MANZANITA

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Pallid Manzanita and the Maritime Chaparral Community

by Michele Hammond, Botanist, East Bay Regional Park District

Visiting Huckleberry Botanic Regional Preserve in early January, I noted that the pallid manzanitas were just about to burst into flower. This plant blooms any time from October to March but seems a bit on the late side this year. Some of last season's small apple-shaped fruit (the meaning of manzanita in Spanish is "little apple") were still fixed to their branches. Rain had fallen and the ground was damp but not sticking to my boots as I hiked the Upper Loop Trail. Huckleberry, a cherished botanic preserve and a well-loved and heavily recreated park, has been at the center of my attention since I became the botanist for the East Bay Regional Park District (the District) in 2016. As I walked on the narrow trail, I admired the beauty of wintertime California plants such as the leafless, zig-zagging branches of hazelnut and the thorny, twisting stems of California rose. I was checking on the oak woodland and maritime chaparral plant communities for the timing of the manzanita blooms, looking for signs of recovery from the driest and hottest time of year and any new root-rot water mold infection. Winter along the coast of California can be the best time to see if a plant or community of plants is stressed by root-rot pathogens. When manzanitas or other perennial shrubs are saturated with rainwater, they should not look like they are wilting. But I digress, more on plant diseases and pathogens later. This article will be an overview of what is impacting the District's pallid manzanita and how we are helping the recovery of this rare manzanita population.

Michele Hammond

New leaves and last year's berries on pallid manzanita at Huckleberry Botanic Regional Preserve, January 2016

The pallid manzanita (*Arctostaphylos pallida*) is a rare shrub that occurs only along ridge tops between El Sobrante and Oakland where there is a combination of maritime climate conditions and low nutrient soils derived from chert or siliceous shales. Mature shrubs are multi-stemmed and lack a burl at the base of the trunk. New leaves of this manzanita have a whitish coating on their surface which gives them a pale or pallid look, hence the scientific name "*pallida*". The auriculate or ear-shaped base of the pallid

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For information about the *Friends*, membership, and becoming a garden volunteer or docent, contact info@nativeplants.org, visit www.nativeplants.org, or call 510-544-3169

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leaves clasp the stem with little to no petiole. Many bees and butterflies visit the white to pink urn-shaped flowers that provide some of the only nectar available on a sunny day in winter.

Maritime Chaparral Community

Maritime chaparral plant communities exist along the coast of California down to northern Baja California and are associated with multiple endemic manzanita species. This endemism (species restricted to a limited area) is caused by both edaphic and climatic conditions due to the complexity of California's geology, topography and ocean influence. Anyone visiting the ridge tops above Oakland and Berkeley knows how, even in the heat of summer, the early morning fog keeps everything cool and damp. Chaparral vegetation and many manzanita species are often found in the hot dry parts of California; however, the maritime chaparral community depends on extra precipitation from coastal fog drip in the driest months of the year. The coast is one of the most developed regions in our state—this development contributes to habitat fragmentation and loss of maritime vegetation.

Three manzanita species grow together in this community, all of them considered to be at least locally rare by the East Bay Chapter of the California Native Plant Society (EBCNPS): brittle leaf manzanita (*Arctostaphylos crustacea* subsp. *crustacea*), Eastwood manzanita (*A. glandulosa* subsp. *glandulosa*), and pallid manzanita (*A. pallida*). Pallid manzanita is listed as federally threatened, California endangered, and a CNPS Rare Plant Rank 1B.1. Other locally rare plants that co-occur with the manzanitas are giant chinquapin (*Chrysolepis chrysophylla* var. *minor*), huckleberry (*Vaccinium ovatum*), and coast silk tassel (*Garrya elliptica*). Shreve's oak (*Quercus parvula* var. *shrevei*) and interior live oak (*Q. wislizeni*) grow with the coast live oak (*Q. agrifolia*) in Sobrante Ridge around and through the chaparral. For a longer park-based list that showcases the diversity of this plant community see the District website.

The majority of all pallid manzanitas grows on District property in five parks: Huckleberry Botanic and Sobrante Ridge regional preserves and Tilden, Sibley, and Redwood regional parks. Other pallid manzanita stands grow in private backyards and on public property including City of Oakland's Joaquin Miller Park and the Chabot Space and Science Center. The

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Nascent blossoms on pallid manzanita, Huckleberry Botanic Regional Preserve, June 2017

populations in Huckleberry and Sobrante Ridge are naturally occurring and are the largest stands of the species. James Roof, founding director of the Regional Parks Botanic Garden, planted pallid manzanitas inside the botanic garden and along Wildcat Canyon and Golf Course roads in Tilden Regional Park—these populations are still thriving today. The pallids located in Redwood and Sibley and on adjacent City of Oakland properties occur along the same ridgeline as the natural stand in Huckleberry—these are all likely the last individuals of what used to be a larger maritime chaparral community. These small isolated stands exist under mature oak woodland communities or non-native eucalyptus and Monterey pines that were planted early in the 20th century.

