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Re: Proposed management activities Monarch Grove Sanctuary and George Washington Park for 2019

The following recommendations and assessments are based on site visits and consultations with City Arborist Albert Weisfuss in summer 2019. They are addressed in the context of the 2011 Management Plan and subsequent consultations with City staff and residents, including annual recommendations from 2014-2018. 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.

Background data on monarch numbers at Monarch Grove Sanctuary (Xerces Society Thanksgiving Counts) provide context of the entire California monarch population. Also, we have also 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 will constitute a long-term accessible record for the local community.

Summary of recommended actions (see page 4 for detailed exposition)
Minimal on the ground actions are recommended this year

1. Two trees west of the nectar beds were blown over in storms in early 2019. These should be assessed to determine if they are salvageable, and removed if not. Replanting in these spots is optional; maintaining sunny conditions for the nectar beds is a priority.
2. Removal of dead eucalyptus in the SE corner of the Sanctuary
3. One bent over pine in the center should be removed.
4. Planting cypress in select locations described below

Planning for future actions in 2020 and beyond include:

1. Oak understory plantings: procurement of acorns and trees, and planning for appropriate sites
2. Toyon and ceanothus understory plantings: procurement of shrubs and planning for appropriate sites

History

Current status of monarchs in California:

The western monarch population that overwinters in California has been declining for decades, and is at its lowest level (~30,000) ever in 2018-2019 (Table 1). The previous low was ~60,000 in 2009-2010, 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.

The fall 2018 population suffered an 84% (six-fold) reduction from fall 2017 (~190,000). This crisis has garnered much attention, and there are numerous efforts at national, state, and local levels to address the cases and consequences. Among the likely causes discussed are:

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 but also related to the rarity of two milkweed species (*Asclepias californica* and *A. cordifolia*) 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).
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. A combination of all the above, “death by a thousand cuts” is the most likely explanation.

Monarch grove Sanctuary 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*). These maps were combined with the monitoring database collected by the Pacific Grove Museum of Natural History paint a dynamic picture of monarch

distribution and abundance in the Sanctuary for 2013-2019. In 2016-2017 and 2017-2018 a simplified map as used by monitors to document monarch distributions. Discussions of the 2013-2018 seasons are in Appendix A.

The numbers of monarchs and their distribution within seasons have been monitored by the Museum since 2013-14 by the (Figure 3a). 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.

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 that 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.

Pacific Grove Golf Course
The Pacific Grove Golf Course numbers in the Thanksgiving Counts is erroneous and should be ignored.

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) The 1999 blue gum plantings are working as anticipated, some growing to >60' tall and providing NW wind shelter and allowing monarchs to stay in the interior of the grove following storms. These trees will continue to function for many decades as part of a multi-species windbreak. The mid-story of pines and cypress is necessary for windbreak function, as the foliage on the blue gums is concentrated in the upper canopy.
2) The 2011 blue gum plantings inside the southern boundary have grown to heights of 25-30' and are beginning to provide additional wind shelter at low heights. These trees will eventually reach heights where monarchs can cluster in a wind sheltered dappled light environment – some early season clustering has been observed on the taller trees. These trees will provide redundancy for the large southern windbreak trees, and will eventually replace them decades from now. Planting some additional trees in key locations would fill gaps and provide a multi-age structure.
3) The densely planted blue gums (2013) in the SE corner are showing signs of overcrowding, with poor growth relative to more widely spaced trees. A few of these trees are now dead, and removal of these dead trees is recommended (see

below). Eventually these trees will either self-thin or be selectively thinned in the future. Thinning will increase the health of the remaining trees, and their canopies will expand to fill in the available space.

4) Pines continue to succumb to pitch canker, and drought effects are still being expressed. 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. Removal of pines heavily infested with pitch canker can slow, but not stop the spread.
5) 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,.
6) Understory live oaks could fill in select parts of the grove and provide good native habitat. Understory native shrubs (toyon and ceanothus in particular) and forest floor forbs could be introduced in parts of the Sanctuary, but need to be protected from deer browsing.
7) 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.
8) Attractive fall blooming nectar plants help retain arriving butterflies early in October and November. *All nectar plants should be in sunny areas if they are to be effectively used.* Yellow Buddleia and tree daisy are the most attractive species in the beds, and replacement of some of the other species in the beds should be considered. Away from the nectar beds, butterflies nectar on the flowering red gum when it is blooming 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

Monarch Grove Sanctuary

Needs for tree management for 2019 are minimal. Detailed recommendations are keyed to zones identified in Figure 5. There are relatively few actions recommended which are summarized immediately below. A more in depth discussion of various issues with photos follows.

1) No hazard trees were identified, so no action is necessary.
2) Removal of the completely dead pine in the pine stand west of the nectar beds.
3) Removal or re-staking of the cypress west of the nectar beds, depending on arborists judgement.
4) Planning for a few additional cypress plantings in key spots, to provide back-up for pines.

