LEVY HERNANDEZ
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# CALIFORNIA NATIVE BEES & COMMUNITY GARDENING

**California Native Bees & Community Gardening**
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Submitted in partial satisfaction of the requirements for the degree of Bachelor in Science in Landscape Architecture in the Department of Human Ecology
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# ABSTRACT

Bees are a diverse group of pollinator organisms that perform essential ecological functions, critical to the reproduction of flowering plants and the production of food consumed by both human and nonhuman organisms.

The scope of this study places the phenomena of bee population decline observed in the past several decades within the context of the concurrent resurgence of urban agricultural landscapes, specifically community gardens, focusing on the state of California; the main goal of this study was to generate design guidelines for community gardens in order to make urban environments more habitable for native bees and help their populations, while making community gardens more fruitful, both in a literal and figurative sense.

Effectively designed and managed, community garden spaces have the potential to: benefit localized, native bee species: educate communities about the bees native to an area and how to help restore their populations; strengthen local food systems by making them more transparent, productive and resilient. Most important, perhaps, is lessening the need to rely on industrialized agricultural systems and their alarming dependence on the exotic European honey bee (*Apis mellifera*).

The major questions relevant to the focus of this study are:

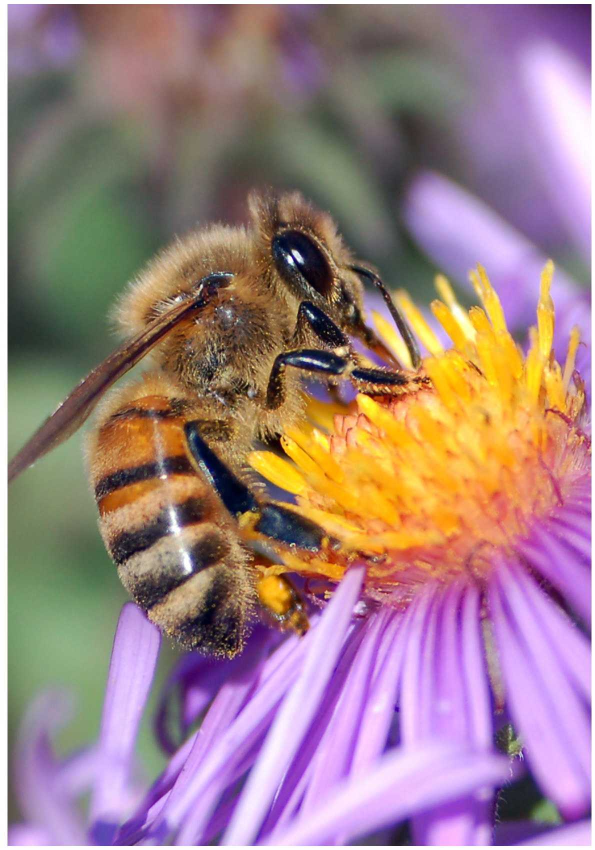
- **What are the behavioral lifestyles and habitat requirements of California native bees?**
- **Knowing these, what kinds of design measures can be implemented in California community gardens to help benefit native bees?**
- **Are there any regionally specific considerations for California community gardens?**

# INTRODUCTION

Pollinators are a vital keystone group of organisms that perform a variety of ecological services, upon which many others depend on in some form or manner. Namely, this includes the pollination of angiosperms (i.e. flowering plants), giving rise to fruit and seeds, being not only important for the reproduction of these plants, but it provides both non-human and human organisms with a bounty of food; roughly 75% of the earth's flowering plants and one third of global crop production depend on insect pollinators (National Academies Press, 2007). Although pollinators are a vast group of different kinds of organisms, bees hold the highest value for crop pollination and production because they are the only group of pollinators that *intentionally* forage through flowers for pollen (Mader et al., 2011), and will thus be the focus of this discussion.

Due to a variety of reasons related to the expansion of the human race, bee populations have been declining worldwide in the past several decades (Goulson et al., 2015; ). The pervasiveness of human development is taking a toll on bee populations, stemming largely from: habitat destruction, degradation, and fragmentation; the introduction of various toxins and chemicals into the environment; the proliferation of harmful vectors of disease and outcompeting, exotic species (Goulson et al. 2015; Mader et al., 2011). Each of these complications are compounded by anthropogenic influences on ongoing climate change.

Perhaps most prolific - or most widely visible and studied - has been the drastic decline of the European honey bee (*Apis mellifera*), an intensely managed species that has had the longest history of domestication and continues to play the largest role in the world's agricultural systems, more so than any other pollinating organism (Geldmann & González-Varo, 2018). Traditional agricultural systems widely employ *A. mellifera* largely because of its exceptionally large colonies, which are still easily manageable and transportable. The extent of our reliance on this single species for much of the world's managed pollination services should have been alarming in and of itself even before we started observing declines in their numbers. Managed colonies are experiencing ongoing reductions, namely due to the proliferation of various pests and diseases, giving rise to a phenomenon coming to be known as "Colony Collapse Disorder".



Bee species native to North America have been shown to be just as, if not more, efficient pollinators than their European counterparts (Mader et al., 2011). Knowing this, it only seems to make sense to manage land in such a way that is beneficial and restorative to native bee species, helping to ensure the delivery of the ecological services they provide to localized areas when the future of employing European honey bee colonies is uncertain.

Pollinator ecology, including the role and importance of bees in natural systems and traditional, rural agricultural systems has long been researched. However, the vast majority of the knowledge focuses on *A. mellifera*, undoubtedly due to its value to so much of the world's agricultural systems. Save for a couple of other species which have also been commercially reared for agricultural production, there is far fewer knowledge on native bee species. Since native bee species have not been studied nearly as extensively as their European counterparts, it is difficult to formulate historical baselines necessary in order to accurately study population dynamics (Mader et al., 2011). Nonetheless, current trends make it safe assume that native bee populations are being negatively affected even if it is currently impossible to say by how much (Mader et al., 2011). Today, knowledge about native bees, including their habitat ranges (geographic extent), specificities to species life and life-cycle characteristics, and their role and relevance within larger ecosystems and bioregions is steadily rising.

Pollinator ecology within the contexts of urban, intensely human-developed environments is also a rising field of knowledge. As land lost to urbanization is predicted to increase in coming years, the need to study urban pollinator ecology is growing as well (Hernandez et al., 2009). The major factors accounting for most of the declines in bee populations have complex and interwoven political, economic and social origins that are not easily addressed. Here at the local level, however, the solutions to many of these problems are relatively simple and straightforward. Many bees are fairly resilient, and there are actions communities can take in spaces like gardens and city parks, to entire neighborhoods and remnant wild areas, to help strengthen and support bee populations. It is true that urban and suburban areas differ greatly from areas designated to conserve bee habitat, but the choices made in these areas still affect the pollinators which frequent them, having a profound effect on the health of the immediate and surrounding environments.

One particular typology of urban spaces where the effects of bee presence are very perceivable are urban agricultural landscape. Although the concept of growing food where people live has been practiced long throughout the history of humankind, more contemporary takes on urban agriculture have proliferated since the 1970s, concurrent with a recent resurgence of interest in food systems. Individuals are becoming increasingly concerned with: where the food they consume is coming from and how it is produced; the transparency of food production; localizing/deindustrializing current agricultural systems or growing food in urban centers.

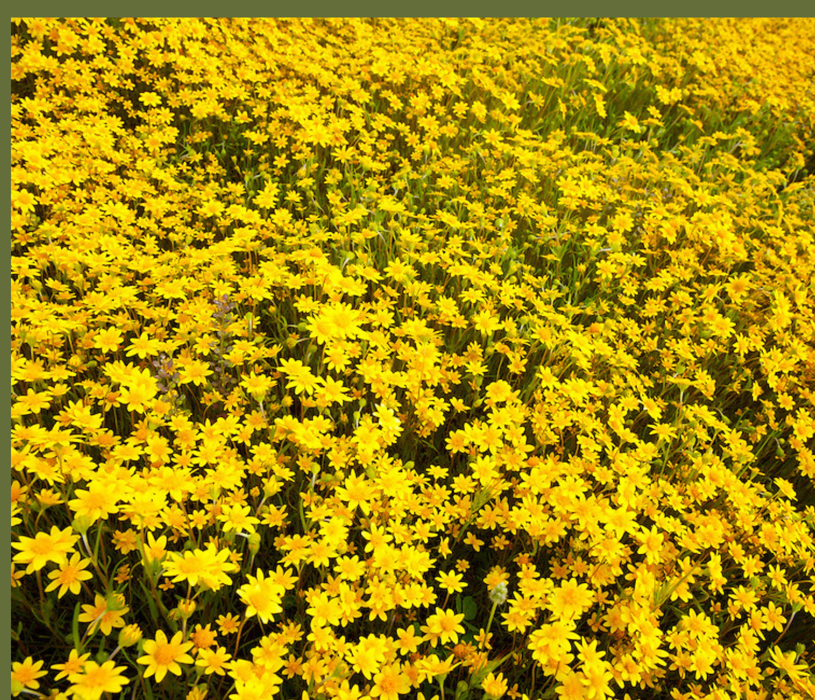
Urban agricultural landscapes can take a multitude of forms, from container plants on one's property to highly institutionalized urban farms. For the purposes of this study, however, community or allotment gardens will be the main focus. These types of gardens generally strive to involve and engage citizens with the outside world and equip them with the skills and knowledge necessary for developing environmental stewardship and agency. As such, community gardens are an ideal space for educating communities about: the phenomena of pollination and food; how diverse bees are; the role and importance of bees to both natural and food systems; the group of bees native to an area; the dangers and instability of relying so heavily on the exotic European honey bee for so much of the world's food production. Since shifting traditional, rural agricultural systems' dependence away from A. mellifera is an entirely different endeavor due to its highly industrialized nature, the focus here will be mainly on non-rural agricultural landscapes.

Urban agricultural landscapes have an incentive to attract a more diverse and native selection of bees. Studies have shown that gardens that attract a more diverse group of bees yield bigger and better crops (Kremen, 2008; Hoehn et al., 2008; Blüthgen & Klein, 2011; Brittain et al., 2013; Garibaldi et al., 2014). Making community gardens more habitable for native bees can strengthen local food systems and make them more resilient, all the while aiding efforts to deindustrialize current agricultural systems. Not to mention that growing food oneself or getting exposure to how food grows are very visceral, indelible experiences; it instills one with a deeper, more appreciative connection to the land and the extraordinary plants and pollinators that live within it, responsible for so many of the things humans love, even beyond the things we can eat. As educational spaces, they have the ability to enlighten community members and supply them with the environmental agency to inform others and to organize for a neighborhood- or municipal-scale changes that could benefit native bees and local food systems beyond the community-scale.