As the hills above Oakland developed into dense residential communities in the 1960s and 1970s, open land including the maritime chaparral on the eastern side of the ridgetops was acquired by the District. Fire suppression to protect the new houses and communities in the East Bay changed the natural fire regime of the chaparral and altered the ability of the pallid manzanita to reproduce itself. The stands now consist of same-age mature plants with dense canopies and branch dieback. In order to reduce the threat of catastrophic fire within this area, the District created a Pallid Manzanita Management Plan (PMMP) that will both aid in the recovery of the species and guide all fire safety maritime chaparral management within the District's more comprehensive Wildfire Hazard Reduction and Resource Management Plan (WHRRMP). The PMMP guides the District in how to preserve

Michele Hammond

Ted Swiecki and Elizabeth Bernhardt test for *Phytophthora* at base of pallid manzanita in Sobrante Ridge, June 2017.

Permanent photo points are frequently used in plant monitoring to assess change over time. Landscape-scale photographs of the hills of Tilden Regional Park have been used to show conversion from grassland to shrubland with comparison scenes over 100 years. Taking a picture can be a very cost-effective way to monitor because all it takes is a person with a camera to snap a photo. With the pallid photo point monitoring, the time scale is much shorter because our objective is to measure the progression of a plant disease. Included here are two photos of SOD-confirmed pallid manzanita in Sobrante Ridge; the photos were taken approximately 17 months apart: June 2017 to October 2018.

Michele Hammond

Same plant as above, taken in October 2018. Notice how dieback has progressed.

and enhance the pallid manzanita and at the same time reduce the fire risk in the area with vegetation management. Regular updates showing fuels reduction work already accomplished and planned for the future for the WHRRMP are posted on the District's website.

Challenges

Pallid manzanitas are both federally threatened and California endangered, and occur in maritime chaparral, a plant community protected under the California Coastal Act. This means this species has some of the highest possible legal protections in our state and country. Yet there are many challenges and threats to its continued existence and the health of its plant community. In Sobrante Ridge and other parks, fire suppression has allowed the natural succession of maritime chaparral into oak woodland, leaving the pallids in shaded decadent groves. The Sobrante Ridge Manzanita Loop Trail shows a lot of the natural branch dieback of older shrubs being overtopped by coast live oaks. The stress of the extreme drought years of 2014–2015 also likely took their toll on pallids growing on some of the more exposed and barren shale outcrops. Predicted climate changes that could affect the pallids include more extreme and longer periods of drought coupled with fewer days of coastal fog.

Phytophthora and Other Plant Pathogens

Drought stress makes plants more susceptible to disease and insect infestations that take advantage of the weakened defenses of the plant. Plant diseases or pathogens affect the health of pallid manzanitas and their maritime chaparral plant community. Leaf spotting on manzanitas in Huckleberry and Sobrante Ridge appeared to increase after the drought. These spots were identified as aerial fungal pathogens *Mycosphaerella* and *Neofusicoccum*, species which make the plants look bad but are unlikely to cause death. The symptoms of these fungal diseases make it harder to see the signs of other more severe pathogen infestations or to detect potential new areas of infection.

The biggest threat to pallid manzanitas and other maritime chaparral plants comes from a class of plant pathogens called *Phytophthora* or water molds. Two types of *Phytophthora* pathogens affect pallid manzanitas: *Phytophthora ramorum*, which causes airborne Sudden Oak Death (SOD), and multiple soilborne root-rot *Phytophthora* species.

More and more people have heard of SOD, the airborne pathogen, which has killed oaks and other plant species throughout central California and now up into southern Oregon. SOD moves through the air in warm rainy weather and causes severe pallid branch dieback. It occurs in most District stands of pallid manzanita, although it is not yet confirmed to kill this species.

Other less well-known species of *Phytophthora* are soilborne, that is, they spread through the soil from infected roots to the roots of nearby susceptible host plants. Some of these soilborne *Phytophthora* are especially virulent (for example, *P. cinnamomi*)—they are known to kill a wide range of native California host plant species.

As they age, pallid manzanitas support lichen growth. Michele Hammond

In 2017, the District hired expert plant pathologist Ted Swiecki from Phytosphere Research to test and map *Phytophthora* infection in pallid manzanita areas. Ted confirmed with root and leaf samples that both airborne *Phytophthora ramorum* and soilborne *Phytophthora* species infect pallid manzanitas. Huckleberry's pallid manzanitas, at this point, have the largest confirmed impact from both types of *Phytophthora* water molds. Sobrante Ridge manzanitas show signs of the leaf spotting fungal pathogen and SOD, but so far they are not confirmed to have any species of the soilborne *Phytophthora*. Photo point monitoring in Sobrante Ridge shows the progression of branch dieback on a pallid confirmed by Ted to be infected with SOD. There are also smaller confirmed patches of soilborne *Phytophthora* affecting manzanitas in Redwood and Tilden regional parks.