5) Removal of dead individuals in the crowded blue gums in the SE corner.
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
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.
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.
9) Protection of the new pine saplings and volunteer seedlings

Detailed discussion and observations

1) **Zone 1 Removal of dead pine (Photo1):** Near Grove Acre Avenue, a dead Monterey pine is among the grove highlighted in panorama and removal is recommended.
2) **Zone 1: Restaking or removing blown-down cypress and pine (Photo 2)**. These two trees were blown over in a storm in winter 2019. The cypress was wired back up, and should be evaluated by the City arborist as to whether it should remain and be more firmly wired until it can stand on its own. The pine, while still alive, will become structurally deficient if allowed to regrow, and likely should be removed. Replanting may not be necessary with the other trees to the west, and maintaining the open sun for the nectar beds and bottlebrush is a priority in this zone.
3) **Zone 2. Removal of bent over pine** (**Photo 3**). This tree will not be structurally sound and removal is recommended.
4) **Zone 2 West side shelterbelt (Photo 4).** The west facing side of Zone 2 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. Plantings can be phased in over a few years as plants become available.
5) **Zone 1 and 6 redwood management (Photo 5).** 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 winter/spring 2018 made for a decent redwood year, and the trees are looking better for now. Redwoods are not well suited for Pacific Grove close to the

ocean because of salt spray. 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 sufficient wind shelter in this area that the lack of the short redwoods will not diminish the butterfly habitat.

6) **Zone 2 Understory Pines (Photo 6)**: New pine plantings have survived their first season and are a few feet tall. A few volunteer pines are also noted and should be protected.
7) **Zone 2 Dead Acacia (Photo 7).** This acacia has died, but removal of the skeleton is not recommended until better wind shelter is established in this area.
8) **Zone 3 Dense blue gum plantings (2013) status (Photo 8):** Several trees here have died and should be removed.
9) **Zone 3 South Fenceline (Photo 9).** 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 30'). The planting of Douglas iris and strawberry as groundcover is a welcome diversification of the herb layer. Putting unplanted potted shrubs in the ground should be a priority. 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. 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.
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 11):** 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. Recent tree trimming 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 12):** 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 wind shelter. An evaluation of the health of these trees is necessary to plan long-term maintenance of this important function.
16) **Nectar beds: (Photos 13, 14, 15, 16).** The tree daisies are highly attractive to monarchs and should continue to be managed to produce copious blooms in October. 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 flowers. The nearby red gum is also attractive when it flowers in fall.
17) **Squirrel disruption of monarch clusters:** There were no reports of the eastern fox squirrel taking down monarch clusters in 2018-2019.
18) **Adaptive Management:** This year (2019) is the sixth 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.

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

There was an erroneous entry into the WMTC data base that the Pacific Grove Golf Course had 815 monarchs during the Thanksgiving Counts. This should be ignored.

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	JAN	Ratio
3000	Lighthouse Field, Santa Cruz	Santa Cruz	1,802	1,933	107%
2983	Moran Lake, Moran Lake	Santa Cruz	1,373	346	25%
2912	Alder Rd.,	Marin	1,256	62	5%
2998	Natural Bridges State Beach	Santa Cruz	1,120	765	68%
2899	Purple Gate, Bolinas	Marin	975	7	1%
2920	Private Property near Big Sur	Monterey	819	29	4%
2935	Butterfly Grove Sanctuary,	Monterey	705	685	97%
3227	Juniper & Kale, Bolinas	Marin	200	0	0%
2833	San Leandro Golf Course,	Alameda	192	5	3%
3249	Deer Flat Ranch	Monterey	163	270	166%

