification of the herb layer. The bare area is an excellent planting zone for additional native species, and a systematic selection process and procurement of a greater diversity of native plants is encouraged. There will always be some negative effects of eucalyptus leaves and duff, but occasional raking can deal with that. The area is too shaded to be a consistent nectar zone
 - 11) **Zone 4 Closing south edge gap:** On the south edge of Zone 4, there is a substantial low canopy gap that should be filled in by planting a nursery raised blue gum or preferably a red gum to diversify. The arborist report suggests some appropriate species. Cypress is not recommended here because of its spreading growth form.
 - 12) **Irrigation system:** Maintaining and operating the irrigation system for establishing trees, and avoiding over-watering and under-watering is an important management action. The reliable early survival of new plantings is dependent on appropriate irrigation, but trees should be weaned off irrigation after a few years once firmly established

- 13) **Management of trees at the Butterfly Grove Inn (Photo 5):** The City and the owners of the hotel need to maintain cordial relations and coordinate actions in this sensitive area. The trees on the property, especially those along the driveway, are critical components of the Sanctuary. Tree trimming several years ago north of the hotel required intervention by the City arborist to reduce the trimming to just what was needed for safety. Balancing safety, tree health, and maintenance of wind shelter can be difficult on adjacent properties.
- 14) **Southern Neighbors (Photo 6):** South of the Sanctuary, trees in the neighbors' yards provide cluster sites (the pine near the shed and several cypress), and additional wind shelter. In 2017-2018, a pines and cypress at 210 and 212 Ridge Road were heavily used by monarchs. While beyond the direct control of the City, maintenance of these trees by the neighbors is important. Outreach by the City is important to find out plans and anticipate changes. Management of hazards over these yards should be done on a case by case basis. But, management actions within the Sanctuary itself are designed to eventually make it more self-contained and less reliant on neighboring property owners.
- 15) **Ridge Road and Short Street trees.** The trees farther south along these two roads play an important role in more distant wind shelter. An evaluation of the health of these trees is necessary to plan long-term maintenance of this important function. This was suggested in 2019, but not done.
- 16) **Nectar beds: (Photos 7, 8, 9, 10).** The tree daisies are highly attractive to monarchs. The yellow Buddleia is also a favored fall nectar source. The bushes are getting quite large, and accumulating dead foliage and branches in their interiors. These bushes should be trimmed in rotation to promote fresh foliage and copious blooms timed for October. The nearby red gum is also attractive when it flowers in fall, but not in all years. The species that are not used for nectar, such as the mallow, should be replaced with nectar providing species to be determined.
- 17) **New trailside nectar plantings:** The edges of the trail north of the nectar beds are prime sunny locations for low growing native nectar plants. Fall blooming species should be chosen from the Xerces Society plant lists (links below), tracked down, bought, and planted as soon as feasible preferably in fall 2020 or winter 2021 so that they may be ready for use in fall 2021.
- 18) https://xerces.org/sites/default/files/publications/19-046_01_MonarchNectarPlants_California_web-3pg.pdf.
- 19) <https://xerces.org/publications/plant-lists/ppbi-california-central-coast>
- 20) **Squirrel disruption of monarch clusters:** There were no reports of the eastern fox squirrel taking down monarch clusters in 2019-2020, as was last observed in 2017-2018.
- 21) **Weather Station:** There has been talk of putting in a weather station. This project is a major commitment if it is to be useful. Deployment, maintenance, and data management are all issues that need to be worked out. The scientific relevance of a single point within the grove needs to be augmented by

distributed sensors and short-term field campaigns to map out wind and light, and correlate with hemispherical photography (Weiss 2011). Further discussions can flesh out the potential cost and commitment of this project.

- 22) **Zones 6, 7, and 2 native forest management:** As discussed with the arborist, there is much room for diversifying the understory in these areas with native trees and shrubs. This is discussed above in the long-term management recommendations. Starting to firm up potential plans this year would be a good start and testing out methods for removing unwanted ground cover and replanting with natives should be a near term goal.
- 23) **Zone 3 South Boundary upper-story opening STUDY:** there are some indications that the dense eucalyptus wall may be blocking too much light in the interior of the Sanctuary. Some simple investigations of light patterns from direct observation and hemispherical photography could address this issue, and removal of some upper branches/trunks can be simulated. No actions would be taken until it was firmly established that this would not let in too much wind.
- 24) **Trailside native plantings:** attractive plantings of native perennial forbs and shrubs along the trail sides will beautify the preserve and add to native biodiversity. Planning and executing some initial plantings in the 2020-2021 rainy season would be a good start.
- 25) **Adaptive Management:** New City staff Caleb Schneider has been given responsibility for managing the grove. This year (2020) is the seventh year where the deliberate adaptive management cycle has been implemented. The cycle starts with a site visit in summer to assess the grove, a written report presented to the BNRC, and a public tour of the Sanctuary soon thereafter (sponsored by Public Works). Work is completed in September prior to seasonal restrictions. Public input is sought at appropriate times and through official channels.