# BACKGROUND

California is an ideal geographic area for the framework of this study. Save for some of the state's high-elevation areas, California's generally Mediterranean climate is conducive to growing food year round with long growing seasons for most plants, leading it to be a high-profile agricultural region and for better or worse known as the "breadbasket of the world". California exhibits 19 of the 24 climate zones defined by the Sunset Western Garden Book and 13 of the 26 zones defined by the United States Department of Agriculture, so at least some of the findings of this study could then be carried over to other parts of the United States.

California's extreme diversity in terms of climate and geomorphology is reflected in its various ecosystems and the fauna and flora that inhabit them. For example, California is home to around 1,600 (known) species of bees, nearly 40% of the species known to inhabit the contiguous United States! Even though none of them make honey or live in hives like their famous European counterparts, they still have a profound effect on the productivity and composition of the ecosystem they inhabit. Additionally, California is also home to over 6,000 (known) species of flowering plants. Although the concept of native plants is highly subjective, for the purpose of this study, the term native will be used to refer to plant species that existed in California prior to European settlement.



With 39.5 million residents, California is also the most populous state in the United States. The Greater Los Angeles Area and the San Francisco Bay Area are the nation's second- and fifth-most populous urban regions, with 18.7 million and 8.8 million residents respectively. Los Angeles is California's most populous city and the country's second-most populous after New York City. California is also home to the nation's most populous county, Los Angeles County and its fifth most densely populated county, San Francisco County.

Community gardens are popping up all over the state, with projects in these large metropolitan areas being highly visible to the rest of the world. California’s inhabitants have the capacity to employ the phenomenon of urban agriculture to observably live more harmoniously with the non-human environment, the focus of this discussion being native bees. Seeing as California is also considered a trendsetter in terms of sustainable practices and policies, perhaps the rest of the nation, or the world for that matter, will be inspired to pursue native pollinator-focused urban agriculture as well.

# MEET THE BEES

*This section will briefly introduce the most common groups of bees found throughout the state of California. These groups are not exactly organized phylogenetically, but rather by similar life characteristics. For most individuals, these common names are relatively easier to discern and remember than taxonomic names and should thus be used when implementing programmatic elements such as learning activities or interpretative signage.*

### Bumble bees

- Social bees that, similar to honeybees, live in relatively large colonies founded by a queen in the spring. New queens mate and then overwinter or hibernate until it comes time to establish new colonies again in the spring.
- These bees are usually active during the morning hours and can forage in colder temperatures compared to most other bees, even flying in light rain.
- Typically make use of abandoned rodent burrows/nests in the ground, near the base of bunch grasses, and existing cavities in wood.
- Some species are commercially reared for agricultural production, especially for greenhouse crops, especially tomatoes. This is namely due to their unique ability to perform buzz pollination. Buzz pollination occurs when bumblebees shiver their flight muscles while clutching onto a flower's anthers, dislodging pollen grains that would otherwise to difficult to obtain.

### Digger or miner bees

- These are ground-nesting bees - hence the common name - that will often make use of sandy or compacted soils. 70% of California's native bees nest in the ground. This is perhaps the reason that so little is known about California native bee species, their elusive, underground nature makes it difficult to find and study populations when compared to those that nests aboveground.
- These are among the first bees to emerge in late winter and early spring. In fact, many are active only in the early spring - the next generation remains underground developing throughout the rest of the year, only to emerge the next spring when their favorite flowers are in bloom.

## Carpenter bees

- These bees are able to "drill" holes in soft, decaying wood and even structural timbers, which they use to nest in. Nearly 30% of California native bee species nest in wood cavities.
- Larger carpenter bee species can be active all day long, even in the hottest weather. Small carpenter bee species are usually more active in the morning.

## Leafcutter bees

- These bees mainly nest in pre-existing cavities in wood, some nest in the ground as well.
- The common name comes from their use of leaf and flower pieces, masticated leaves, and plant hairs to construct different chambers within their nests.
- Can be seen foraging throughout the day, even in the hottest weather.

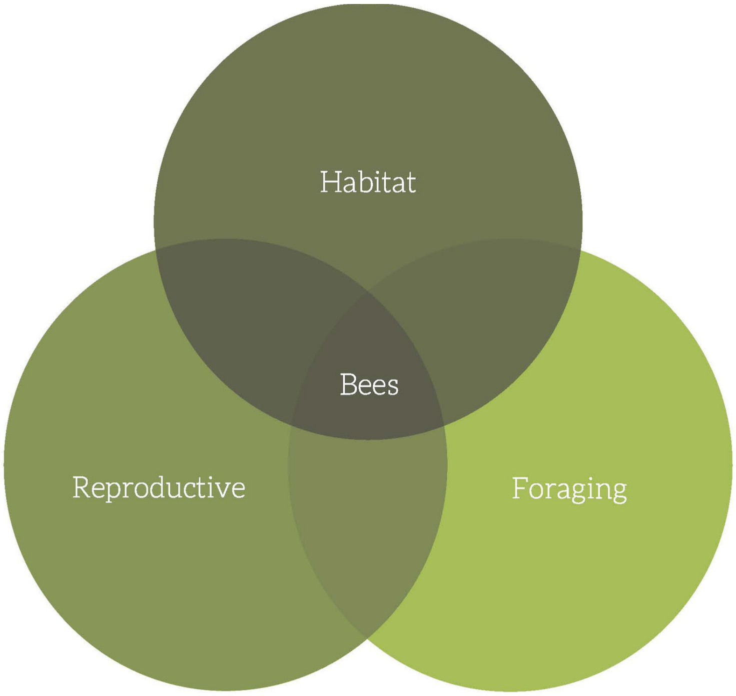
## Mason bees

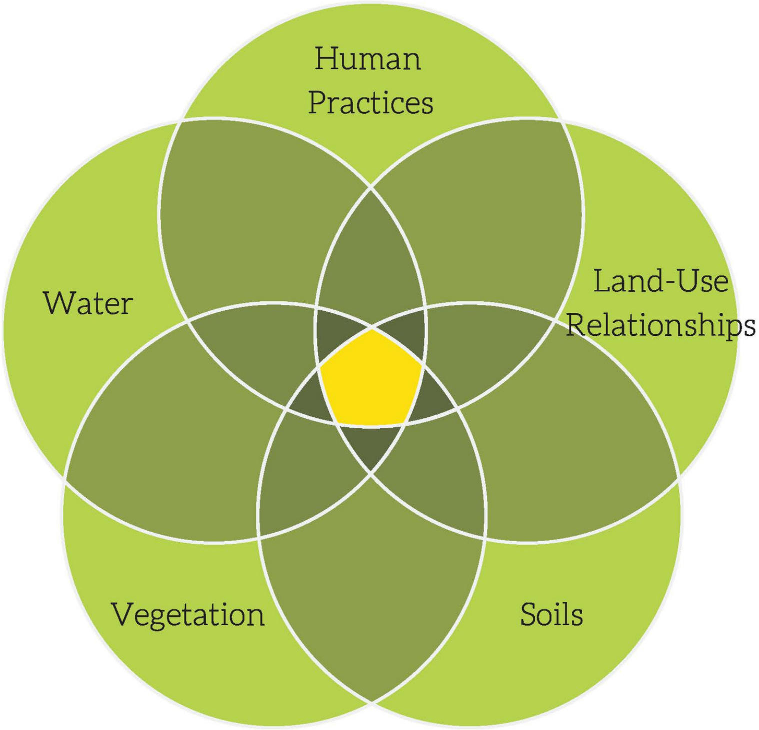
- These bees also make use of pre-existing cavities in wood.
- Their common name comes from their use of mud and sometimes small pebbles to construct different chambers within the nest.
- Generally are more active in the morning hours.

## Sweat bees

- Most of the bees nest in the ground, some in cavities.
- The common name comes from the tendency of these bees to land on one's skin and drink perspiration, for both its moisture and salt content.
- Generally well-known bees, as they will occupy nest blocks and are managed for pollination on farms and in backyards.
- Usually forage in the morning hours.
- Can be extraordinary colors like metallic green, blue, copper or gold.

# DESIGN GUIDELINES




Given the array of different lifestyles of California native bees, it is important to restore or introduce their habitat requirements wherever feasible in order to help their at-risk populations. Community gardens are a great space to implement these interventions because they can serve as havens of green space for bees and other wildlife within the (sub)urban fabric. Not to mention that as educational spaces, they can enlighten community members about habitat interventions, allowing them to inform others or implement these ideas into their own properties.

The basic needs of any healthy bee population can be divided up into three, though not completely isolated, categories: Habitat, Reproductive, and Foraging requirements. In terms of land management practices that pertain to urban agricultural landscapes, these three categories can then be split up into five categories for which design guidelines will be presented for in the following section, including: Human Practices, Land-Use Relationships, Soils, Vegetation, and Water.

# HUMAN PRACTICES

- **Omit or limit the use of chemical pesticides**; these can be absorbed into the nectar and pollen of flowers and can be fatal to bees when consumed (Wilson and Carril, 2016).
  - If one must use pesticides, apply them exactly as instructed on labels. Try to use the minimum amount suggested on the label as well.
  - Keep the spray contained, hitting only the target areas and **NEVER** directly onto flowers.
  - **DO NOT** apply during windy or rainy weather, as they can runoff or spread to areas unintended for application.
  - Try to spray in the evenings when humidity is low, so the pesticide doesn't linger in ambient moisture, and when most bees are not active and resting in their nests.
  - Seek out organic alternatives to chemical pesticides.
- Organic mulch is a great addition to any garden; however, ground-nesting bees have trouble traversing through thick layers of it. Instead of mulching everywhere, **allow some areas in the landscape to remain mulch-free** so native female bees can find a place to create their nests. Sunny, bare patches of soil or south-facing slopes are ideal.

- Pathways of compacted dirt (e.g. decomposed granite or DG) are often excellent ground-nesting habitat, especially when adjacent to flowering plants. Consider using these types of pavements over those like concrete, which are not usable to ground-nesters at all.

- Rocks walls can serve as excellent nesting habitat for cavity nesters, as they provide multiple cracks and crevices in which nests can be built.
- Leave pruned/dead branches, stumps, or logs in the garden for cavity-nesting bees. These can be both aesthetically pleasing to humans and provide nesting habitat as they decay with time. Trees regularly self-prune branches, place these in a sunny spot of the garden when this occurs or after manually pruning.

# HUMAN PRACTICES

- Construct bee blocks for cavity-nesting bees.
  - Using any piece of untreated lumber, drill holes between 1/4" to 1/2" in diameter, preferably about 1.5" to 3" deep. Several can be put in one block of wood, as most cavity nesters do not mind having neighbors, even solitary ones.
  - Attach another piece of wood to cover the top limiting rain that can fall directly into the nest holes.
  - It's also advised to keep the block off the ground by mounting it on a post, helping to prevent extra moisture from seeping into the wood, as well as minimizing attacks from predators.
  - Place the nesting blocks in the garden, ensuring that the entrances to the holes **facing south or southeast**. This will allow them to warm up earlier, especially on cool days, signaling the bees inside them to start gathering pollen sooner in the day.