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

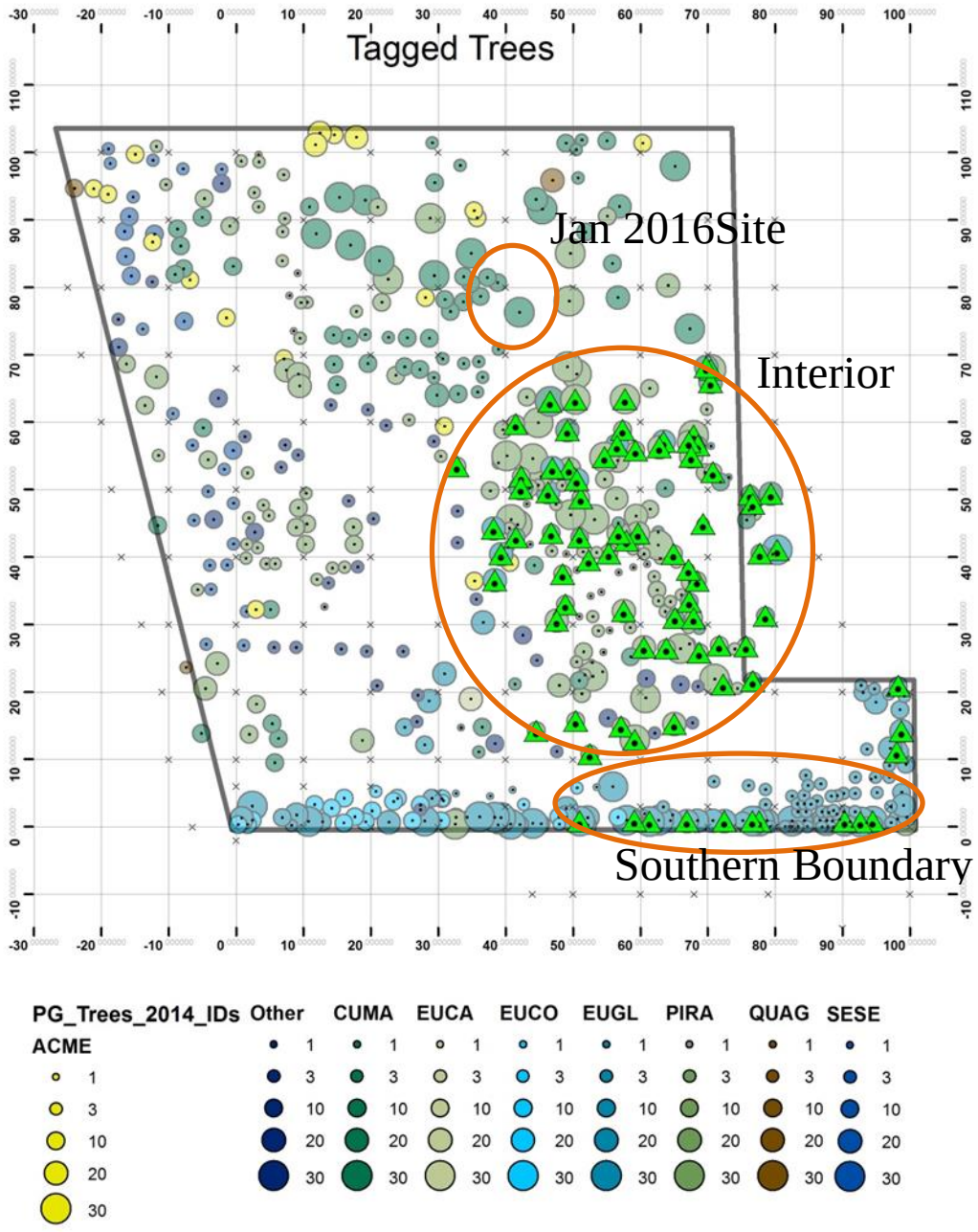


Figure 2a. Daily Maximum Wind

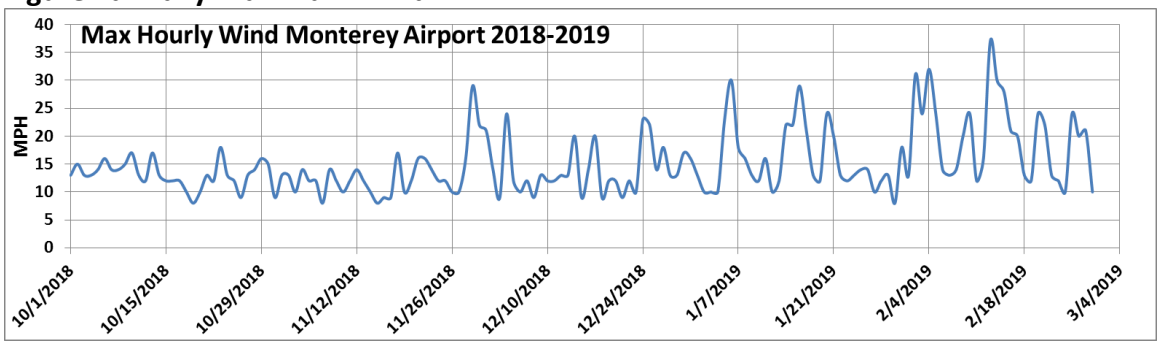


Figure 2b Rainfall

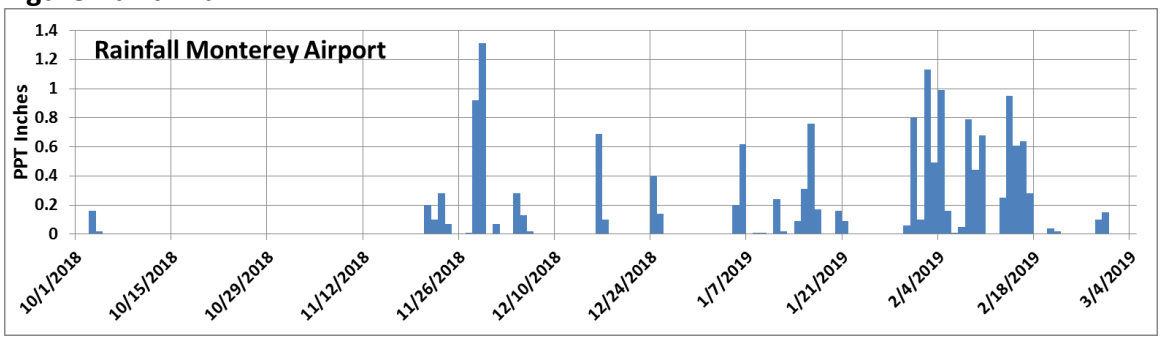


Figure 2c. Temperature

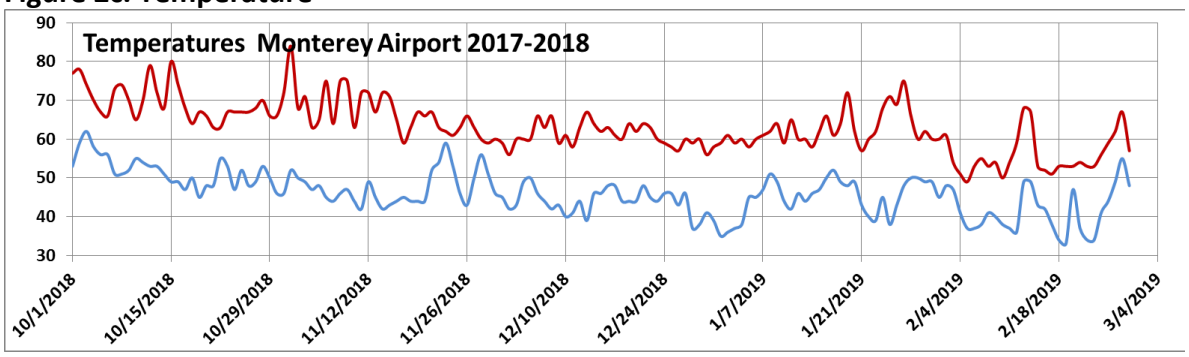