George Washington Park

George Washington Park (GWP) is ready for a more detailed site restoration and management plan. Observations and recommendations (largely repeated from previous years) include:

- 1) This is a unique site for California monarchs; it is one of the few remaining Monterey pine/live oak habitats for monarchs.
- 2) GWP has been used intermittently by monarchs, a few individuals can be found there every year at some point, but major clusters were observed only in 2003, 2004, and 2006 (Table 1). In 2006, there were more than 10,000 monarchs at GWP and very few at Monarch Grove Sanctuary. Since then, there has been only one year (2011 with 61 observed) with monarchs at Thanksgiving, none were observed from 2012 to 2019. Individual monarchs have been observed here during other times of the overwintering season.
- 3) The historic cluster sites in GWP are losing sufficient wind shelter for monarchs, and additional senescence of mature trees threatens this important component of habitat suitability. In particular, the largest pine at the historical overwintering site has died, but there are several mid-story pines that are in positions to replace this tree over coming decades. Losses of forest cover to the south and west through overstory tree mortality is reducing wind shelter.
- 4) Removal of dead standing trees is recommended where they have stationary targets, especially around the edge of GWP. Dead trees that may fall across trails in the interior should be evaluated on a case-by-case basis. Trees can be left as safe wildlife snags where appropriate, but a more naturalistic topping should be considered.
- 5) Reduction of accumulated deadfall by CALFIRE in 2014, 2015, and 2016 removed large piles of downed tree debris. This is important preparation for eventual site restoration. Some branch and log piles have been retained and downed logs are used to redirect foot traffic to fewer trails.
- 6) Plantings of pine seedlings to the SW of the historical cluster site, similar to the plantings at the southern end of GWP, should commence.
- 7) Live oak plantings can provide the under- and middle-story necessary for wind shelter in a mature pine forest.
- 8) Operations on the perimeter of the park are the priority, to maintain safety from falling dead trees on adjacent roads, and to create a fire buffer.
- 9) The full impact of the recent drought will continue to be expressed. Trees may take one or two years to die after major drought stress and high rainfall season like 2016-2017 and 2018-2019 may not allow for recovery once drought stress has weakened trees.
- 10) Establishment of a designated trail system and decommissioning of meandering paths impacting root systems of the trees is occurring. Ingrowth of poison oak is effectively shutting some social trails.
- 11) Now that there have been reductions in downed trees and debris, and the full impact of the drought on mature trees will become apparent, the long-term

suitability of George Washington Park for monarchs should be assessed, with methods similar to those employed at Monarch Grove Sanctuary.

12) An assessment of pitch canker and tree health is especially important

13) Once assessments are done, a long-term planting scheme (pines, oaks, and native understory shrubs) should be developed and implemented. The key elements of such a planting scheme should be to provide eventual replacements for canopy trees, create and maintain a mid-story of oaks and pines, and maintain wind shelter from all directions around defined canopy gaps.

Literature cited

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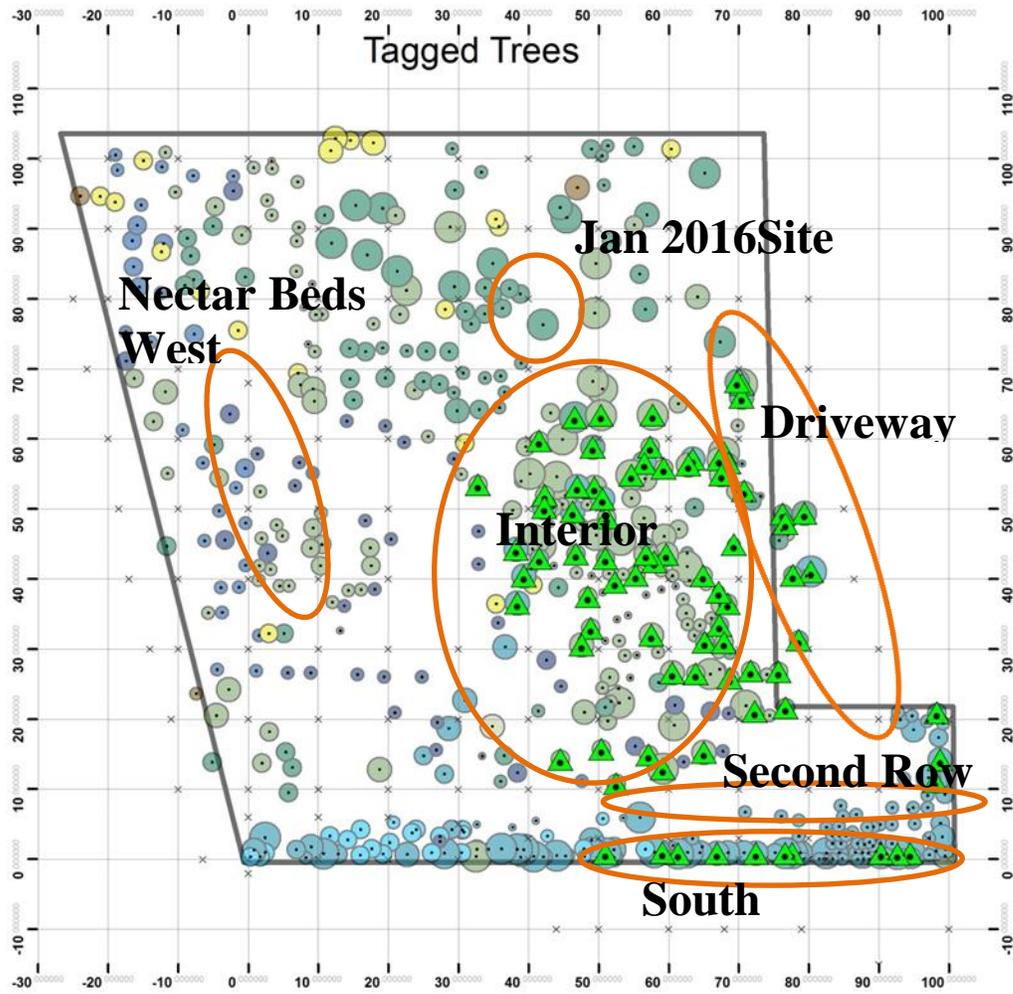
**Table 1. Monarch Butterfly Thanksgiving Counts Xerces Society
Monarch Grove Sanctuary (MGS) George Washington Park (GWP), Monterey County,
and California Totals. *MGS was the only site counted that year.**