Invasive plant species like French broom (*Genista monspessulana*) overtop and shade out the pallid manzanita along the edges of the maritime chaparral in Huckleberry. Dedicated CNPS volunteers have been pulling broom and other invasives like cape ivy (*Delairea odorata*), periwinkle (*Vinca major*), and non-native grasses along Huckleberry's trails and staging area. On a positive note, a pallid manzanita seedling was discovered by staff and volunteers next to a couple of larger pallids after broom was removed near the Botanic Garden in Tilden. The following spring, this seedling responded to the new light and resources with new leaves and branch growth—only to be completely browsed by deer or possibly woodrats! This winter, Botanic Garden staff protected the seedling with a cage to prevent further herbivory damage. We have high hopes this hardy one-foot shrub will grow new leaves in 2019. Staff in Redwood saw a similar regeneration response to the removal of dense overstory canopy cover around a mature pallid manzanita along Eastridge Trail. Routine fuel-reduction work, where trees were pruned and removed around the shrub, stimulated the pallid seedbank to germinate and grow around 30 new pallid seedlings. This is great news for the regeneration of pallid manzanitas because it demonstrates that they will sprout from seed even when there has been no fire. Friends of Sausal Creek has had similar seedling growth without fire in the pallid stand near the Chabot Space and Science Center.

Solutions

The District has begun to develop and implement strategies to manage the recovery of the pallid manzanita and to prevent the spread of plant pathogens like *Phytophthora*. Some of the work that seems most relevant to park users and volunteers is included here.

Bay laurel trees (*Umbellularia californica*) are the primary carriers of Sudden Oak Death (SOD) in our woodlands. The leaves of bay trees release the SOD spores during the wet time of year and infect plants nearby or downwind. Removal of bay laurel seedlings and saplings and pruning of larger bays around priority oaks or other plant species is recommended by plant pathogen experts to reduce the impact of SOD. The Garbelotto lab at UC Berkeley plays an active role in SOD scientific research and has been helpful in recommending

EBRPD photo pool

Graceful branch structures of pallid manzanita, marker 15, Huckleberry Botanic Regional Preserve, December 2007

both prevention and containment measures to the District. As part of the pallid recovery plan, the District will remove bay trees upwind from or near pallids and maritime chaparral areas. This removal will be done with careful consideration to the bay tree's value both in conserving erosive banks, especially along Huckleberry's steep slopes, and in riparian habitat. Bay trees growing up through the canopies of oaks can be the cause of SOD infection and eventual death of the oaks and potentially manzanitas.

At the District, our Integrated Pest Management resource analyst Pam Beitz has been working out Best Management Practices (BMPs) to avoid introducing or spreading plant pathogens. Studies by the Garbelotto lab show that brushing and/or blowing off dirt clods and vegetative debris from boots and other equipment is very effective at reducing the risk of *Phytophthora* transfer to almost zero. Staff and outside contractors are following new guidelines to be cleaner and work cleaner to prevent new infestations of pathogens.

Huckleberry has an experimental pallid regeneration plan with the goal of stimulating seedling recruitment into the population within five years. It prescribes removing overtopping native and nonnative woody plants as well as the deep leaf litter and duff around the pallid manzanitas within a planned experimental framework. Over the years of the study we will adapt the treatments to the techniques that lead to seedling growth and survival and stop anything that appears to be harming the pallids.

BMPs and plenty of other recommendations and information are available at the California Oak Task Force website, CalPhytos.org, and will be available on the District's website soon. Other resources for more information are included in the references.

What You Can Do

Stay on trail as much as possible. Start with clean shoes and end with clean shoes. Try to leave the mud where it came from. If you or your volunteer group is working off-trail and disturbing soil, clean your boots and tools before entering the park. Try to work in dry conditions when mud is not sticking to shoes—this is when there is the lowest risk of pathogen movement. If it is necessary to work near rare plants or rare plant communities or to work in wet weather, brush, blow and/or knock dirt and vegetation off shoes and tools and disinfect with 70 percent isopropyl alcohol or diluted bleach.

Purchase plants from nurseries that are following the current best management practices for phytosanitary propagation and are, therefore, a low risk for carrying plant pathogens. This is especially important when planting next to wildland areas or parks. Ask before you buy! Soilborne *Phytophthora* pathogens infect potted plants from large and small nurseries. See more information at CalPhytos.org.

Plant wisely if your garden is adjacent or close to wildland areas. Always use locally sourced plants and, with sensitive species like manzanitas, consult the folks at the Regional Parks Botanic Garden or a local expert.

Join Professor Garbelotto's UC Berkeley Forest Pathology and Mycology Lab on their annual SOD Blitz where they train volunteers to detect, sample, and map potential SOD-infected plants. Get information from their website about SOD and other plant pathogens and how to prevent their spread. Check out their website to see the results and map of recent SOD confirmations.

Join volunteers who meet frequently with the East Bay Chapter of the California Native Plant Society to restore natives and remove invasive weeds from Huckleberry, Redwood, or Sibley preserves. For more information, visit the group's meetup page. Email the author at mhammond@ebparks.org if you have any questions or want to get involved.

Michele Hammond is the Botanist for the East Bay Regional Park District (EBRPD) and currently assesses rare plant communities and practices vegetation management for parkland in Alameda and Contra Costa counties. She maps and manages rare plants as well as newly acquired parkland within the East Contra Costa Habitat Conservation Plan. Michele earned a B.A. and M.S. in Environmental Science from U.C. Berkeley.