Figure 3a. Monarch numbers through seasons. Data from Pacific Grove Museum

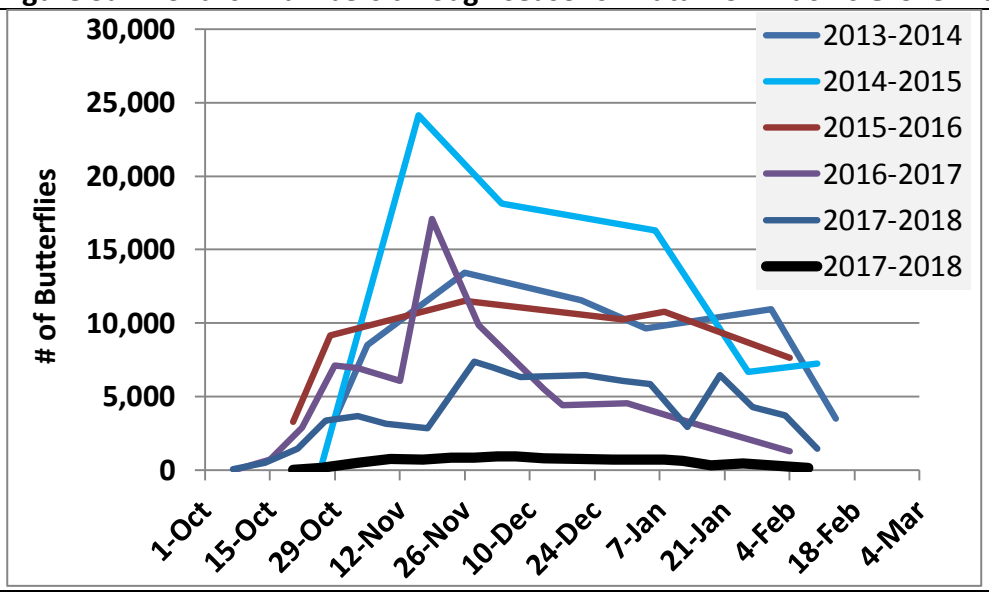


Figure 3b. Monarch numbers through 2016-17 and 2018-19 seasons

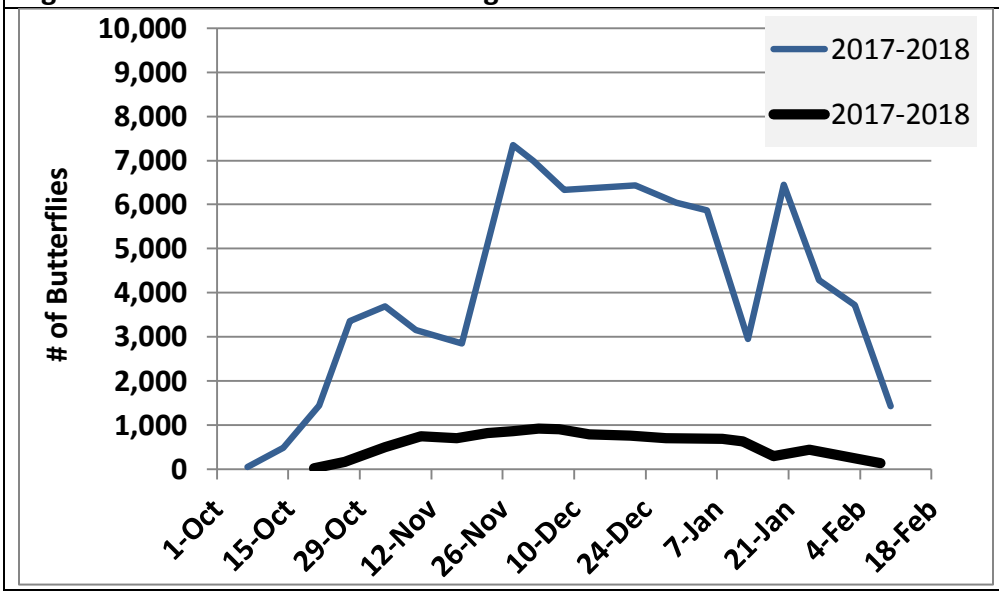


Figure 4a. Tree species usage by date 2018-2019