Year	MGS	GWP	CA Total	Monterey Co.	MGS % CA	MGS % Monterey	MGS CA Rank
1997	45,000		1,235,490	45,000	4%	100%*	10 (tie)
1998	35,000		564,349	41,000	6%	85%	5
1999	25,000		267,574	25,000	9%	100%*	3 (tie)
2000	20,000	0	390,057	20,000	5%	100%*	6 (tie)
2001	14,960		209,570	31,203	7%	48%	4
2002	4,700		99,353	11,593	5%	41%	5 (tie)
2003	22,802	2,750	254,378	68,979	9%	33%	2
2004	10,867	4,325	205,085	54,481	5%	20%	4 (tie)
2005	12,199	2	218,679	37,540	6%	32%	4
2006	28,746	11,795	221,058	59,957	13%	48%	1
2007	8,181	2	86,437	15,426	9%	53%	3
2008	17,866	0	131,889	31,063	14%	58%	2
2009	793	0	58,468	4,735	1%	17%	17
2010	4,968	0	143,204	8,634	3%	58%	4
2011	12,265	61	222,525	27,788	6%	44%	4
2012	10,790	0	144,812	29,048	7%	37%	4 (tie)
2013	13,420	1	211,275	35,772	6%	38%	3 (tie)
2014	18,128	0	234,731	55,879	8%	32%	3
2015	11,472	0	292,888	27,787	4%	41%	3 (tie)
2016	17,100	0	298,464	64,804	6%	26%	3
2017	7,350	0	192,629	35,657	4%	21%	8
2018	705	0	28,429	2,758	2.5%	26%	15
2019	642	0	21,944	2,792	2.9%	25%	8

Table 2. Comparisons of Thanksgiving (NOV) with New Years (JAN) counts at Northern California sites that had >100 butterflies at Thanksgiving Counts.

SITE ID	SITE NAME	COUNTY	NOV 2019	JAN 2020	Ratio 2020	NOV 2018	JAN 2019	Ratio 2019
3000	Lighthouse Field, Santa Cruz	Santa Cruz	3402	2600	76%	1802	1933	107%
2998	Natural Bridges State Beach	Santa Cruz	1997	25	1%	1120	765	68%
2920	Private Property near Big Sur	Monterey	1750	50	3%	819	29	4%
2833	San Leandro Golf Course	Alameda	702	252	36%	192	5	3%
2935	Butterfly Grove Sanctuary	Monterey	642	316	49%	705	685	97%
2983	Moran Lake, Moran Lake	Santa Cruz	400	30	8%	1373	346	25%
3248	Deer Flat Ranch	Monterey	369	244	66%	163	270	166%
2912	Alder Rd.,	Marin	200	0	0%	1256	62	5%
2832	Chuck Corica Golf Course	Alameda	177	0	0%	177	-----	-----
3010	Ocean View and Marine Drive	Santa Cruz	167	54	32%	167	-----	-----
3227	Juniper & Kale, Bolinas	Marin	113	12	11%	200	0	0%

Figure 1. Monarch Occupied Trees (Green Triangles) 2012-2014, Grid in meters



PG_Trees_2014_IDs	Other	CUMA	EUCA	EUCO	EUGL	PIRA	QUAG	SESE
ACME	● 1	● 1	○ 1	● 1	● 1	○ 1	● 1	● 1
● 1	● 3	● 3	○ 3	● 3	● 3	○ 3	● 3	● 3
● 3	● 10	● 10	○ 10	● 10	● 10	○ 10	● 10	● 10
● 10	● 20	● 20	○ 20	● 20	● 20	○ 20	● 20	● 20
● 20	● 30	● 30	○ 30	● 30	● 30	○ 30	● 30	● 30
● 30								