- Leave hollow twigs in the garden, either in wrapped bundles or solitarily. Hollow stems from plants like elderberry, bamboo, reeds, and yucca are great options for this.
  - The stems should be roughly six to nine inches in length. It is important that one end of the stem is closed to inhibit entry of environmental elements or potential predators. Cut stems just below a node, so that one end is naturally closed. Otherwise, a small dollop of sealant will work just fine, too.

- An important note about nesting blocks and stem bundles is to **replace these every few years** in order to minimize parasites. Bee nests that are repeatedly used tend to increase the presence of bees' natural enemies, diminishing their success.

- Consider establishing a **citizen science program** in the community garden, which can take numerous forms and have varying goals. These types of programs can really get people involved in the garden.
- Seek out partnerships with **local schools, educational programs, or organizations** to get the site visited by more individuals and expand its potential to educate.

# LAND-USE RELATIONSHIPS

- Gardens should be within **500 feet to one mile** of other floristically-rich land uses, such as other urban agricultural projects, parks, and gardens, or known bee habitat(s). This is the average flight range of most bees, generally from the largest bees who are able to cover more ground to small bees which have smaller flight ranges (Mader et al., 2011).
- Coordinate with neighboring landowners to ensure they also take the steps necessary to expand urban bee habitat themselves. Encourage them to plant some of the same plants you have on your property. Most importantly, ensure they aren't managing their land as to disrupt your efforts, such as using pesticides. This will help make expand urban pollinator habitat and make the urban environment more permeable to bees.

# SOILS

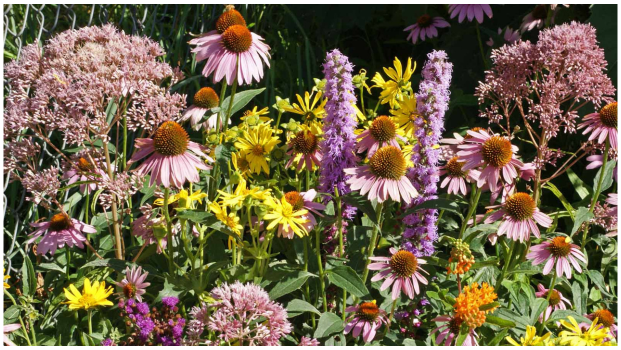
- Conduct soil tests to determine which plants are best for the site and where plants maintained for consumption are safe to grow.
- Soils found unsuitable for food production can be set aside for bee-focused design measures.
- Supply patches of bare soil for ground-nesting bees; a single one square foot patch is suffice for most species.
- If they're present, south-facing slopes are great nesting sites for ground-nesting bees.
- Since some bees make use of mud for their nests, **provide a patch of continuously moist soil where feasible** - a leaky faucet or billowing water feature adjacent to a patch of bare soil should work well for this.

# VEGETATION

- Management/maintenance capabilities and long-run scenarios should always be considered when selecting which plants to grow in a garden.
- Grow plants which are suitable for your local geographic area; consult **USDA Hardiness Zone** (refer to Appendix, pg. 48) and **Sunset Zone** (refer to Appendix, pgs. 49-50) resources.
  - The USDA Hardiness Zones indicate the average annual minimum winter temperature for an area, helping to select appropriate, cold-hardy plants.
  - The Sunset Zones are a nice indicator of what kinds of plants are suitable for an area because it not only takes into account winter minimum temperatures, but also summer highs, lengths of growing seasons, humidity, and rainfall patterns.
- Bees almost exclusively forage in **sunny conditions** so implement bee plantings in areas with little to no shade with suitable, sun-loving plants. Relatedly, making use of drought-tolerant plants is a smart move for much of the state.

- Plan the garden to have a succession of blooms throughout the year, especially from **late winter or early spring to late summer or early fall**, when most adult bees are active.
- The majority of the plants used in a garden should be native to the ecoregion it is located in; localized bee populations have co-evolved with native plant genera for millennia. Additionally, it has been documented that native bees forage on native plants more frequently than on non-native plants (Mader et al., 2011).
  - Find out if your area is home to any specialist bee species, that is, one that is entirely dependent on just one or a few plant species. The life cycles of these organisms are heavily dependent on each other.
  - Non-native plant species also have their place in the garden, however, especially those which: flower on the margins of seasons; flower year-round; thrive even in exceptionally strenuous conditions (extreme heat, drought, standing water, etc.)
  - Plants from other Mediterranean climates, such as South Africa and southeast Australia, do quite well in California. For example, lavender (*Lavandula* spp.), which is native to throughout Mediterranean Europe, is highly attractive to many kinds of bees.

- Plant plants with different flower forms and sizes in the garden; morphologically, bees can be split up into two groups: **long-tongued** or **short-tongued**.



  - Long-tongued bees favor deep, tubular flowers, such as those of the mint family (*Lamiaceae*), the beardtongue family (*Plantaginaceae*), the lopseed family (*Phrymaceae*), and some members of the figwort family (*Scrophulariaceae*). However, long-tongued bees are not averse to collecting nectar from open, flat flowers as well.

  - Short-tongued bees are relatively more limited in the flowers they can forage on; they can mostly take advantage of flowers that are more flat and open, such as those of the daisy family (*Asteraceae*). However, some short-tongued bees are small enough that they can go inside tubular flowers.

- Plant plants with varying flower colors to attract a variety of bees; most bees are attracted to white, yellow and blue flowers but their curiosity will take them to just about any flower.

- Be wary of popular hybrids and cultivars of ornamental plants; although these are often "improved" specimens, they usually have compromised pollen and nectar production capabilities and are therefore not as useful to bees as strict species forms. For example, *Chilopsis linearis* 'Timeless Beauty' is a prized variety of desert willow because it is has a longer flowering period but holds less value to bees as it is nearly sterile, producing very little pollen and seedpods.
- Group plants in at least 3' x 3' patches, as this way they are easier for bees to recognize than being randomly placed throughout the garden. As one can imagine, this is more critical for small plants than most shrubs and trees which easily surpass this size.
  - For edible plants located in plots, coordinate with neighboring plots to align your crops into bigger patches to help ensure pollination and enhanced crop production.
  - When plots for edible plants are not actively being used, plant/seed with annuals to provide bees with food resources, maintain good soil, and limit weed proliferation.
  - In plots, use companion plantings of wildflowers in the sunflower, carrot and mint families to attract beneficial insects (predators + parasitoids) and limit the need for pesticides.
- Keep dead trees (where safe), pruned branches and/or hollow stems in the garden for cavity-nesting bees.

# WATER

- Bees, like all living organisms, need water too!
  - Most bees can get the water they need from flower nectar.
  - Some bees will seek out additional water from moist soils or morning dew that collects on plant surfaces, especially hairy or fuzzy foliage, as shown below.

- Run aboveground irrigation systems (or water by hand) before sunrise and/or after sunset; this will not only ensure that roaming bees won't be sprayed and potentially injured or killed, but will also help reduce water loss due to evaporation. Implementing subsurface irrigation systems forgoes this precaution.

- If your climate is very dry, however, consider placing one or more shallow dishes or bird baths in the garden; to prevent bees from drowning, place landing surfaces such as pebbles or something that will float on the surf, such as a piece of wood or cork.

- Since some bees make use of mud for their nests, provide a patch of continuously moist soil where feasible - a leaky faucet or billowing water feature should work well for this.

# Planning the CA native bee garden

**Bee friendly**
Implement interpretive signage and/or reach out to local schools and organizations to get more community members to learn about native bees.

**Bee messy**
Leave stumps, fallen & pruned material, logs, and/or hollow twigs for cavity-nesting bees; where safe, keep dead or dying trees. Provide patches of bare soil (sans mulch), since most CA native bees (70%) are ground-nesters.


**Bee showy**
Plan for the garden to have flowers throughout the seasons, especially late winter to early fall.

**Bee organic**
Abstain from harmful chemical pesticides and herbicides, which can be fatal.

**Bee native**
The majority of the plants used should be native to the area, as these are the ones bees are best adapted to.

**Bee productive**
Pollinator-dependent crops should be within at least 500' of foraging resources to get the best produce.

**Bee diverse**
Plant a diversity of flowering plants from different families. Incorporate flowers of different shapes, colors and sizes. Bunch grasses provide nesting sites.

**Bee sunny**
Bees prefer foraging in warm, sunny areas. Provide patches of bare soil and other nesting opportunities in sunny spots.

**Bee bountiful**
Plant large patches (at least 3'x3') of the same flowering plant for better foraging efficiency.

Some of the most relevant of design guidelines from the previous chapter can be summed up by the graphic above. Such a graphic would be good to include when making informational documents such as brochures, or implemented into lesson plans for educational programs.

# CALIFORNIA'S BIOREGIONS

California’s diversity of native bees can be attributed to its large area, and the varied climate, geomorphology, and flora exhibited here. It is important to be knowledgeable about the composition and history of these biological communities, especially in order to inform efforts and concepts related to conservation, preservation, and restoration. In terms of the focus of this study, a study of California's biological communities can illuminate relevant information about helping native bee populations constantly infringed upon by human development and behavior.

California can be segregated into ecoregions, major ecosystems defined by distinctive geography and subject to similar environmental forces such as precipitation, solar radiation, winds and so on. These divisions can be practical for the research of these ecosystems and for informing land management practices, in this case, regionally specific design guidelines or bee-friendly plant selections.

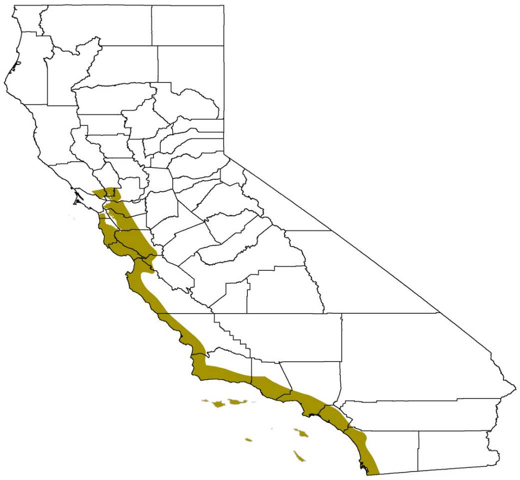
One classification system that is particularly useful for this study is **Bailey’s Ecorgions**. This system was developed in 1978 by the USDA Forest Service and has been regularly updated since then to account for climate change and shifts in vegetation. The largest ecosystems in this classification system are domains, which are groups of related climate zones, differentiated based on precipitation and temperature. Within the domains are divisions, which are also differentiated based on precipitation levels and patterns, as well as temperature. Divisions can then be subdivided into provinces, which are differentiated based on vegetation or other natural land covers. The finest level of detail is described by subregions, called sections, which are subdivisions of provinces based on terrain features.