Further Reading

Kauffmann, Michael Edward, Tom Parker, Michael Vasey, Jeff Bisbee. 2015. *Field Guide to Manzanitas*. Kneeland, California: Backcountry Press. (Author's note: this guide is an excellent resource that provided a lot of information in this article—it has regional keys to identify the manzanitas that are easier to use than the all-encompassing Jepson Manual.)

See the District website for wildland plant checklists for the parks where maritime chaparral is located: https://www.ebparks.org/about/stewardship/plants/.

CalPhytos.org and the California Oak Mortality Task Force will provide more information on Phytophthora species in California's native habitats and phytosanitary nursery practices.

UC Berkeley Forest Pathology and Mycology Lab, Mateo Garbelotto, nature.berkeley.edu/garbelottowp

Adventures in Bed 103 *by Maggie Ingalls*

As a docent, I urge you to wander the garden looking at the many different manzanitas, which range in size from ground covers to small trees. The Regional Parks Botanic Garden boasts by far the best collection of manzanitas in any botanic garden anywhere. They come from all over the state of California, so their natural habitats also vary. Growing them all in one location is challenging. Surprisingly, even growing locally common manzanitas can be difficult.

For a view into some of these challenges, let us focus on one species: the Mt. Diablo manzanita (*Arctostaphylos auriculata*). This is the namesake of the auriculata complex of manzanitas, which was the subject of Bart O'Brien's article in the previous issue of *Manzanita* (Volume 22, Number 4). Last August I toured the Botanic Garden looking for all nine species discussed in Bart's article. The Mount Diablo manzanita was one of the easiest to find. There were four of them in a row in Bed 103, which is in the Valley-Foothill section of the garden, not too far from the Visitor Center. One of these plants was clearly suffering: most of the leaves were brown and dry. Discussions with Theo Fitanides, the gardener in charge of the section at that time, provided some interesting information about these four plants.

Pattie Litton

Dieback on Mt. Diablo manzanita in Botanic Garden, August 2018

It is unclear how many wild individuals this collection represents, but there are visible distinctions within the group. One of the four has been struggling for several years. It may have an underground root rot (a water mold), or a stem-based *Botryosphaeria* (a fungus), or both—or something else entirely! Theo pruned off large dying limbs in 2016, in 2017, and again on the day after my August 2018 visit. You can see the manzanitas as they were that day in the photo. The dry, brown foliage was caused by lack of water to the leaves, either by tip-down dieback followed by an embolism (air bubble or clot) in the vasculature, or by bottom-up dieback of roots, which also results in an embolism.

Although worried about the brown leaves, I found I was also looking at several examples of plant tenacity. In the photo you may be able to see that one branch of the diseased shrub has rooted. This process, known as "layering," happens when a branch or twig lies on the ground long enough to send out roots. Not all plants will readily do this, but it is very common among manzanitas, particularly the prostrate forms. Theo said that this new part of the shrub appears to be healthy and has a chance to survive, but he has backups if it doesn't; he was able to take cuttings of the original, which are growing nicely in the garden's nursery. The plant to the right of the pruned individual is very sparse on its left side, the side that would have been overshadowed by its companion. Now it will have more light

and may grow into the newly open space if there is enough remaining healthy tissue to support that growth.

If you want to admire these examples of plant tenacity, you will need to move fast. Garden staff is already making plans to redo this part of Bed 103. They will send a soil sample out to be tested for *Phytophthora* and other pathogens. If the soil is contaminated, the Mt. Diablo manzanitas will have to be moved to a new location. If the soil is clean, the staff might replant with the cuttings that are waiting in the nursery.

The Mount Diablo manzanita is one of our local iconic species, so you would think it would be easy to grow in the Botanic Garden. And it is easy to grow for the first five or ten years. The roots spread out in the suitable soil mixture that the gardeners have provided. Then, about six feet down, the roots encounter the layer of clay that underlies the garden. The plant roots have difficulty piercing this layer, and diseases can result. This clay layer can cause problems for other species as well.

Whatever changes are made to Bed 103, rest assured that there will always be Mt. Diablo manzanitas in the garden! Like all gardens, the Botanic Garden is constantly changing, but it will continue to be one of the premier collections of California's beautiful native plants.

If you go looking for the Mt. Diablo manzanita, make sure that you take the time to gently feel the wonderfully soft and fuzzy leaves of this attractive plant. Study the elegant arrangement of overlapping leaves. In August, there was a lovely pink edging on the new leaves and flower buds. Combined with its rich red bark color, this manzanita species is a subject worthy of contemplation!