Figure 2a. Daily Maximum Wind

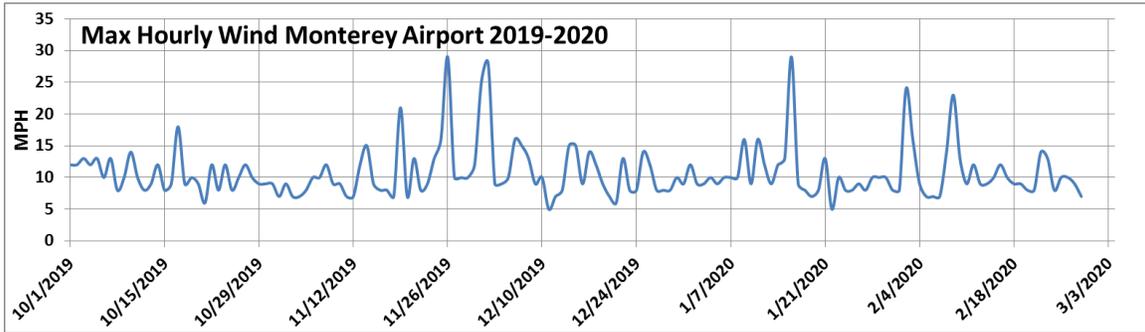


Figure 2b Rainfall

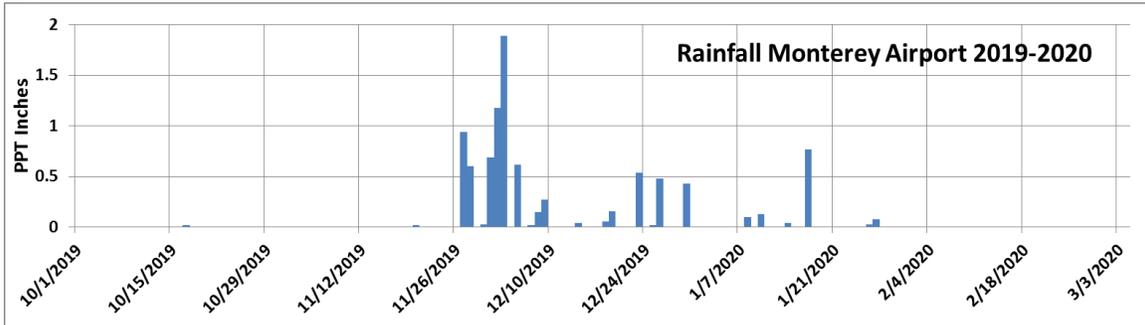


Figure 2c. Temperature

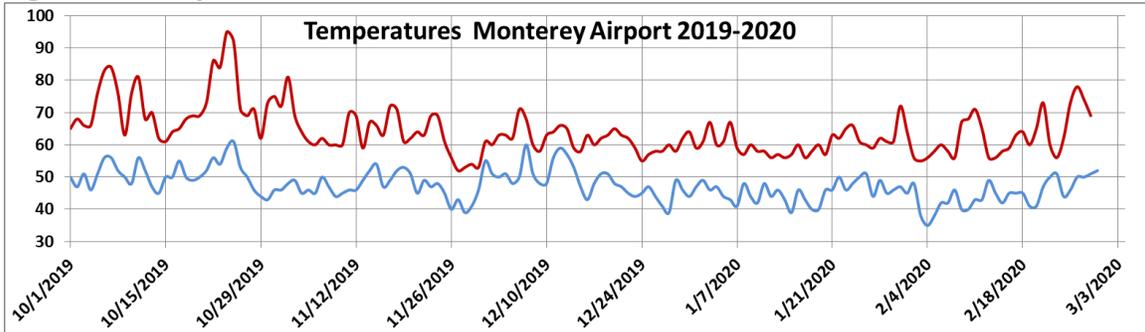


Figure 3a. Monarch numbers through seasons. Data from Pacific Grove Museum

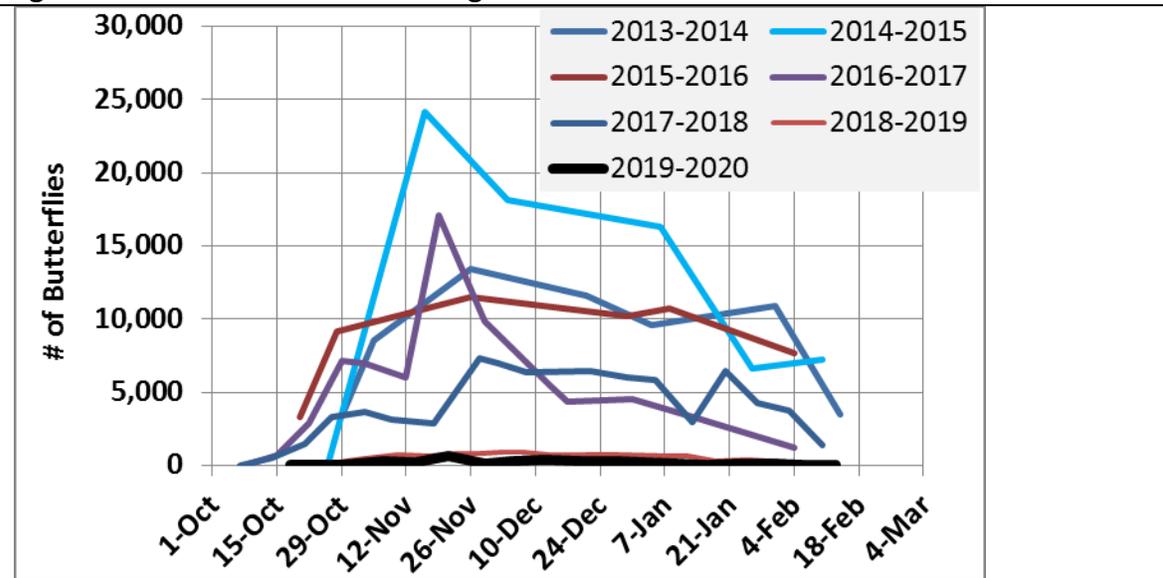


Figure 3b. Monarch numbers through 2018-19 and 2019-2020 seasons

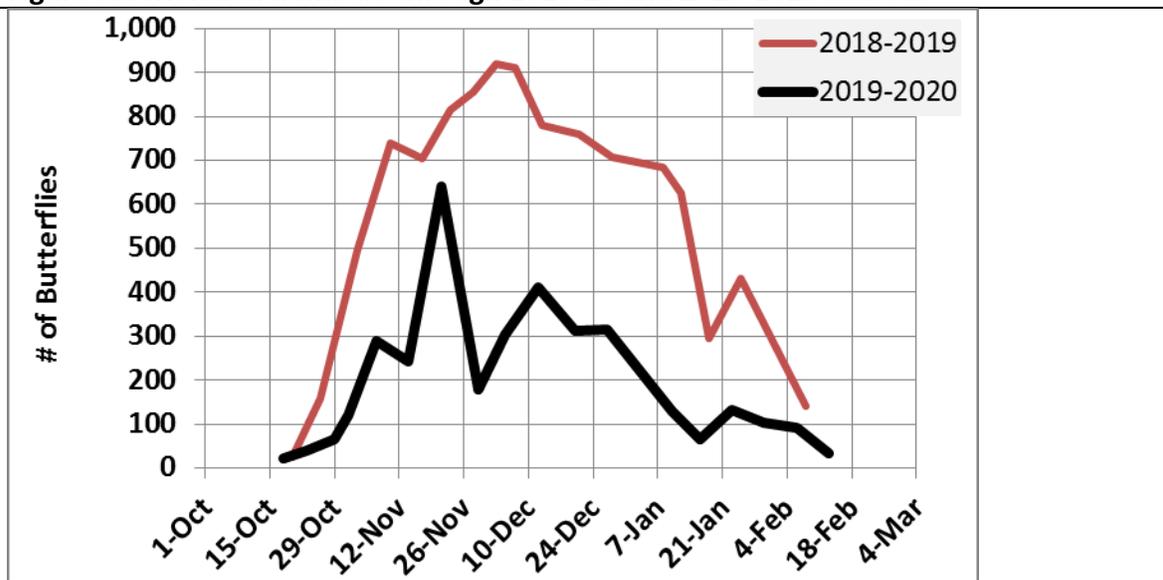


Figure 4a. Tree species by date 2019-20

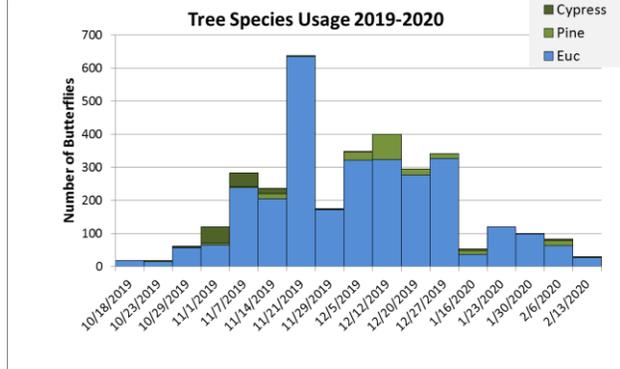


Figure 4c. 2018-2019

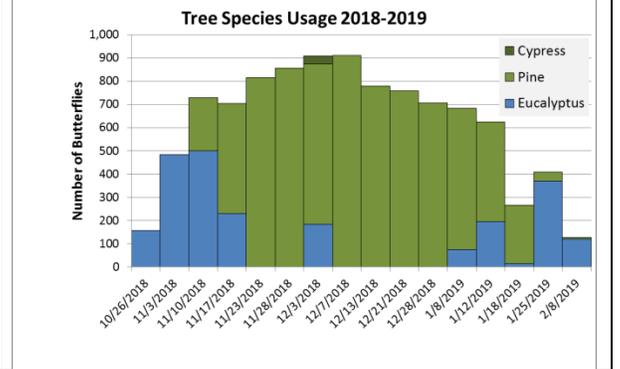