For the purposes of this study, provinces will be used, as this is a good level of detail where similar ecosystems and similar bee species characteristics can be expected to cooccur. Outlined in the description of each of California’s provinces are: typical climatic conditions, important biological communities, highlighting several plants of importance, and regionally relevant information about bees in these areas. The information in this section came mostly from the U.S. Forest Service’s website:
https://www.fs.fed.us/land/ecosysmgmt/colorimagemap/ecoreg1_provinces.html

This site should be visited if more detailed information or information on areas outside of California are desired. Additionally, included in the Appendix of this document are more expansive lists of plants native to each of these provinces that are known to be beneficial to bees (pages 42 - 47). As mentioned before, the bulk of the plants used in a particular project should be native to the province it’s located in.

# COASTAL CHAPARRAL

*This expansive area consists of coastal plains, low mountains, and interior valleys from San Francisco County to San Diego County.*



## Climate

- Characterized by hot, dry summers and rainy, mild winters. This coastal province has a more moderate climate than the interior and receives some moisture from fog in summer. Fire is common, usually set by lightning during the summer dry season.
- Average annual temperature ranges from 50° to 65° F.
- Average year-round precipitin between 10-50 inches, with a pronounced summer drought.
- This area is relatively temperate, exhibiting USDA Hardiness Zones 9 through 10.

## Biological Communities

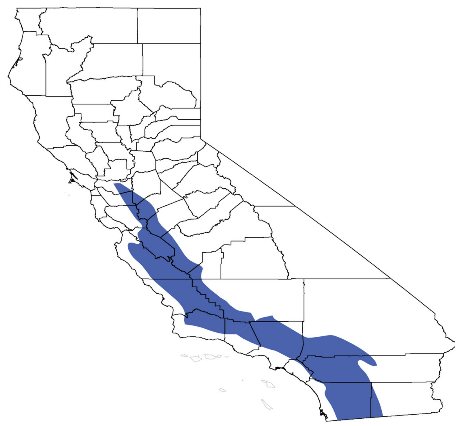
Plant communities are well marked in this province. The coastal plains and larger valleys have sagebrush and grassland communities. On the hills and lower mountains, there are sclerophyll forests consisting of low trees with small, leathery leaves that can withstand the lack of summer precipitation, including various oaks (*Quercus* spp.) On steep hill and mountain slopes too dry to support oak woodland or oak forest, much of the vegetation can be characterized as chaparral, which varies in composition with elevation and exposure. It consists mainly of chamise (*Adenostoma fasciculatum*) and various manzanitas (*Arctostaphylos* spp.) that are adapted to periodic occurrence of fire. Exposed coastal areas support desertlike shrub communities called coastal scrub, dominated by coyote bush (*Baccharis spp.*), California sagebrush (*Artemisia californica*), and bush lupine (*Lupinus albifrons*). Toward southern California, sages (*Salvia* spp.) become abundant within coastal scrub communities.

## The Bees

Bees are important for a wide range of crops in this region but especially grapes, nuts, citrus, grapes, blackberries, cucumbers, and artichokes.

# COASTAL WOODLAND

*This province occupies the central part of the California Coast Ranges and the mountains of southern California. The mountains of southern California are steeply sloping, with narrow stream valleys that are widely spaced.*



## ▼ Climate

- Characterized by hot, dry summers and rainy, mild winters. Temperatures average 53 to 65F in the Coast Range, but are only 32 to 60F in the mountains of southern California, always falling with rising elevation.
- Precipitation, which ranges from 12 to 40 in per year, is evenly distributed through fall, winter, and spring, and increases with elevation. Most of this is rain; the little snow that falls in winter melts quickly. Frost and short periods of freezing weather occur occasionally in winter. Coastal areas have a more moderate climate than the interior and receive some moisture from fog in summer.
- This area exhibits relatively temperate USDA Hardiness Zones, 8 through 10.

## ▼ Biological Communities

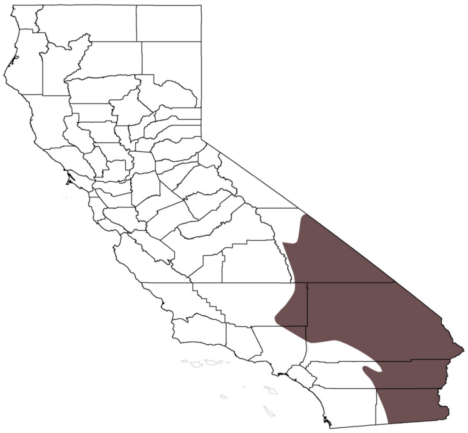
Dominated by alternating patches of sclerophyll forest and chaparral, but the latter occupies a much greater area. Forests consistently appear on northfacing slopes and wetter sites; chaparral occupies southfacing slopes and drier sites. The most important evergreen trees of the sclerophyll forest are various Oaks (*Quercus* spp.) California laurel (*Umbellularia californica*), Pacific madrone (*Arbutus menziesii*), golden chinkapin (*Chrysolepis chrysophylla*), and Pacific bayberry (*Myrica californica*). Several deciduous trees, shrubs, and herb associates are also characteristic.The chaparral community of fire-adapted shrubs extends over a wide area with a diversity of habitats. The most important species are chamise (*Adenostoma fasciculatum*) and manzanita (*Arctostaphylos* spp.). Other common species are toyon (*Heteromeles arbutifolia*), California scrub oak (*Quercus berberidifolia*), mountain mahogany (*Cercocarpus* spp.), and many species of *Ceanothus*. At higher elevations and near the ocean, chaparral is often interspersed with, or alternates with, coniferous forests. The interior valleys have sagebrush and grassland communities. Riparian forest with many broadleaf species grows along streams.

## ▼ The Bees

Bees are important pollinators for a range of crops including apples, strawberries, citrus, and cantaloupes in this area.

# SEMIDESERTS & DESERTS

*The American Desert includes the Mojave, Colorado, and Sonoran Deserts. Its topography is characterized by extensive plains, most gently undulating, from which isolated low mountains and buttes rise abruptly.*



## Climate

- Summers here are long and hot!
- Average annual temperature range from 60° to 75° F.
- Average year-round precipitation between 2-10 inches. In the Colorado and Mojave Deserts of southeastern California, there are virtually no summer rains. No part of the province has regular rains, and a year or more may pass without measurable rainfall, especially in the region's western parts.
- Despite the heat exhibited in this area, temperatures at night can get quite low and thus this area is categorized by USDA Hardiness Zones 8A through 10A.

## Biological Communities

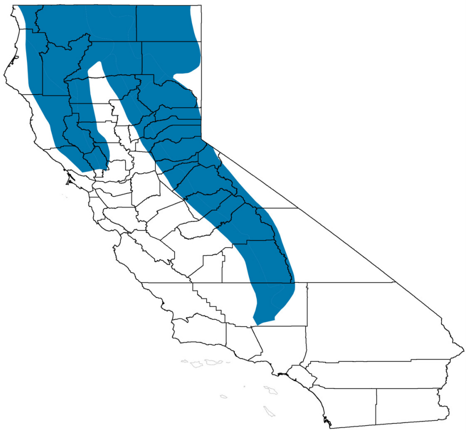
Vegetation is usually very sparse, with bare ground between individual plants. Cacti and thorny shrubs are widespread, but many thornless shrubs and herbs are also present. On the Sonoran Desert plains, the most widely distributed plant is the creosote bush (*Larrea tridentata*), which covers extensive areas in nearly pure stands. On some parts of the plains cacti are common as well. Mesquite (*Prosopis* spp.) is less widespread and grows only along washes and watercourses. At the base of the mountains, the vegetation is dominated by paloverde (*Parkinsonia* spp.), ocotillo (*Fouquieria splendens*), and saguaro (*Carnegiea gigantea*), but bitterbrush (*Purshia tridentata*) is also a common shrub. Vegetation in the Mojave Desert is mostly creosote bush and various saltbrush species (*Atriplex* spp.). The desert mountains are exceptionally barren, and many are almost devoid of vegetation.

## The Bees

Bees are important for a wide range of crops in this area, especially cantaloupe, broccoli, cabbage, and various citrus fruits. Be sure to leaves lots of bare soil in the garden, as there are a fair amount of ground-nesting bees in this area. Hollow stems from Yucca spp. are great nesting sites for cavity-nesting bees. This area exhibits a fair amount of bee species that specialize on cactus plants, so do not shy away from using these kinds of plants in the garden.

# COASTAL RANGES

*This area can be characterized as primarily steep forested mountains and valleys throughout Northern California.*



## Climate

- Usually consists of dry summers and wet winter seasons which are typically longer and drier in the east and at lower elevations.
- Average annual temperature ranges from 35°F to 52°F but falls with increasing elevation.
- Average year-round precipitation is between 10-15 inches, rising to 70 inches (mostly in the form of snow) at higher elevations.
- This area exhibits some of the coldest and widest variety of USDA Hardiness Zones, from 5B to 9B.

## Biological Communities

Vegetation zones are spatially demarcated in this area. The lower slopes and foothills are covered by pine trees and close-growing shrub associations, in which buckbrush (*Ceanothus* spp.) and manzanita (*Arctostaphylos* spp.) are prominent. Higher slopes are dominated by digger pine (*Pinus sabiniana*) and blue oak (*Quercus douglasii*), forming typical open or woodland stands. Several oaks (*Quercus* spp.) are common associates throughout the region.

## The Bees

Bees are important for a wide range of crops in this area, especially blueberries, strawberries, peaches and pears. Ceanothus spp. and Arctostaphylos spp. are two particularly important groups of plants, blooming in late winter or early spring, a time when a lot of bees in this area are active. Surprisingly, oak can also be an important source of pollen.

# COASTAL STEPPE

*This area can be characterized as primarily low mountains along the Northern California coast dominated by low coastal ranges that extend seaward into sloping marine terraces and inland into a few broad valleys.*

## Climate

- Average annual temperature ranges from 50° to 55° F.
- Average year-round temperature between 40-100 inches.
- This area exhibits relatively warmer USDA Hardiness Zones, from 10A to 11.

## Biological Communities

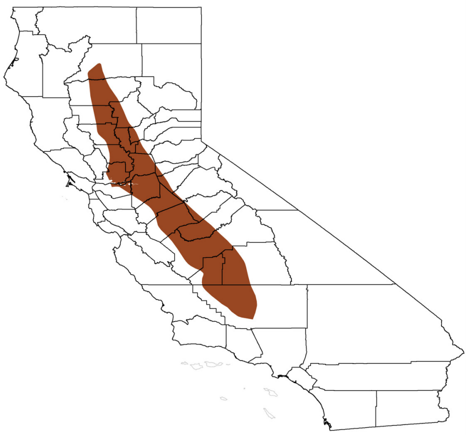
This area is dominated by moist Douglas-fir and coast redwood forests. These forests typically have a well-developed understory, usually dominated by large and colorful Pacific rhododendrons and western azaleas (Rhododendron spp.); other shrubs, especially salal (*Gaultheria shallon*) and California huckleberry (*Vaccinium ovatum*), are usually present. Many ferns and flowers grow in the cool shade, such as western sword fern (*Polystichum munitum*) and redwood sorrel (*Oxalis oregana*).