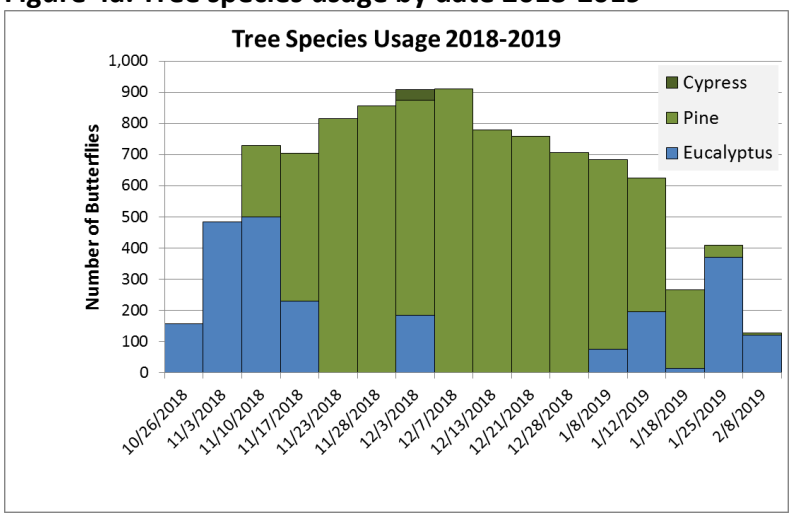


Figure 4b. Tree species usage by date 2017-2018

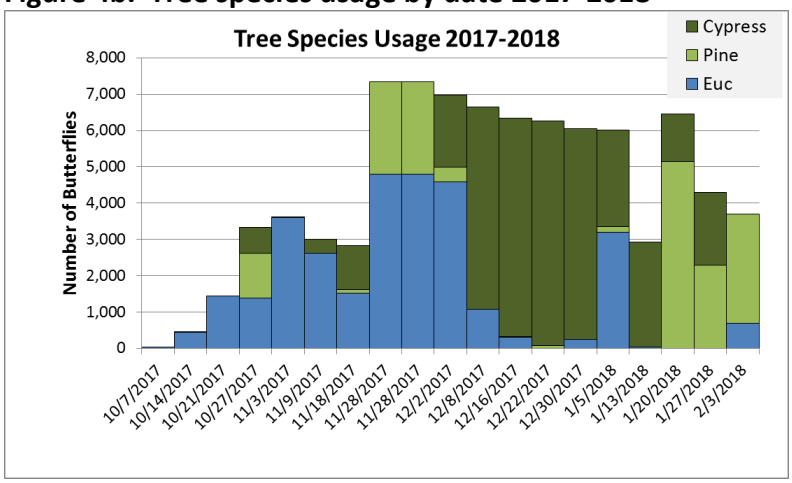


Figure 4c. Tree species usage by date 2016-2017

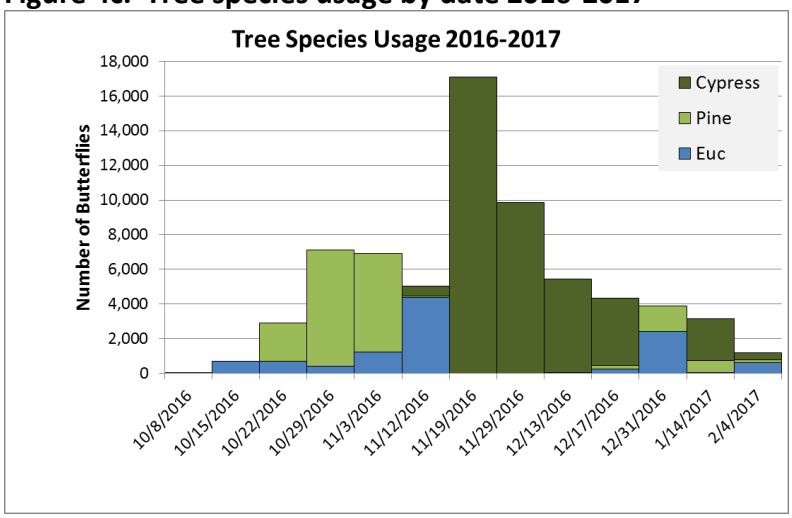
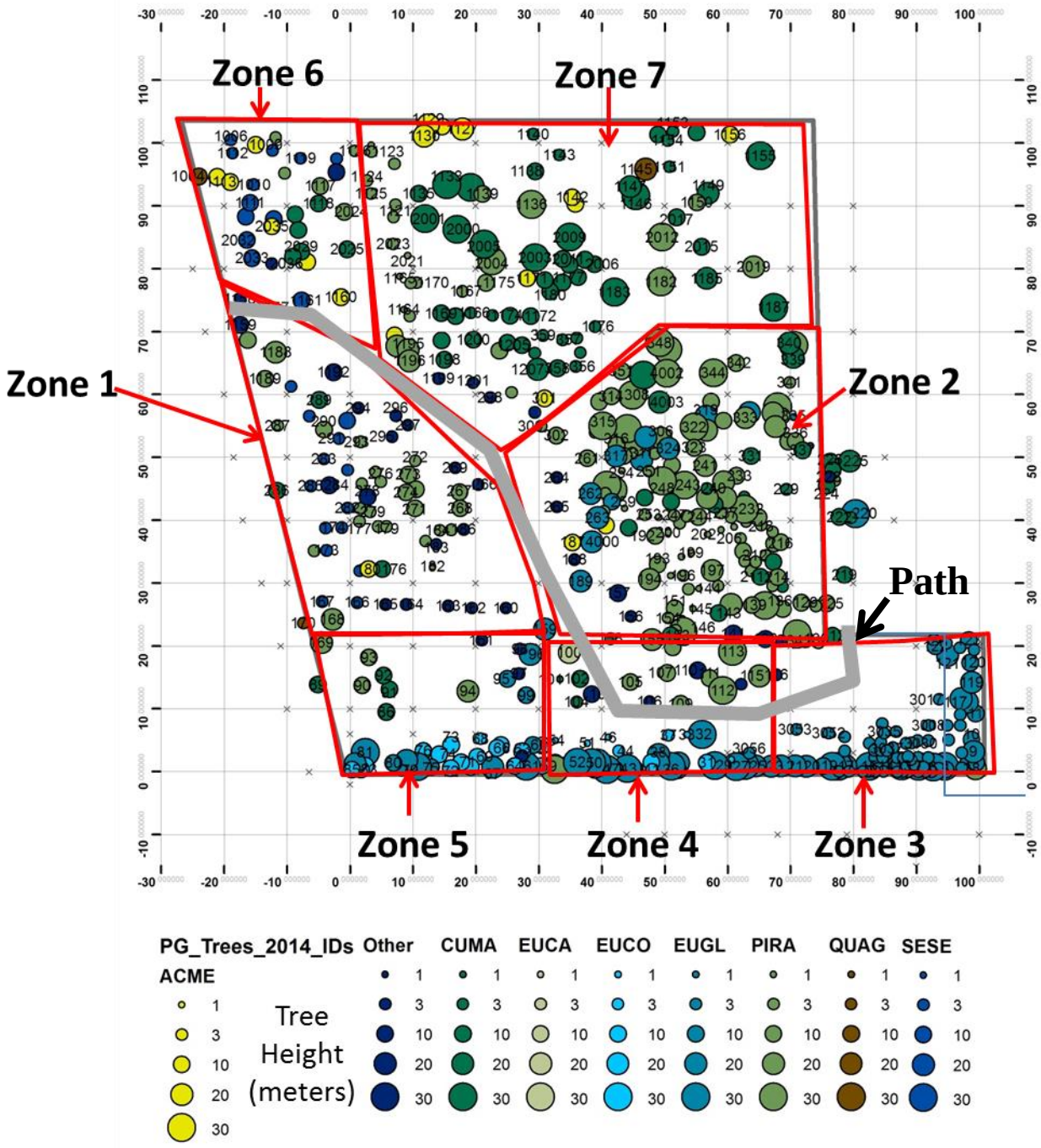