Figure 4c. 2017-2018

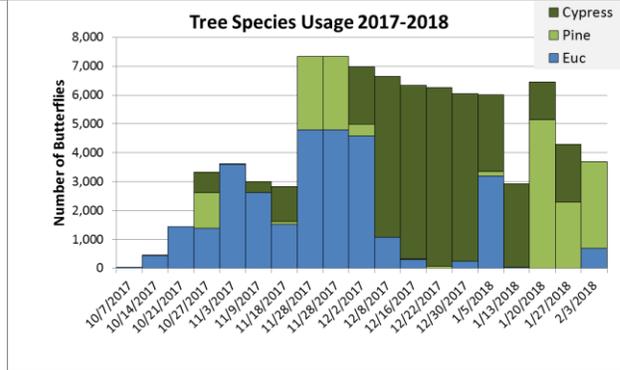


Figure 4d. 2016-2017

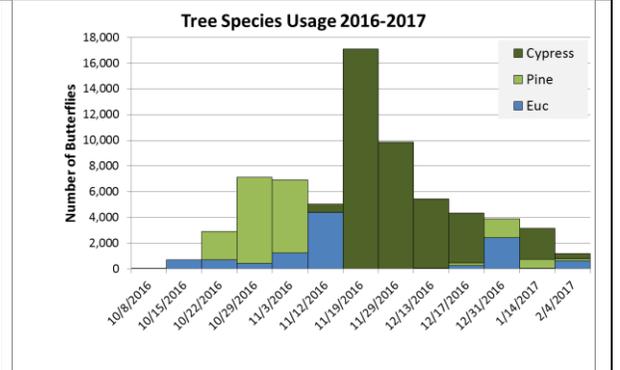


Figure 5a Abundance by Monarch Cluster Zones

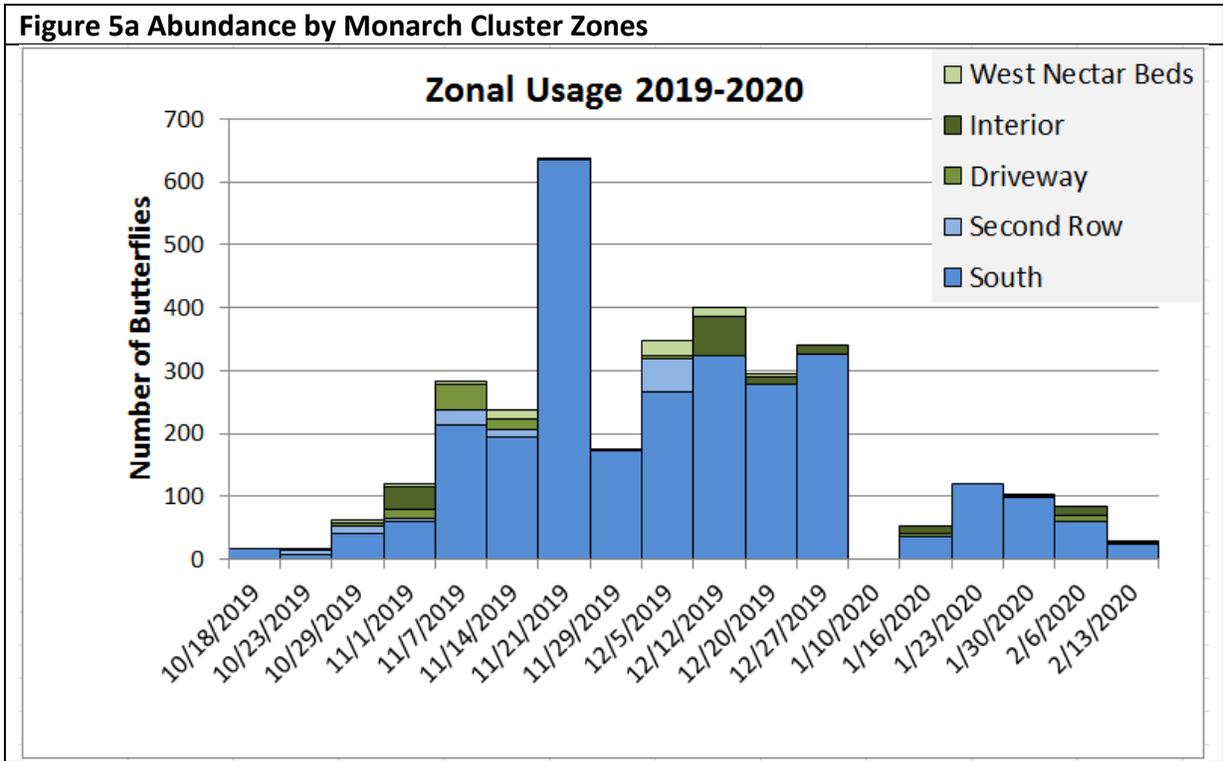
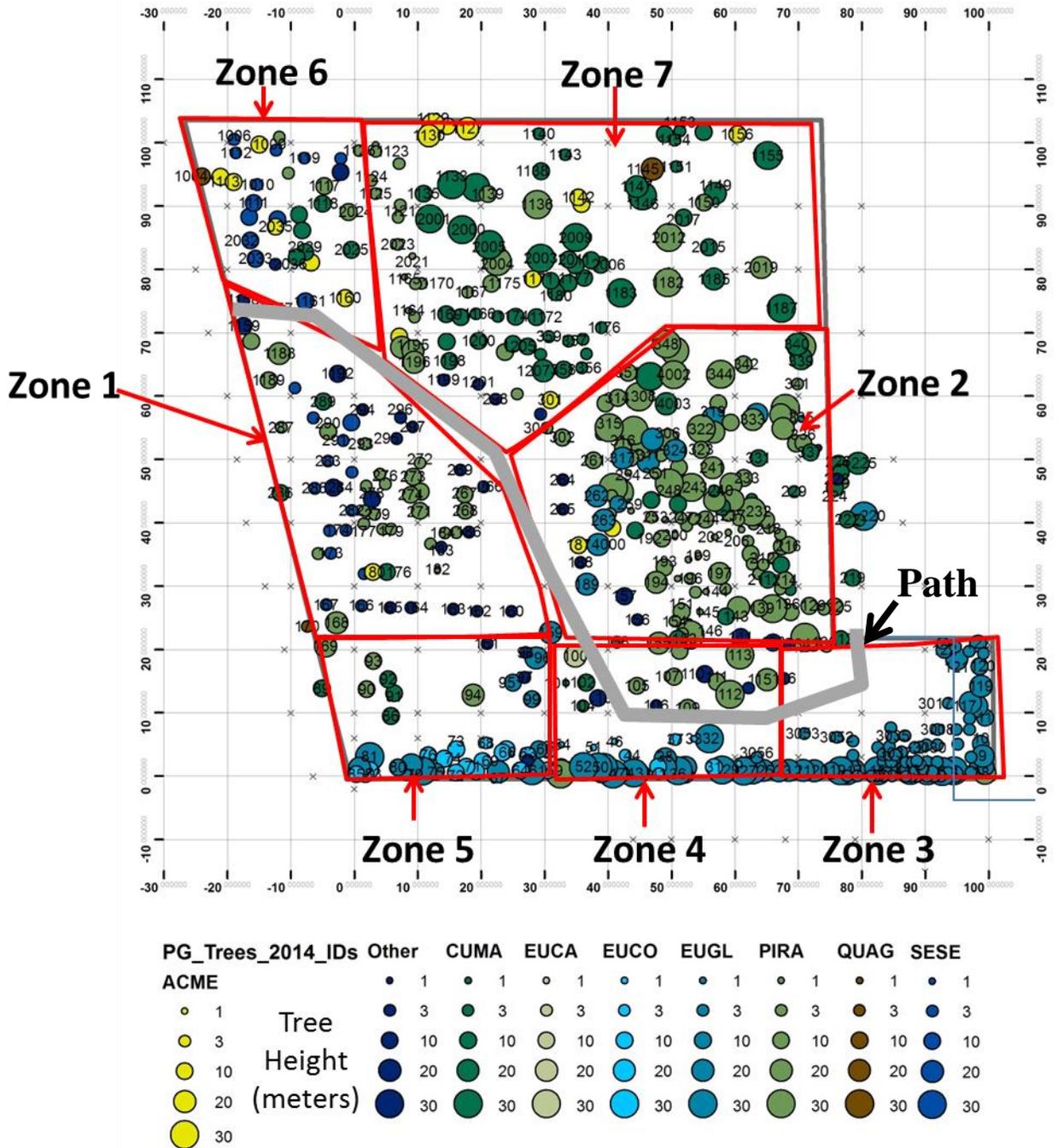


Figure 5. Management Zones. Grid in Meters



Photos

Photo 1. Panorama of western exposure of Zone 2 Interior showing open understory to be sealed up. Photos taken looking east from nectar beds (fence seen in lower right)



Photo 2. Panorama of redwoods in Zone 1 looking south from main trail



Photo 3 Dead potted Eucalyptus and live potted cypress SE corner, Zone 3



Photo 4 Panorama of South Boundary, viewing area to right



Photo 5. Panorana toward Hotel and Interior from viewing area



Photo 6 Over the South fence Pine tree (circled) is the major cluster tree in many years



Photo 7 Nectar Use Tree Daisy Nov 2018



Photo 8 Nectar Use Tree Daisy Nov 2018



Photo 9 Nectar use Buddleya Oct 2015



Photo 10 Nectar use red gum Oct 2015



Photo 6 Over the South fence Pine tree (circled) is the major cluster tree in many years

Appendix A.