## The Bees

Soft wood from redwoods makes a great nesting site for wood-cavity nesting bees! Consider using woodland plants mentioned above in gardens.

# DRY STEPPE

*This province lies within the Central Valley of California, a flat alluvial plain between the Sierra Nevada and the Coast Ranges. This area has broad, nearly level valleys bordered by the lower foothills of the surrounding uplands.*



## ▼ Climate

- Characterized by mild, often foggy winters and hot summers, except near the San Francisco Bay.
- Water is scarce in many areas as precipitation, mainly limited to winter months, is potentially exceeded by evaporation during the summer months.
- Average annual temperature ranges from 60° to 67° F.
- Average year-round precipitation between 6-30 inches.
- USDA Hardiness Zones 8-9

## ▼ Biological Communities

This province is characterized by a vegetational zone that had been dominated by natural grasses and wildflowers.

## ▼ The Bees

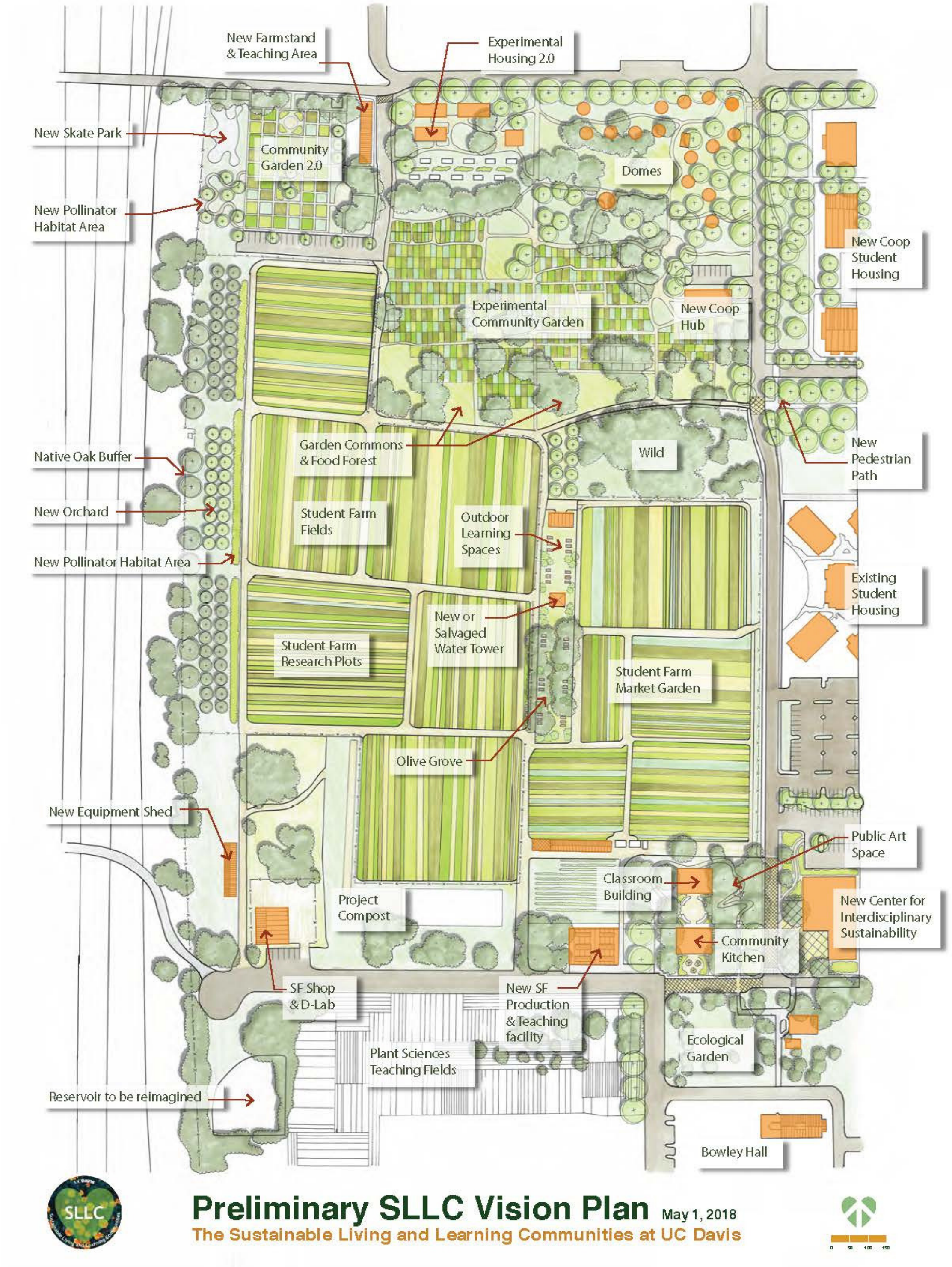
Bees are of special importance to this extremely agriculturally productive area, especially alfalfa, nuts (especially almonds and walnuts), as well as various stone fruits and citrus fruits. However the monocultures - enormous areas of land planted with one type of crop - virtually become a food desert when not in bloom, as they leave little to no room for the profusion of native wildflowers that could otherwise support an abundance of bees. Urban and suburban landscapes can thus act as oases in this area of the state largely dominated by agricultural use.

# SUSTAINABLE LIVING & LEARNING COMMUNITIES

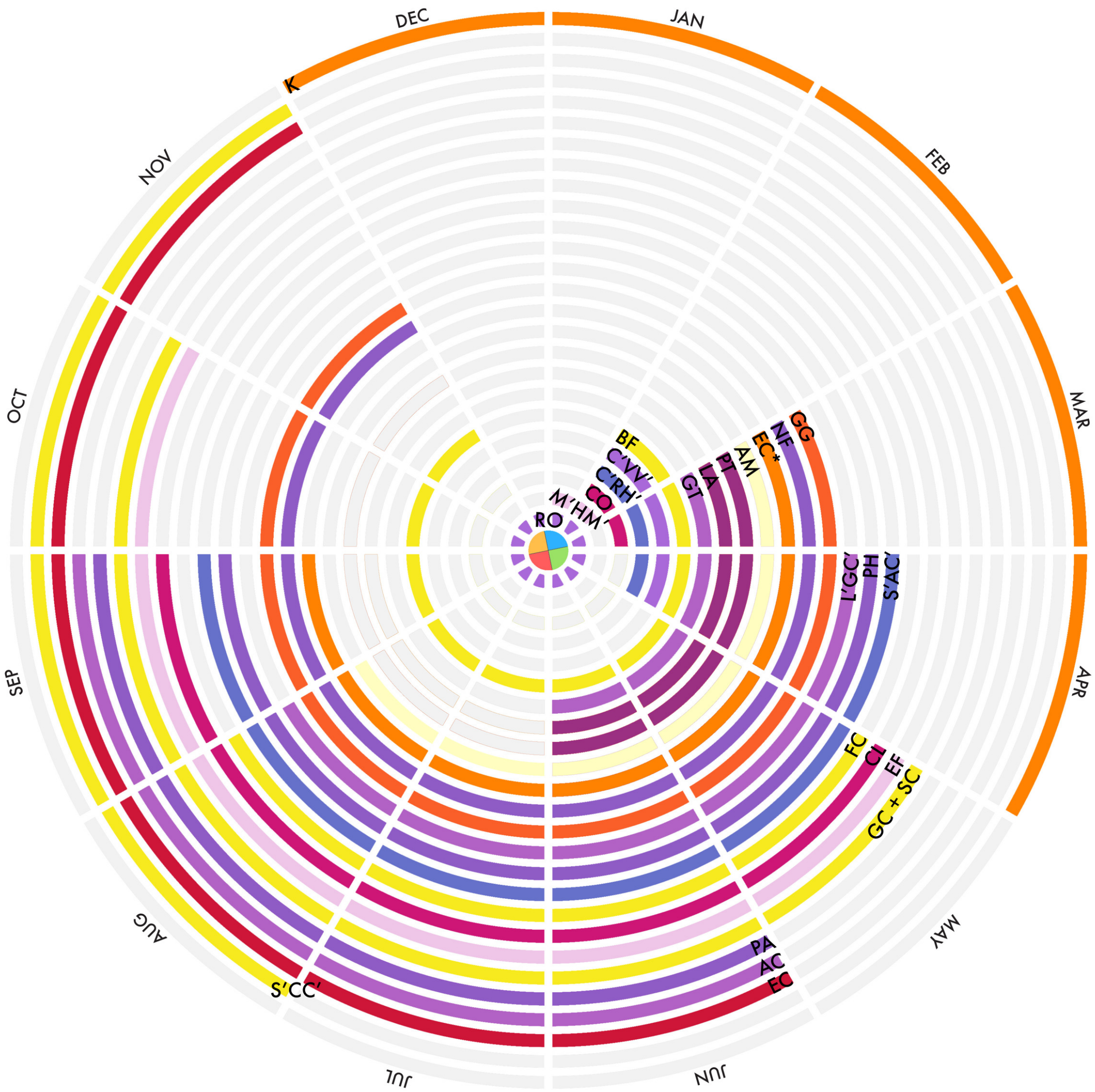
*To demonstrate how the guidelines presented in the last section can be implemented into a real-world project, the case of making the Sustainable Living & Learning Communities (SLLC) at the University of California, Davis more permeable for native bees will be presented.*

# THE SLLC

The SLLC is a portion of the university's western campus which includes: agricultural fields where students and faculty work together to create, maintain and explore sustainable food systems; an expansive, more traditional community garden; and the Domes, a co-operative living community. Currently, the SLLC is in the midst of working towards a vision plan for the future development of the SLLC; this is shown by the plan below, prepared by Allegra Watson, Simon Han, and SooMin Hur.