***Maggie Ingalls** has been a passionate gardener for almost 30 years, first in Southern California, then in the suburbs of Chicago, and now in Benicia. She is a member of both the Friends of the Regional Parks Botanic Garden and the editorial board of* Manzanita*. She is proud to be a docent at the garden, specializing in children's tours. She also volunteers with the Solano Land Trust, where she is restoring native habitat on King Ranch.*

Pattie Litton

Pink-tinged new leaves on Mt. Diablo manzanita in Botanic Garden, August 2018

Pattie Litton

Note major branch pruned from center of Mt. Diablo manzanita, Botanic Garden, August 2018

Status of Pallid Manzanita

by Heath Bartosh, Chair of the State CNPS Rare Plant Program Committee

The entire California Floristic Province is a globally recognized biodiversity hotspot (Figure 1) and manzanita species are one of the best California examples of this exemplary diversity. Our wonderful Golden State is endowed with the most manzanita diversity of any geopolitical area, and *Arctostaphylos* is the largest genus in the Heath Family (Ericaceae) in North America. Nearly all currently recognized manzanita taxa occur in cismontane California (including northwestern Baja California, Mexico). Amazingly, 54 percent (59 taxa) of Californian manzanitas are considered rare according to the California Native Plant Society. This is due to many of these species having very restricted distributions, sometimes reduced to a small area on a narrow ridge.

Within the California Floristic Province, recent papers (Chan et al. 2006; Ackerly et al. 2012) have revealed biodiversity hotspots on a more local level, showing us that the San Francisco Bay Area, and particularly the East Bay (Alameda and Contra Costa counties), harbor important areas for plant diversity. These localized biodiversity hotspots include Mount Diablo, the Oakland-Berkeley Hills, and Sobrante Ridge, among others. These areas are refugia for paleoendemic plant species but, more importantly, act as a fertile breeding ground for speciation and radiation of neoendemics. It should be no surprise then that known populations of the East Bay's endemic manzanitas help define the area's biodiversity hotspots. Pallid manzanita (*Arctostaphylos pallida*) is a significant representative of the maritime chaparral hotspot in the Oakland-Berkeley Hills.

The Oakland-Berkeley Hills are considered a hotspot for another reason: residential development. Beautiful views of San Francisco Bay and the Golden Gate encouraged homebuilding, which rapidly altered pallid manzanita habitat in the early to mid-twentieth century. Between 1915 and 1941, U.S. Geologic Survey topographic maps show how the largest population of pallid manzanita, in and near Huckleberry