Figure 5. Management Zones. Grid in Meters



Photos

Photo 1. Panorama of Zone 1 looking west. Theere is a dead pine in the group highlighted that should be removed.

Photo 2. Windthrown Pine Zone 1

Photo 3. Bent over Pine Zone 2

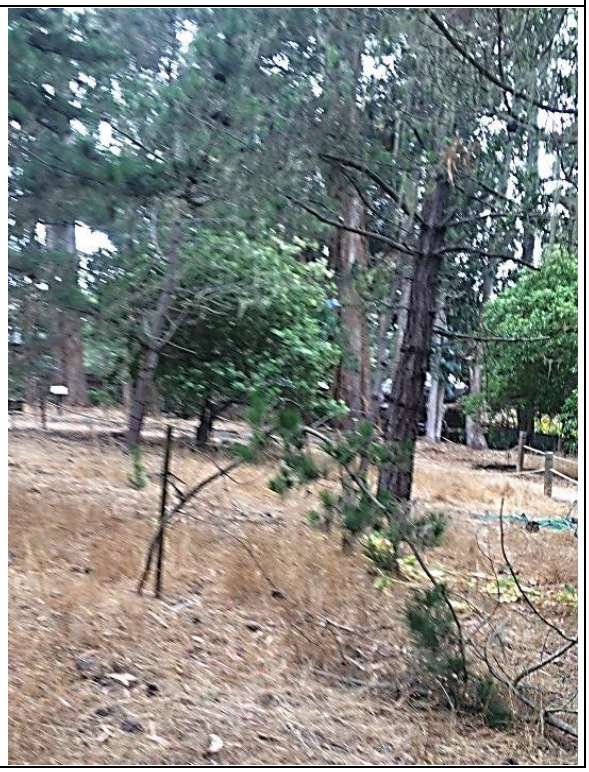


Photo 4. Panorama of western exposure of Zone 2 Interior showing open understory to be sealed up

Photo 5. Panorama of redwoods in Zone 1 looking south

Photo 6 Planted pines 2018

Photo 7 Dead Acacia Zone 2

Photo 8. SE Corner eucalyptus saplings

Photo 9. South Fenceline

Photo 10 Panorama South Fence

Photo 11. Looking toward Hotel from viewing area

Photo 12 Over the South fence Pine tree (circled) is the major cluster tree in many years