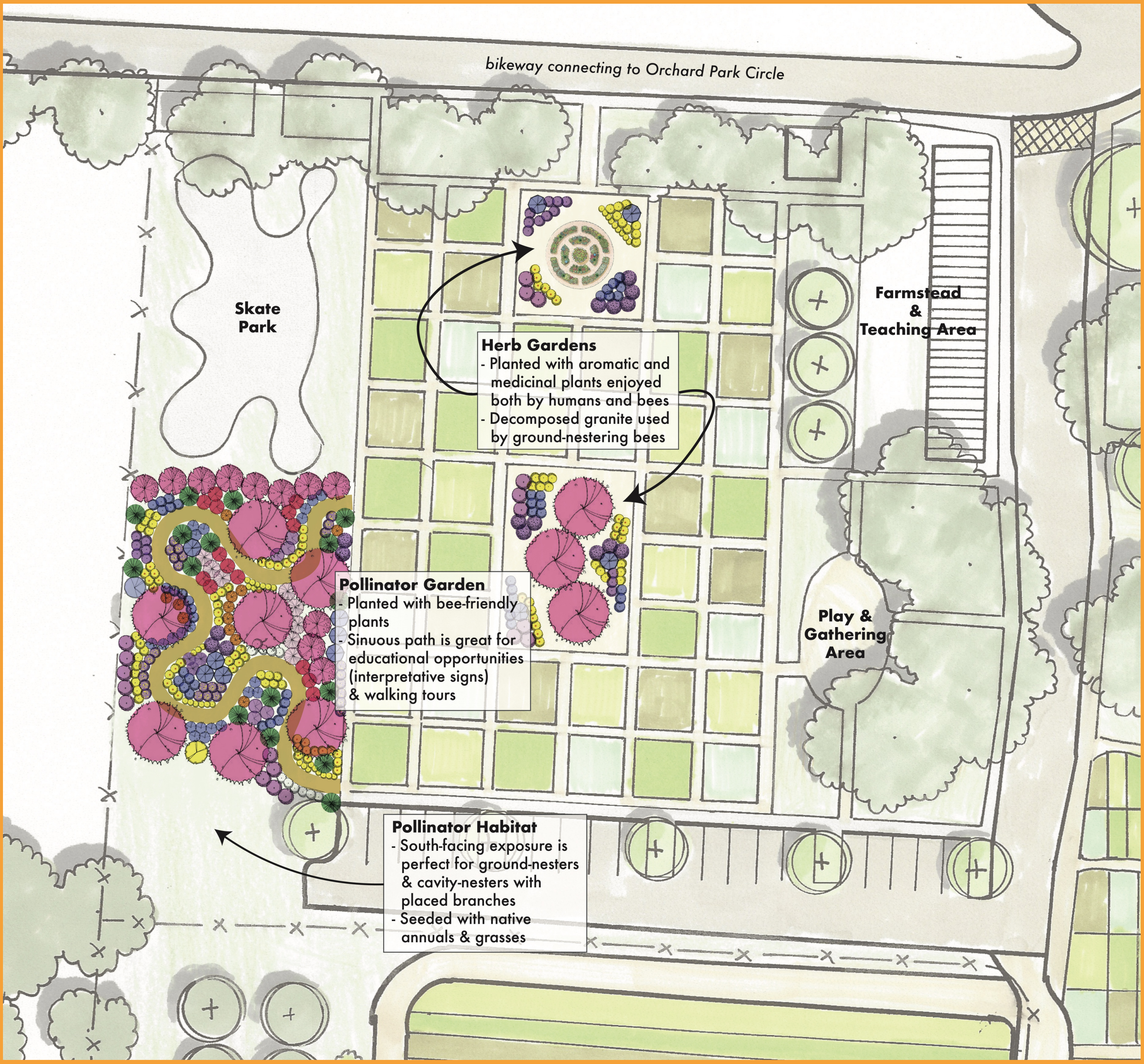
Below are the plants used for bee intervention proposals for this project, including a bloom calendar. Additionally, a comprehensive list is included on page 41 of this document. It is important to note that the plants were selected to provide foraging resources from late winter through early fall, the period of time where most native adult bees are active.




- **AM**: *Achillea millefolium*
- **AC**: *Aster chilense*
- **BF**: *Bulbine frutescens*
- **C'RH'**: *Ceanothus* 'Ray Hartman'
- **C'VV'**: *Ceanothus* 'Valley Violet'
- **CO**: *Cercis occidentalis*
- **CL**: *Chilopsis linearis*
- **EC**: *Epilobium canum*
- **EF**: Eriogonum fasciculatum
- **EC**: *Eschscholzia californica**
- **F**: *Fremontodendron californicum* 'Ken Taylor'
- **GG**: *Gaillardia* x *grandiflora*
- **GT**: *Gilia tricolor**
- **GC**: *Grindelia camporum*
- **K**: Kniphofia 'Christmas Cheer'
- **L'GC'**: Lavandula 'Goodwin Creek Grey'
- **LA**: Lupinus albifrons
- **M'HM'**: Manzanita 'Howard McMinn'
- **MR**: Muhlenbergia rigens (grass, not shown)
- **NF**: Nepeta x faassenii
- **PA**: Perovskia atriplicifolia
- **PH**: Penstemon heterophyllus 'Margarita BOP'
- **PT**: Phacelia tanacetifolia*
- **RO**: Rosmarinus officinalis
- **SC**: Salvia chamaedryoides
- **S'AC'**: Salvia clevelandii 'Allen Chickering'
- **S'CC'**: Solidago californica 'Cascade Creek'

Plants with (*) are annuals and are not explicitly portrayed in plans.

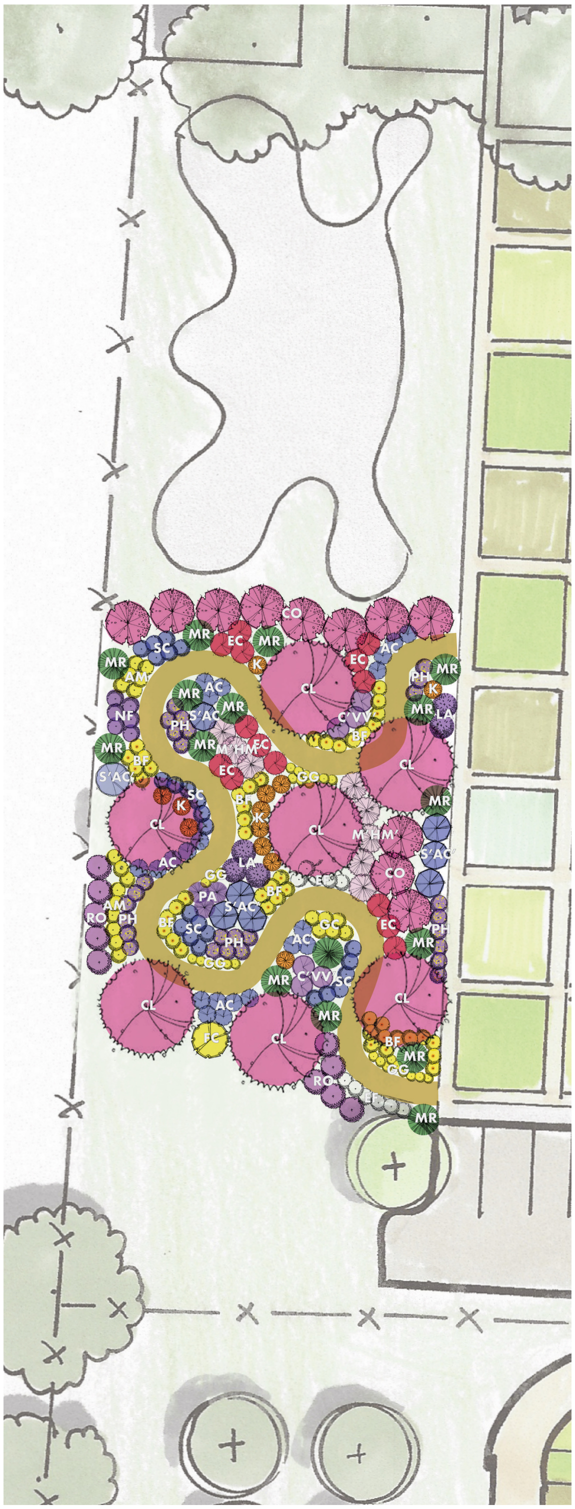
# NEW COMMUNITY GARDEN




Part of the plan is a new community garden to the northwest, including garden plots, various open spaces for gathering, a pollinator garden, and a skate park.

The planned Pollinator Garden is a great, relatively large area that can attract native bees to the garden. Its large size allows it to exhibit many different kinds of bee-attractant plants. Additionally, its sinuous path naturally allows one to dither while walking through it, making it a good spot for educational programming, such as informative tours or interpretive signage.

## Plan



## Perspective

Potential concerns about pollinator habitat being so close to human-centered programmatic elements can be alleviated by:

- Incorporating some plants with flower colors different from blue, purple, yellow and white, which bees are most attracted to
- Incorporating trees and large shrubs to get more bees away from the scale of a human, which will also create some shady patches, whereas bees prefer foraging in sunny, warm conditions
- Planting a hedgerow to limit noise coming from the skate park

## Section

Within the community garden, two smaller gardens are planned. These areas should be planted with bee-friendly plants, attracting them to crops in the vicinity. These plant could double as herbs, aromatic plants and medicinal plants that appeal to human visitors as well.