2013-2018 season summaries

Thanksgiving counts of 10,790 in 2012, 13,420 in 2013, and 18,128 in 2014, 11,472 in 2015, indicate that the Sanctuary continued to attract large numbers of butterflies that remained through the overwintering season.

In 2012-2013, the butterflies largely moved onto pines and cypresses in the interior of the grove following strong storms in November and December 2012. The interior habitat provided suitable light and wind conditions through the remainder of the season. The 1999 blue gum trees grew to 40-60' tall and provide critical NW wind shelter as part of a multi-species windbreak. Viewing opportunities were provided from the hotel driveway.

In 2013-2014, butterfly numbers peaked in late-November at 13,500 and remained at ~10-11,000 through early February, with a sharp drop in mid-February to <5,000 as they dispersed to the breeding grounds. Butterflies remained at the southern boundary through early January 2014. The strongest wind events during this period were in early December (max speeds 21-22 mph, gusts of 28-31 mph). By January 27, 2014, they had moved into the interior of the grove and were clustered on pines and cypress. There was a wind event on January 11 (max speed 16 mph, gusts to 28 mph). By February 14, butterflies had moved back to the southern boundary on Eucalyptus prior to dispersing away to breeding grounds.

In 2014-2015, numbers declined from 24,000 in mid-November to 16,000-18,000 from December through early January and persisted through strong storms in November-December. The decline to 6,000-7,000 by late January through February 10 represents dispersal to breeding grounds during a record warm January. Butterflies started clustering on the southern boundary, but by early December, following strong storms (max winds 25 mph, gusts 40-65 mph) they moved to the interior and remained there through February 10. Apparently the interior conditions were suitable during the warm relatively calm January (one wind event with 30 mph gusts), and butterflies did not move back to the southern boundary. The butterflies that remained in the grove persisted through another high wind event in early February (32-37 mph gusts).

In 2015-2016, butterflies arrived as usual in October and hit peak number quite similar to 2013-2014 (11,000, Figure 2). Numbers remained steady into late-January, and dropped in February as butterflies left the grove. A warm dry February led to dispersal to breeding grounds by the end of the month. Butterflies started clustering in October-November in the western and southern part of the grove, and by December had moved to the interior of the grove following several wind events (40 mph gusts), with the strongest gusts of the season (50 mph) in December (Figure 3). In early January, Dr. Weiss observed monarchs clustering on a tall Monterey cypress about 25 m off the

northern boundary, well north of the typical interior cluster sites (Figure 1). They moved back into the interior and hotel driveway later that month.

In 2016-2017, butterflies arrived as usual in October (50 observed on October 8, rising to 7,100 by October 29) and hit peak numbers of 17,100 in mid-November (Figure 2). Numbers dropped to ~10,000 by late-November, and 4,400-5,500 through December. By mid-January, numbers were down to 3,200 and dropped to 1,250 by early February. Butterflies started clustering in early October along the southern boundary on a mix of Eucalyptus and pines. But by Oct 22-29, they had moved to the interior, probably in response to strong winds around Oct. 15 (peak gusts ~40 mph). The butterflies then moved to the Eucalyptus on the southern boundary by Nov. 12, and into the neighbors' yards (210 and 212 Ridge Road) on cypress through December. On December 31, butterflies were split between the hotel driveway and the southern neighbors. On the final two dates, Jan 14 and Feb 4, the butterflies were in the interior of the grove.

In 2017-2018, butterflies arrived as usual in October with 42 observed on October 7, rising to 3,353 by October 29, and hit peak numbers of 7,350 on November 28 (Figure 2). Numbers held at ~ 6,000 through January 5, then dipped temporarily to 2,947 on January 13 following the large storm and wind event, but recovered to 6,450 by January 20. The windstorm (max wind = 24 mph) apparently scattered the butterflies, but they regrouped soon thereafter. Then with warmer weather, numbers declined to 1,411 by February 10, the last monitoring date of the year before the monarchs left the site during record warmth in mid-February.

2018-2019 season summary

Weather:

The 2018-2019 season had 10 wind events with maximum speed >20 mph, some of them multi-day, starting in late November (Figure 2a), with particularly strong events in early-January, mid-January, and early February. The wind events were associated with storms (Fig. 2b); note the numerous rain storms in February. There was a notable warm period in late January with temperatures >70°F, before an extended cold period through February.

Butterfly numbers:

In fall 2018, butterflies arrived as usual in early October with 24 observed on October 20, rising to 158 by October 26, 705 for the official Thanksgiving count on November 17, and hit peak numbers of 919 on Dec 3 (Figure 3). Numbers held between 600-800 between late-December and mid-January. The mid-January storm scattered the butterflies (down to 295 on January 18), but they had reassembled partially (up to 432) by January 25. The warm period noted above probably stimulated them to break diapause and subsequently leave the grove, and the last significant numbers (140) were observed on February 8. For clarity, only 2017-2018 and 2018-2019 are shown in Figure 3b.

The Thanksgiving 2018 numbers were down by a factor of 10 from fall 2018, more than the overall California population. The Monterey County population was down by even more (a factor of 13). MGS contained 2.5% of the California population, and 26% of the Monterey County population

Notably, MGS retained nearly 100% of its butterflies through the New Year's count, one of the best performances of any site in Northern California (Table 2).