Photo 13 Nectar Use Tree Daisy Nov 2018

Photo 14 Nectar Use Tree Daisy Nov 2018

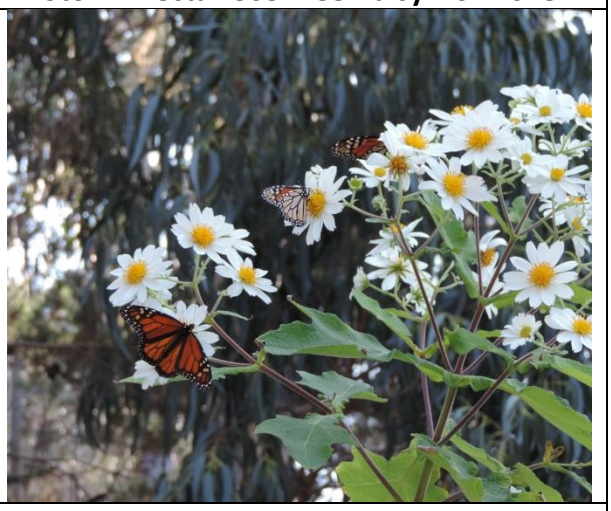


Photo 15 Nectar use Buddleya Oct 2015

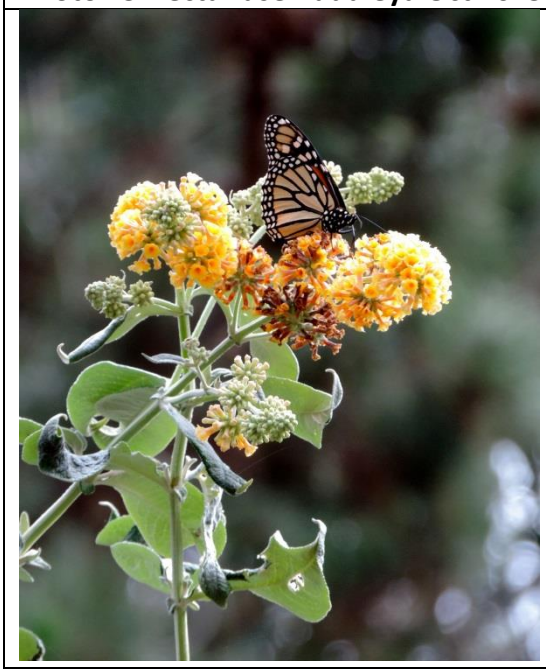


Photo 16 Nectar use red gum Oct 2015

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 rounds.

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.