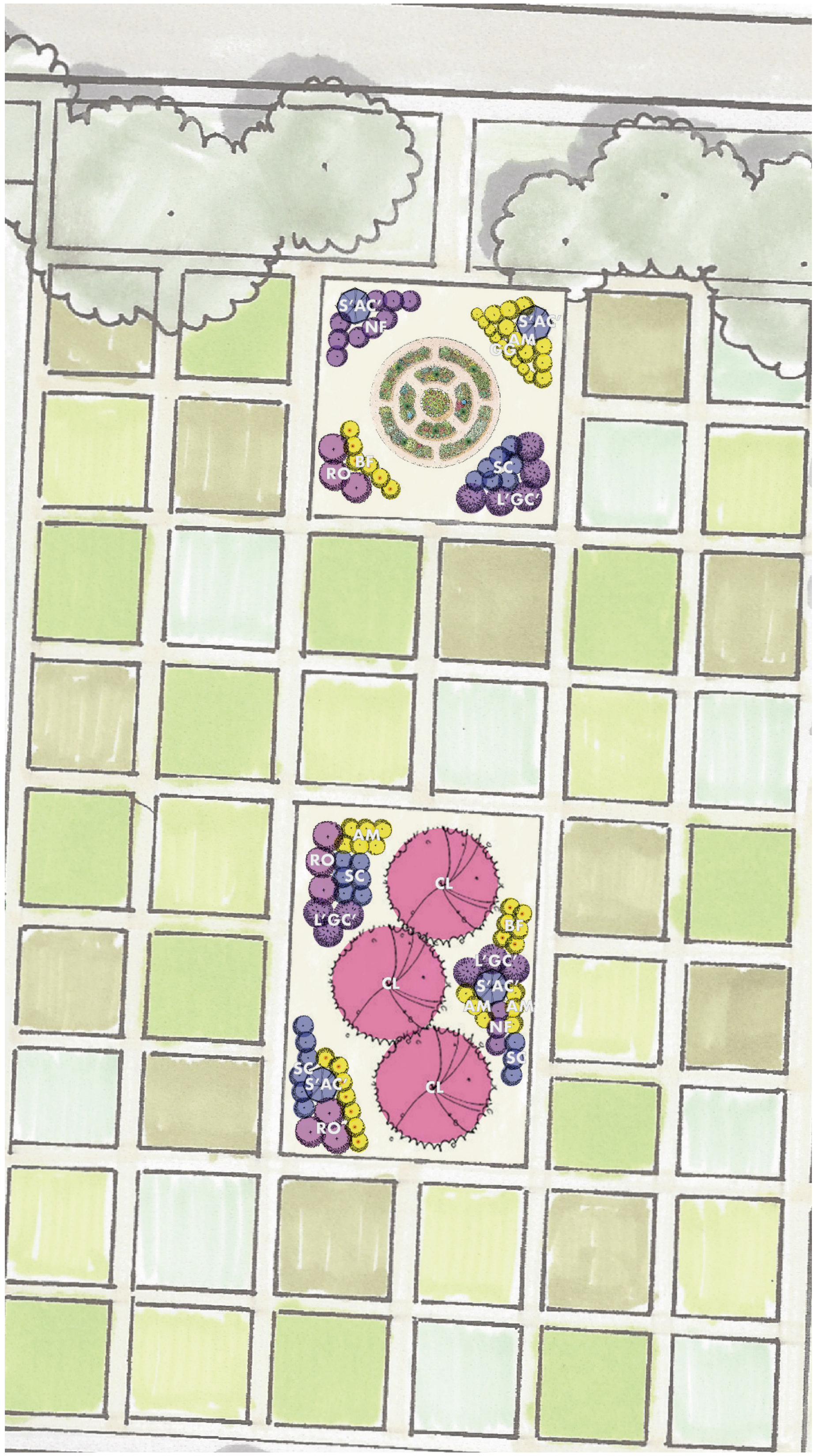
For example, Lavender (*Lavandula* 'Goodwin Creek Grey') is a very attractive to bees, while the leaves and flowers are pleasantly fragrant; dried flowers are popular for making potpourri.

Cape balsam (*Bulbine frutescens*) flowers in late winter / early spring and thus can be a good foraging resource for bees emerging in the early spring; its succulent leaves are known to have similar healing properties to *Aloe vera*.

Rosemary (*Rosmarinus officinalis*) flowers practically year-round in this area and is a popular cooking herb.

Yarrow (*Achillea millefolium*) has beautiful clusters of white flowers that bees love; its leaves can be used to make tea.

## Plan



# HEDGEROW NEW POLLINATOR HABITAT

## Plan

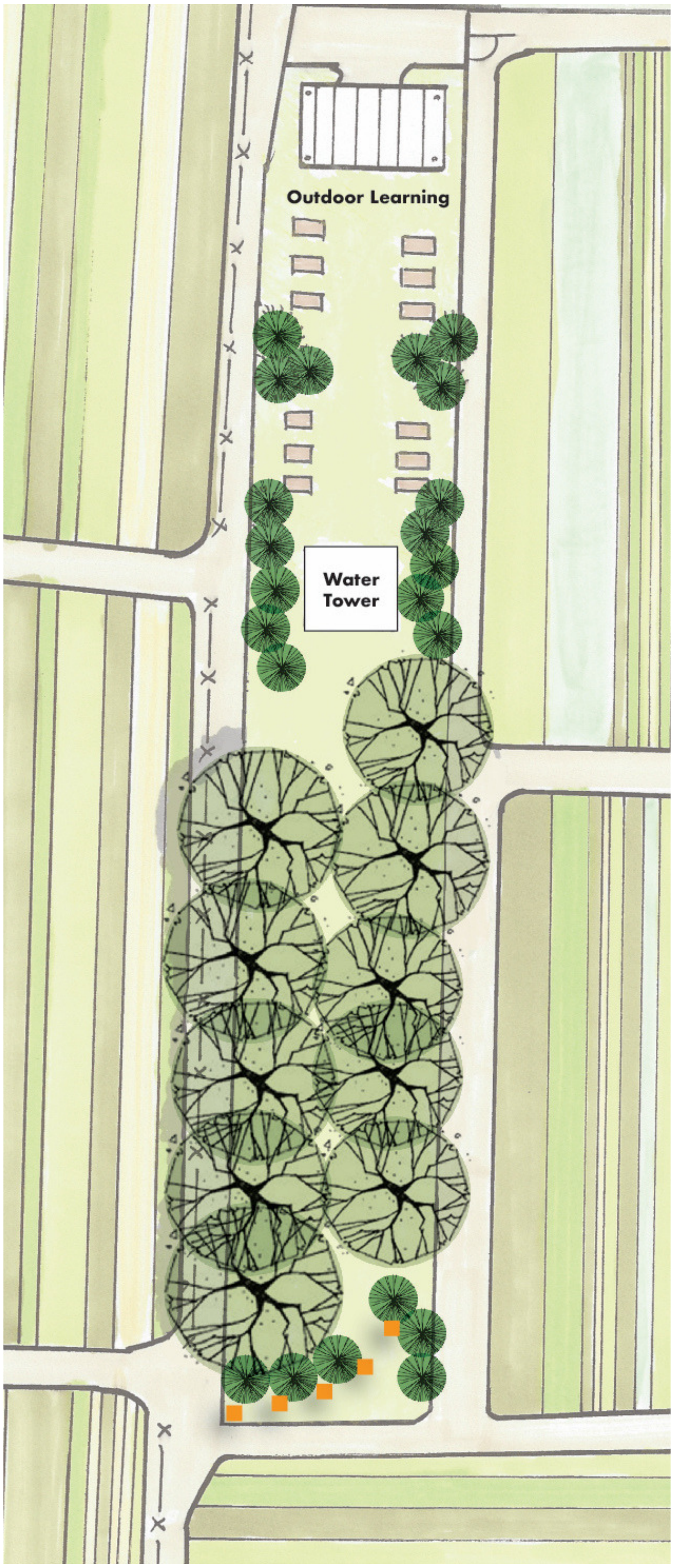

Along the site's western edge, a new orchard and hedgerow to attract pollinators is planned. This is another expansive area to showcase many different kinds of bee-attractant plants, benefiting the adjacent agricultural land. The untilled land below the orchard is a great spot to set aside for ground-nesting bees. Alternatively, the ground could be seeded with native grasses and wildflowers.

Seeing as this part of the site is directly surrounded by agricultural land, this would be a good site to use solely plants with flower colors of yellow, blue, purple, and white, as these are the colors bees are most attracted to.

The plants here will flower throughout the seasons, but mostly from late winter / early spring through late summer / early fall, the period of time that most native bees are active. This will help ensure efficient pollination of pollinator-dependent crops growing in the farm throughout the seasons. These could be especially helpful for the proposed orchards adjacent.

# OLIVE GROVE

## Plan




At the center of the SLLC, outdoor teaching and gathering spaces are being envisioned. A water tower will provide character and vertical interest, as well as serve as a marker for this unique spot of the site. An existing olive grove's northern half will be cleared for this, retaining those on the southern half. These olives can provide pollen when in bloom, and their mature size makes them great potential nesting sites for cavity-nesting bees.

The area underneath the olive trees is too shady for bee plantings, but can be planted with bunchgrasses to provide potential nesting sites. The groundcover could be seeded with native grasses and bee-friendly wildflowers (as shown in the illustrations below), leaving some areas with bare soil for ground-nesting bees.

The southern edge of this space is a great spot to exhibit bee blocks or stem bundles, especially with its southern exposure and proximity to outdoor teaching spaces. Refer to the *Human Practices* section of this document for more elaboration about these implementations.

## Perspective

# CONCLUSIONS

Current declining trends of bee populations worldwide are alarming, especially when one considers agricultural systems' substantial dependence on the European honey bee (*Apis mellifera*). Wild populations of bees are at risk now more than ever. In order to maintain healthy ecosystems and ensure the delivery of pollination services in the future when the management of *A. mellifera* is questionable, the focus must turn to calling attention to and preserving native bee populations. Community gardens are a great space to this and raise awareness of this current predicament. Effectively designed and managed, community garden spaces have the potential to: benefit localized, native bee species: educate communities about the bees native to an area and how to help restore their populations; strengthen local food systems by making them more transparent, productive and resilient. Most important, however, is lessening the need to rely on industrialized agricultural systems and their alarming dependence on the exotic *A. mellifera*.

# APPENDIX

# SLLC PLANT LIST

| Name | Common name | Form | Flower form | Flower color | Bloom time | Sun | Native? |
|---|---|---|---|---|---|---|---|
| *Achillea millefolium* | yarrow | perennial | Flat | White | March - Aug | Full sun, part sun | Yes |
| *Aster chilense* | CA aster | perennial | Flat | Purple, yellow | June - Sep | Full sun, part sun | Yes |
| *Bulbine frutescens* | cape balsam | succulent | Flat | Yellow | Feb - Nov | Full sun, part sun | No |
| *Ceanothus* 'Ray Hartman' | Ray Hartman ceanothus | shrub | Flat | Blue-purple | Feb - Apr | Full sun | Yes |
| *Ceanothus* 'Valley Violet' | valley violet ceanothus | sub-shrub | Flat | Light purple | Feb - Apr | Full sun, part sun | Yes |
| *Cercis occidentalis* | western redbud | shrub/small tree | Tubular | Pink | Feb - March | Full sun, part sun | Yes |
| *Chilopsis linearis* | desert willow | small tree | Tubular | Pink | May - Sept | Full sun | Yes |
| *Epilobium canum* | CA fuchsia | perennial | Tubular | Red | Jun - Nov | Full sun | Yes |
| *Eriogonum fasciculatum* | CA buckwheat | perennial | Flat | White | May - Oct | Full sun | Yes |
| *Eschscholzia californica* | CA poppy | annual/perennial | Flat | Orange | March - Sep | Full sun | Yes |
| *Fremontodendron californicum* 'Ken Taylor' | flannel bush | shrub | Flat | Yellow | May-Aug | Full sun | Yes |
| *Gaillardia x grandiflora* | blanket flower | biennial | Flat | Red-orange, yellow | March - Nov | Full sun | No |
| *Gilia tricolor* | gilia | annual | Tubular | Purple, white | March - June | Full sun | Yes |
| *Grindelia camporum* | bird's eye gilia | perennial | Flat | Yellow | May - Oct | Full sun | Yes |
| *Kniphofia* 'Christmas Cheer' | hot poker | perennial | Tubular | Orange, yellow | Dec - Apr | Full sun, part sun | No |
| *Lavandula* 'Goodwin Creek Grey' | lavender | sub-shrub | Tubular | Purple | Apr - Aug | Full sun | No |
| *Lupinus albifrons* | silver lupine | shrub | Tubular | Purple | March - June | Full sun | Yes |
| *Manzanita* 'Howard McMinn' | manzanita | shrub | Tubular | White | Jan - Feb | Full sun | Yes |
| *Muhlenbergia rigens* | deer grass | grass | - | - | - | Full sun | Yes |
| *Nepeta x faassenii* | catmint | perennial | Tubular | Purple | March - Nov | Full sun, part sun | No |
| *Perovskia atriplicifolia* | russian sage | perennial | Tubular | Purple | June - Sept | Full sun | No |
| *Penstemon heterophyllus* 'Margarita BOP' | foothill penstemon | perennial | Tubular | Purple | Apr - Sep | Full sun | Yes |
| *Phacelia tanacetifolia* | phacelia | annual | Tubular | Light violet | March - June | Full sun | Yes |
| *Rosmarinus officinalis* | rosemary | sub-shrub | Tubular | Indigo | Year-round | Full sun, part sun | No |
| *Salvia chamaedryoides* | salvia chamaedryoides | perennial | Tubular | Blue | May - Oct | Full sun, part sun | No |
| *Salvia clevelandii* 'Allen Chickering' | CA blue sage | shrub | Tubular | Blue, purple | Apr - Sept | Full sun | Yes |
| *Solidago californica* 'Cascade Creek' | goldenrod | perennial | Flat | Yellow | Aug - Nov | Full sun | Yes |