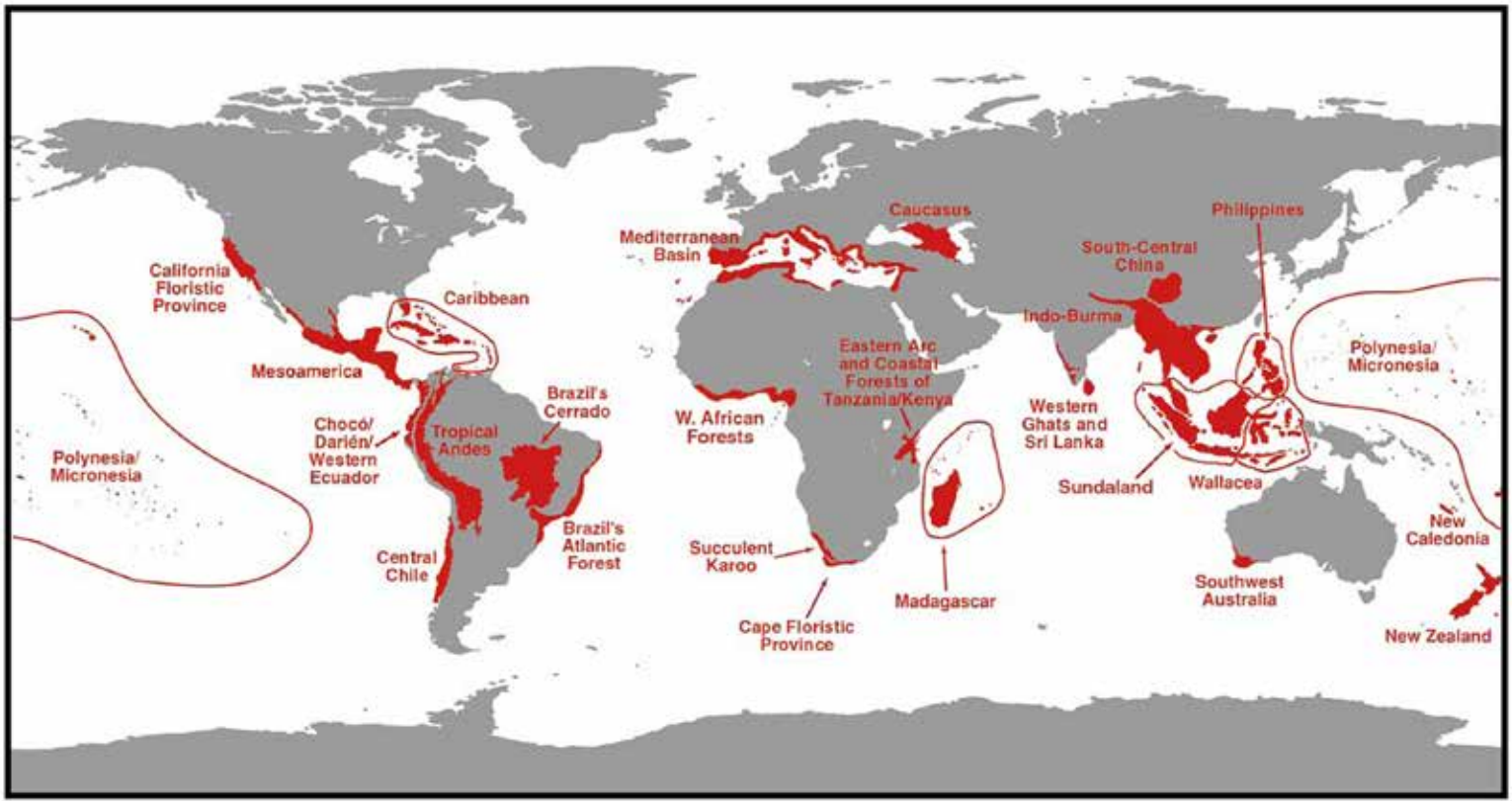


Figure 1. Map of Biodiversity Hotspots Worldwide (Myers et al. 2000)

Botanic Regional Preserve, was fragmented by road construction and homebuilding (Figure 2). Unfortunately, we do not know the extent of pallid manzanita habitat or population loss due to this early development. Not only did physical alteration of the habitat occur at this time, but the introduction of nursery stock for ornamental plantings around homes was probably part of the introduction of the soil pathogen *Phytophthora* in this area, a pathogen that would eventually threaten pallid manzanita.

In addition to the threat to manzanitas from ornamental plantings, misguided efforts resulted in the planting and expansion of eucalyptus, pines, and cypress trees in areas of pallid manzanita habitat. Pallids, like most manzanita species, live in the absence of a tree canopy in full sun and can slowly die from a decrease in sun exposure. This has already happened to a small number of individuals near the Chabot Space and Science Center. There, unmanaged pines and eucalyptus eventually shaded pallid manzanitas enough to cause their mortality.

Of course, with this population expansion comes the need to protect these homes from fire. This effort has worked well. According to the CalFire database, since the start of modern fire history record keeping, only two fires have been recorded in the range of pallid manzanita: the 1991 Tunnel Fire and the 1998 Sibley fire, but neither burned existing pallid manzanita habitat. Without a disturbance regime such as fire to manage the landscape, shrub species like pallid manzanita have a difficult time regenerating. Although some manzanitas stump sprout, pallid manzanitas are obligate seeders that depend on seed banking and germination to replace individuals within a population over time. These seeds are fire adapted and have germination triggers that favor fire effects, although broadcast-journalist-turned-manzanita-phile Wendy Tokuda pointed out an interesting observation some years ago at Redwood Regional Park: She found that tree removal work along one of the trails acted as a fire surrogate that actually caused pallid manzanita seeds to germinate from the ground disturbance and the presumed scarification the seeds received from this activity.

Overall, the lack of fire, or a reasonable surrogate, may be the single biggest threat to the long-term survivability of pallid manzanitas. Because natural germination triggers are few in the Oakland-Berkeley Hills, stand replacement and rejuvenation is extremely restricted, and planted trees continue to encroach and shade some pallid manzanitas out of existence.

How might climate change impact pallid manzanitas? With climate change, there is always a focus on the losers, that is plant species that will suffer under a warmer climate regime, but it is possible there will also be climate change winners. Maybe species representative of a fire-adapted Mediterranean climate will fall into the winner category. Could pallid manzanitas be a climate change winner? David Ackerly et al. (2015) looked at vegetation communities in the Bay Area and projected vegetation change under different climate scenarios. Figure 3 shows how vegetation might change in Contra Costa County, where the majority of pallid manzanita populations are found, under increasingly warmer climates. The vegetation types used in this figure were aggregated into coarse level categories, and although maritime chaparral is not called out specifically, it could be associated with the chamise chaparral category since chamise (*Adenostoma fasciculatum* var. *fasciculatum*) is a large component of maritime chaparral. Figure 3 shows a strong trend toward increasingly expanding chaparral under warmer climate scenarios. Could this bode well for pallid manzanitas? Possibly, but there are some caveats.

Fog is an ecological driver of the distribution and composition of maritime chaparral. Warmer climates could reduce the number of foggy days and the distance fog travels in from the coast. This would be a stressor to maritime chaparral in general, and pallid manzanita habitat in particular, with potentially negative impacts to this fog-dependent community from a lack of fog drip and other foggy benefits.

Another possible climate change effect would be an increase in fire frequency. If the interval between fires is less than thirty years, it could convert chaparral habitat to grasslands or weed lots. As we know, much uncertainty is associated with future climate change, but it is important to assist threatened ecosystems by building as much resiliency in and around them as possible.

What does this resiliency look like for a species like pallid manzanita that lives within

Figure 2. USGS topo maps from 1915 (this page) and 1941 (opposite page) show the pallid manzanita populations under discussion. Pallid manzanita polygons (shown in red) are from the California Natural Diversity Database. Note the encroachment of roads in just 26 years.