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

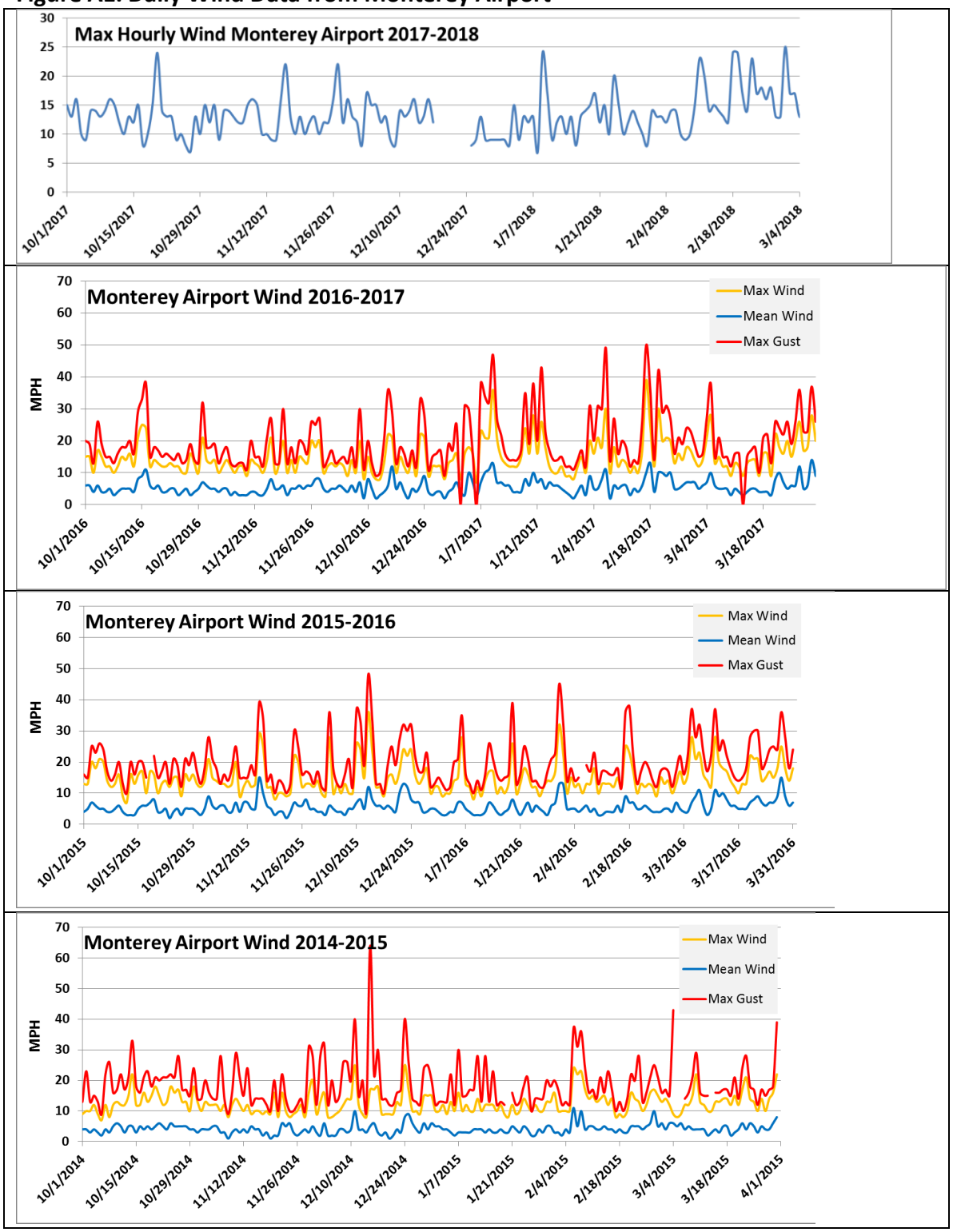
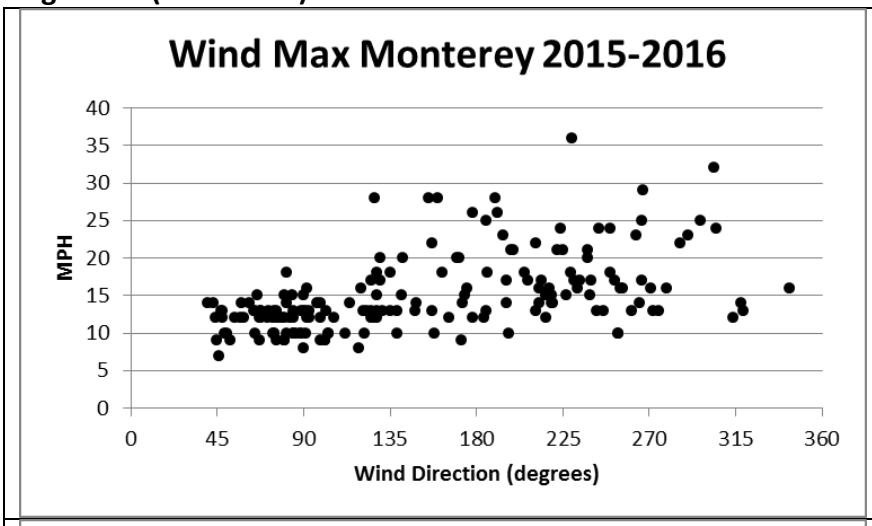
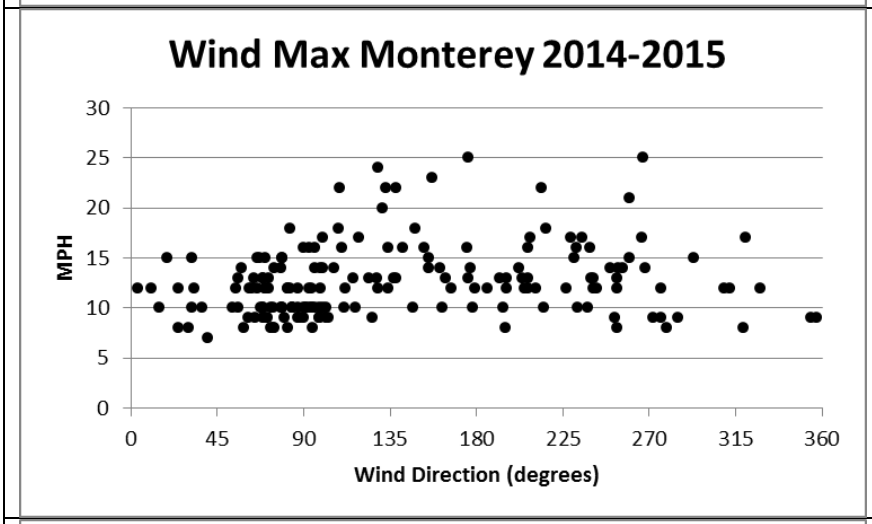
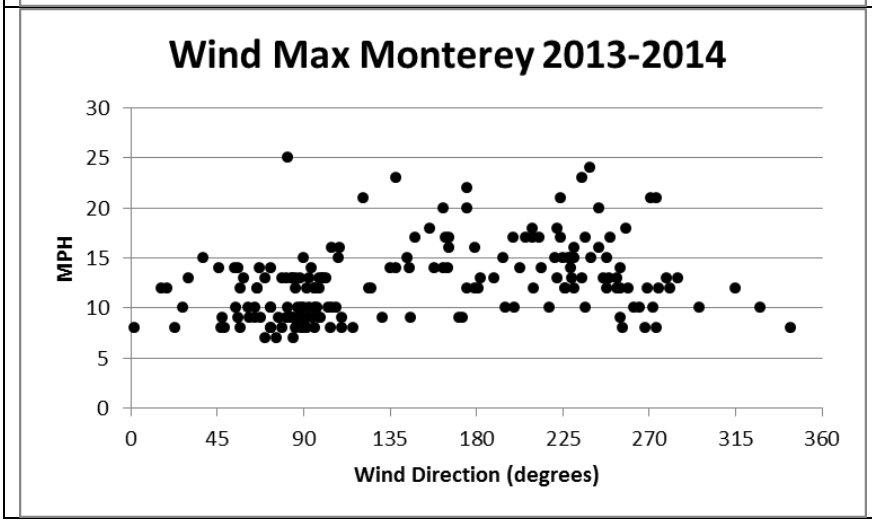



Figure A1 (Continued). Maximum wind and wind direction Monterey Airport