Butterfly distribution:

The monarch distribution was concentrated on the southern edge and the pine on the neighbor's (210 Ridge Road) property for much of the season - except for a period in mid-January when 90 butterflies were farther north and west compared with 150 on the pine and 30 loners. This distribution change was likely the result of the strong storm in mid-January with 3 days of maximum winds >20mph (Figure 2). The butterflies re-assembled on the southern boundary for the remainder of the season.

Tree species usage:

Use of tree species varied through the season (Figure 4a). From October into early November, butterflies primarily used eucalyptus along the southern boundary. For most of the remainder of the season, they used pines, primarily the 210 Ridge Rd. pine. Later in the season (January) they began using eucalyptus again. There was virtually no use of cypress in 2018-2019.

The use of tree species contrasts with that in earlier years, when cypress was much more heavily used (Figures 4b and 4c). In 2017-2018 butterflies primarily used the SE corner and 210 Ridge trees, but clustered on cypress in addition to the 210 Ridge Rd. pine.

These observations from 2013-2018 indicate that Monarch Grove Sanctuary continues to provide enough wind shelter and varied light conditions to support a large monarch aggregation early in the season, and maintain substantial numbers of butterflies through the remainder of the winter. There is sufficient wind shelter for the interior of the grove for butterflies to remain there following storms, and sufficient light that they can take flight as needed. The major wind directions that produce the highest sustained winds are SE-SW and W-NW (Figure 3) and the grove is now much better protected, especially from W-NW than in previous decades because of the growth of the 1999-planted Eucalyptus trees. 2016-17 provided a real test of wind shelter given the large number of storms and high wind events.

Figure A1. Daily Wind Data from Monterey Airport

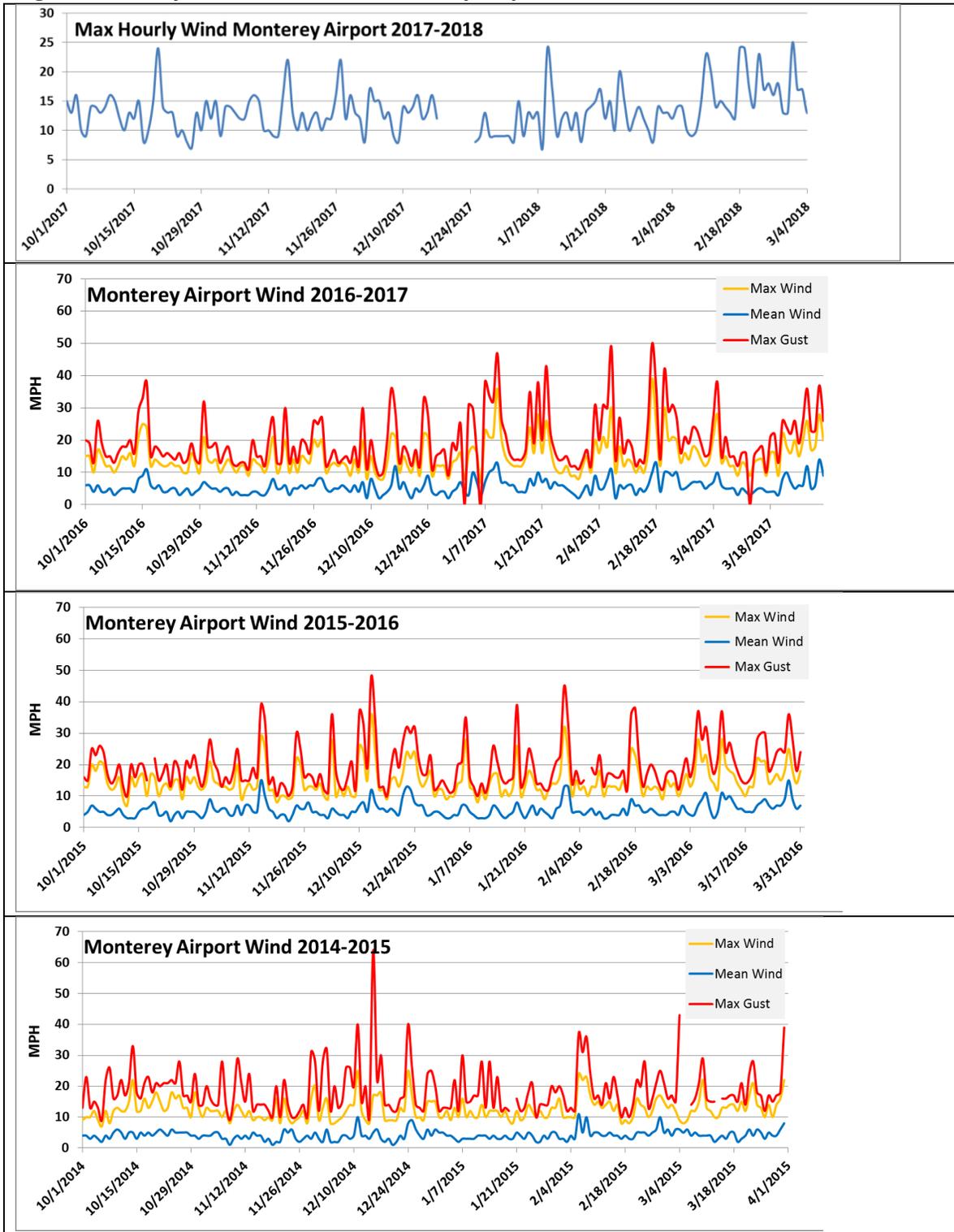


Figure A1 (Continued). Maximum wind and wind direction Monterey Airport