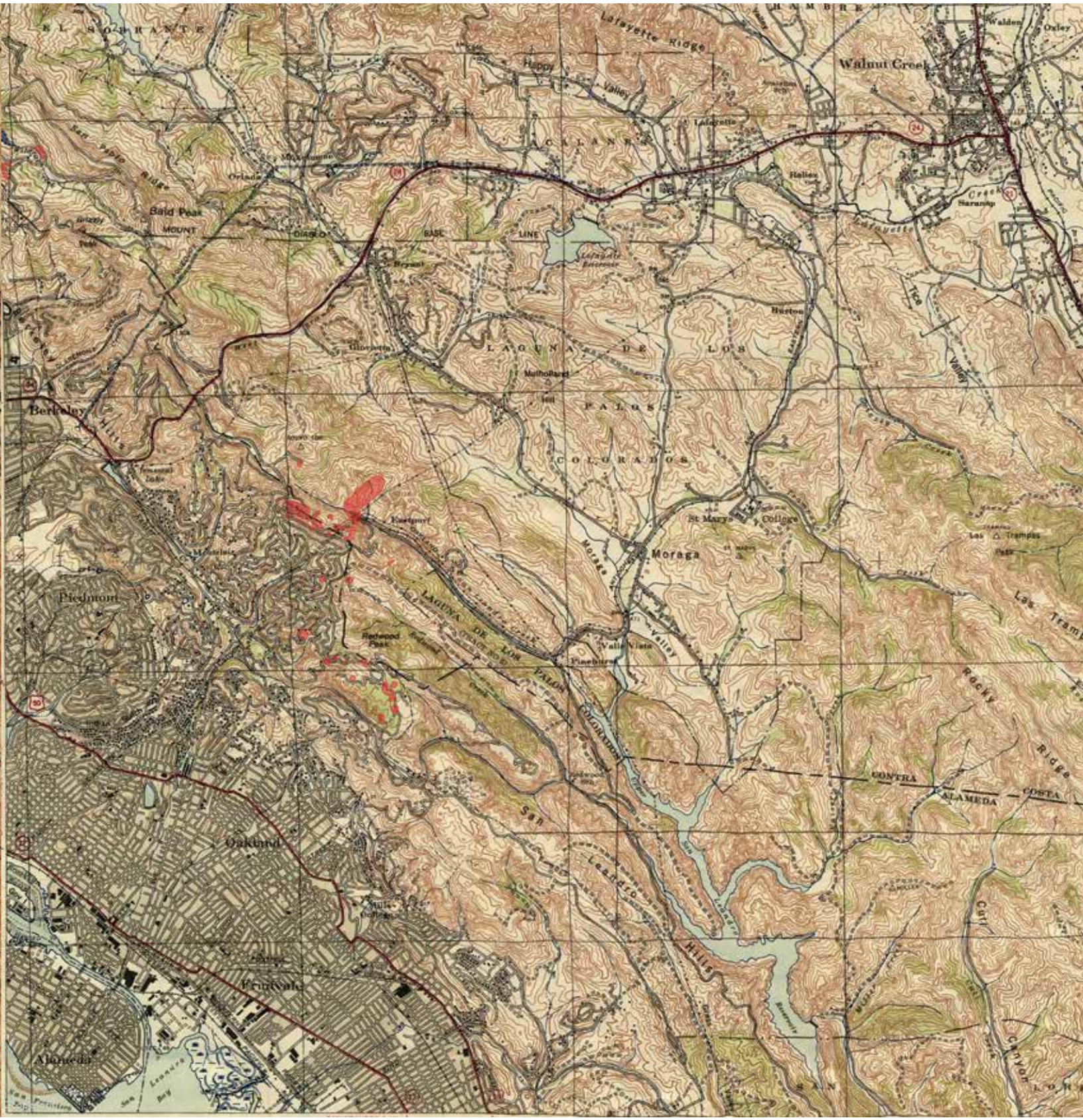
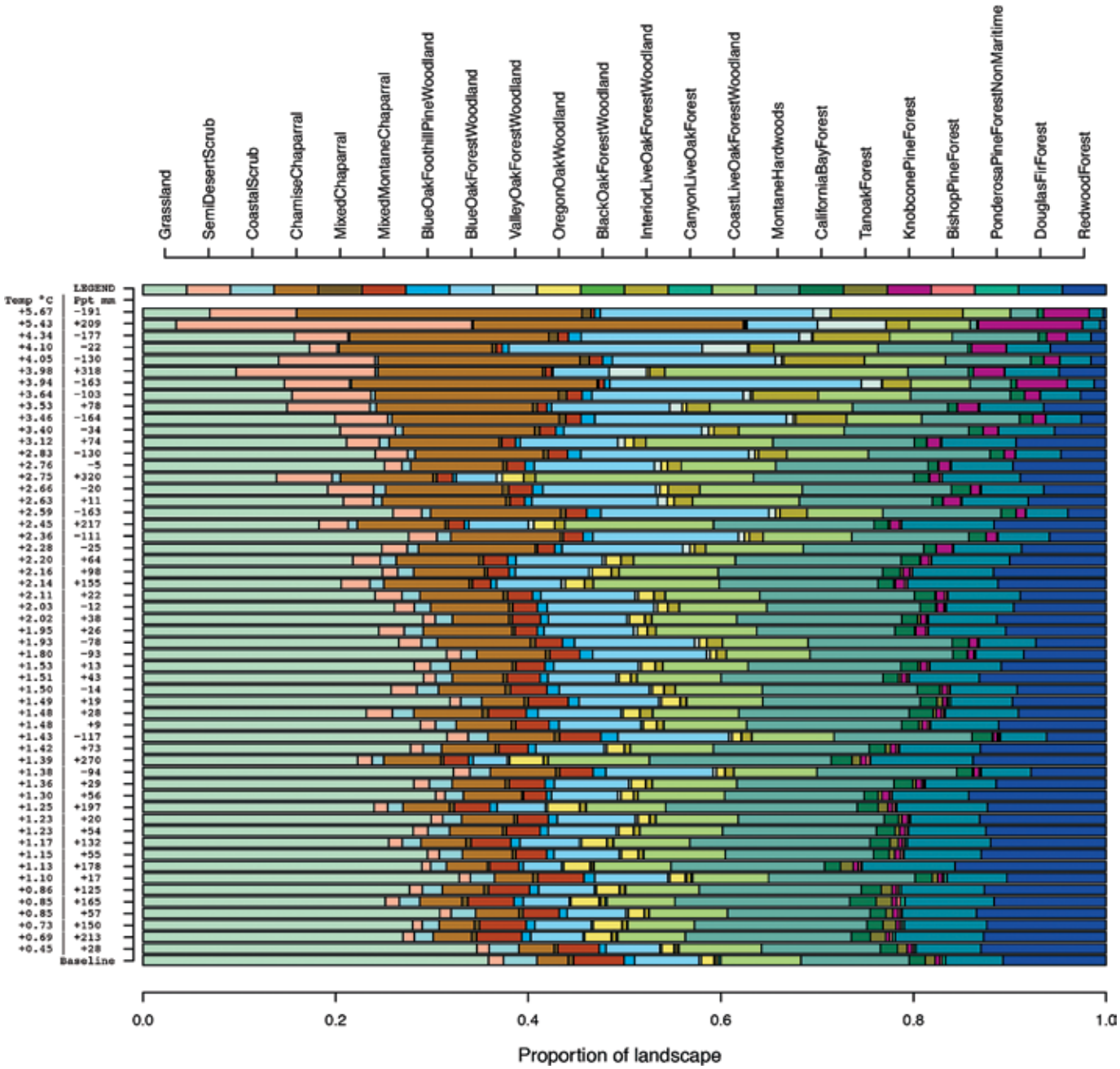

Lafayette Ridge
Walnut Creek
Happy Valley
Lafayette
Orinda
Bald Peak
MOUNT DIABLO
BASE LINE
Briones Reservoir
Briones
Bryant
Burton
Tice Valley
LAGUNA DE LOS PALOS COLORADOS
Mulholland
Berkeley Hills
Fairmont Park
St Mary's College
Moraga
Las Trampas Peak
Piedmont
Redwood Peak
Valle Vista
Rocky Ridge
CONTRA COSTA
ALAMEDA
Oakland
San Leandro Hills
Fruitvale
Alameda
Curt Canyon

Figure 3. Possible changes in vegetative type across the San Francisco Bay Area under various climate scenarios. Future climates are arranged in order of increased warming in mean annual temperature from bottom to top. (Ackerly 2015).



such a narrow band of suitable habitat, in a very small corner of the world? Recognizing the constraints and opportunities for co-existence and management of this species is a reasonable first step. Here I have pointed out serious threats to pallid manzanita from development, *Phytophthora* infection, tree planting, fire suppression, and potential climate change impacts.

Let us work to foster positive outcomes, while putting effort into minimizing negative actions. For instance, there is still pressure to develop homes on individual lots in pallid habitat. Local planning departments should no longer permit residential development in occupied or suitable pallid manzanita habitat. If pallid population expansion and restoration is going to be as successful as possible, all of the available habitat will be needed; continued fragmentation must be stopped. Management actions that can abate the spread of *Phytophthora* should also be part of the effort. Seasonal trail and road closures should be enacted to help protect uninfected pallid manzanita stands while acting to quarantine those already afflicted. While fire may not be a reasonable management tool with the surrounding residences, tree removal can be. Reducing canopy cover in pallid habitat should be a priority. Ms. Tokuda showed us that this action may also have positive benefits that result in the germination of new pallid recruits. There may be existing pallid seed banks in areas that just seem like eucalyptus stands. If these trees were removed, new pallids might be coaxed out of the soil. To prepare for climate change, we must attempt to expand existing populations and establish new colonies in suitable habitat. These efforts should be targeted for a variety of slope, aspects, elevations, and soil types. This type of activity will require experimentation with germination, fire surrogates, pathogen abatement, and so on. Most importantly, monitoring this extremely imperiled species needs to continue because of the numerous threats it faces.

More than botanists and conservationists, all people of the East Bay need to recognize the incredible biodiversity hotspot that we have in the Oakland-Berkeley Hills and Sobrante Ridge and understand that pallid manzanitas are a big part of this diversity. Pallid manzanita is a unique species that we all should be proud to have in our backyards. It is a badge of honor that should be appreciated, and its protection and management should be supported by all who live nearby.

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