# PROVINCE PLANT LISTS

## Coastal Chaparral

| Botanical Name | Common Name | Type | Flower Color | Flower Season | Sun | USDA Zones | Sunset Zones |
|---|---|---|---|---|---|---|---|
| *Acer macrophyllum* | bigleaf maple | Tree | Greenish yellow | March-June | Sun to partial shade | 6-9 | 1-9, 14-24 |
| *Achillea millefolium** | yarrow | Perennial | White | May-August | Sun | 3-9 | All |
| *Adenostema fasciculatum* | chamise | Shrub | White | May-July | Sun | 6-10 | 7-9, 14-24 |
| *Arctostaphylos spp.** | Manzanita | Shrubs & small trees | White | Feb-June | Sun to partial sun | Species dependent | Species dependent |
| *Asclepias spp.* | Milkweed | Perennial | White, magenta | June-Aug | Sun | Species dependent | Species dependent |
| *Ceanothus spp.* | Ceanothus | Shrubs and trees | Blue, some white | Feb-June | Sun to partial sun | Species dependent | Species dependent |
| *Cornus glabrata* | Brown dogwood | Shrub/small tree | White | April-May | Sun to shade | | 4-9, 14-17, 19-24 |
| *Delphinium spp.* | Larkspur | Perennial | Red | March-May | Partial sun to partial shade | Species dependent | Species dependent |
| *Dicentra formosa* | Pacific bleeding heart | Perennial | Pink | March-April | Partial shade to shade | 4-8 | 4-9, 14-24 |
| *Eschscholzia californica* | CA poppy | Annual/Perennial | Orange-yellow | March-June | Sun | 6-11 | All |
| *Fragaria chiloensis** | Beach strawberry | Perennial | White | March-May | Sun to partial shade | 5-9 | 4-24 |
| *Gilia capitata* | Bluehead gillia | Perennial | Blue | April-May | Sun | All | All |
| *Helenium puberulum* | Rosilla | Perennial | Yellow | May-August | Sun | 8-11 | 5-9, 14-24 |
| *Heteromeles arbutifolia* | toyon | shrub | White | June-Aug | Sun to partial sun | 9-11 | 5-9, 14-24 |
| *Lupinus albifrons* | Silver bush lupine | Shrub | Blue | March-June | Sun | 8-10 | 7-9, 14-24 |
| *Mahonia spp.* | barberry | Shrub | Yellow | Feb-May | Partial shade to shade | Species dependent | Species dependent |
| *Mimulus cardinalis* | Scarlet monkeyflower | Perennial | Red | April-May | Shade | 6-9 | 6-11, 14-24 |
| *Phacelia spp.* | Phacelia | Perennial | White | April-May | Partial sun | Species dependent | Species dependent |
| *Prunus ilicifolia* | Holly cherry | Tree | White | March | Sun to partial sun | 9-10 | 5-9, 12-24 |
| *Ranunculus californicus* | California buttercup | Perennial | Yellow | Feb-May | Sun to partial sun | 6-9 | 2-9, 14-24 |
| *Rhus integrifolia* | Lemonade sumac | Shrub/small tree | Pale pink | June | Partial sun to sun | 9-11 | 8, 9, 14-24 |
| *Salvia leucophylla* | Mexican bush sage | Shrub | Lavender | May-June | Sun | 6-10 | 8, 9, 14-24 |
| *Salvia mellifera* | Black sage | Shrub | White | May-June | Sun | 7-10 | 7-9, 14-24 |
| *Trichostema lanatum* | Woolly bluecurls | Shrub | Violet | May-August | Sun | 5-10a | 7-10, 14-24 |
| *Verbena lasiostachys* | Western vervain | Perennial | Purple | June-July | Sun | 3-10 | 7-9, 14-24 |

# Coastal Woodland

| Botanical Name | Common Name | Type | Flower Color | Flower Season | Sun | USDA Zones | Sunset Zones |
|---|---|---|---|---|---|---|---|
| *Acer macrophyllum* | bigleaf maple | Tree | Greenish yellow | March-June | Sun to partial shade | 6-9 | 1-9, 14-24 |
| *Achillea millefolium** | yarrow | Perennial | White | May-August | Sun | 3-9 | All |
| *Aesculus californica* | CA buckeye | Tree | White | April-May | Sun to partial shade | 7-8 | 3-10, 14-24 |
| *Aquilegia formosa* | western columbine | Perennial | Red and yellow | April-June | Sun | 3-8 | 4-9, 14-24 |
| *Arctostaphylos spp.* | woolyleaf manzanita | Shrub | White | Feb-March | Sun to partial sun | Species dependent | Species dependent |
| *Asclepias spp.* | Milkweed | Perennial | White, magenta | June-Aug | Sun | Species dependent | Species dependent |
| *Ceanothus spp.* | Ceanothus | Shrubs and trees | Blue, some white | Feb-June | Sun to partial sun | Species dependent | Species dependent |
| *Cercis occidentalis* | redbud | Shrub/small tree | Pink | Feb-April | Sun to partial shade | 7-9 | 2-24 |
| *Clarkia spp.* | clarkia | Perennial | Pink | May-June | Sun to shade | Species dependent | Species dependent |
| *Cornus glabrata* | Brown dogwood | Shrub/small tree | White | April-May | Sun to shade | 7-10 | 4-9, 4-17, 19-24 |
| *Eriodictyon californicum* | Yerba Santa | Perennial | Lavender pink | April-June | Sun | 5-10 | 7-9, 14-24 |
| *Eschscholzia californica* | CA poppy | Annual/Perennial | Orange-yellow | March-June | Sun | 6-11 | All |
| *Frangula californica* | coffeeberry | Shrub | Greenish | May-June | Sun to shade | 7-9 | 3-10, 14-24 |
| *Gilla capitata* | Bluehead gillia | Perennial | Blue | April-May | Sun | All | All |
| *Helenium puberulum* | Rosilla | Perennial | Yellow | May-August | Sun | 8-11 | 5-9, 14-24 |
| *Heteromeles arbutifolia* | toyon | Shrub/small tree | White | June-Aug | Sun | 9-11 | 5-9, 14-24 |
| *Lupinus albifrons* | Silver bush lupine | Shrub | Blue | March-June | Sun | 8-10 | 7-9, 14-24 |
| *Mahonia spp.* | barberry | Shrub | Yellow | Feb-May | Partial shade to shade | Species dependent | Species dependent |
| *Mimulus cardinalis* | scarlet monkeyflower | Perennial | Red | April-May | Shade | 6-9 | 6-11, 14-24 |
| *Penstemon spp.* | penstemon | Perennial | Blue | April-May | Sun | Species dependent | Species dependent |
| *Phacelia spp.* | phacelia | Perennial | Purple, white | April-May | Partial sun | Species dependent | Species dependent |
| *Prunus ilicifolia* | Holly cherry | Tree | White | March | Sun to partial sun | 9-10 | 5-9, 12-24 |
| *Prunus virginiana* | Chokecherry | Tree | White | March | Sun to partial sun | 3-8 | 1-3-10 |
| *Ranunculus californicus* | California buttercup | Perennial | Yellow | April-May | Sun to partial sun | 6-9 | 2-9, 14-24 |
| *Rhus integrifolia* | Lemonade sumac | Shrub/small tree | Pale pink | June | Partial sun to sun | 9-11 | 8, 9, 14-24 |
| *Romneya coulteri* | Matilijia poppy | Perennial | White | May-July | Sun to partial shade | 7-11 | 4-9, 14-24 |
| *Salvia carduacea* | thistle sage | Annual/Perennial | Lavender to blue | March-June | Sun | 7-10 | 7-9, 14-16, 18-24 |
| *Salvia columbariae* | chia | Perennial | Purple | March-June | Sun | 6-10 | 8, 9, 14-24 |
| *Salvia leucophylla* | Mexican bush sage | Shrub | Lavender | May-June | Sun | 6-10 | 8, 9, 14-24 |
| *Salvia mellifera* | Black sage | Shrub | White | May-June | Sun | 7-10 | 7-9, 14-24 |
| *Solidago californica* | California goldenrod | Perennial | Yellow | August-September | Partial sun to shade | 6-10 | 1-9, 14-23 |
| *Trichostema lanatum* | Woolly bluecurls | Shrub | Violet | May-August | Sun | 5-10a | 7-10, 14-24 |

# Semideserts & deserts

| Botanical Name | Common Name | Type | Flower Color | Flower Season | Sun | USDA Zones | Sunset Zones |
|---|---|---|---|---|---|---|---|
| *Acacia greggii* | catclaw acacia | Tree | Pale yellow | May-Jun | Full sun | 9-10 | 7-24 |
| *Agave parryi* | Parry's agave | Succulent | Yellow | Jun-Aug | Full sun | 7-10 | 6-24 |
| *Calliandra eriophylla* | fairyduster | Shrub | Pale to deep pink | February | Full sun | 7-11 | 10-12 |
| *Carnegiea gigantea* | Saguaro | Cactus | White | May-Jun | Full sun | 8-11 | 12, 13, 18-21 |
| *Cucurbita foetidissima** | Missouri gourd | Vine | Yellow | May-Aug | Sun | 5-10 | 7-24 |
| *Cylindropuntia bigelovii* | Terrybear cholla | Cactus | Yellow | Feb-May | Full sun | 8b-11 | 10-13, 19-24 |
| *Dasylirion wheeleri* | Common sotol | Succulent | White | May-Aug | Full sun | 6-10 | 10-24 |
| *Ferocactus wislizeni* | Candy barrel cactus | Cactus | Orange-yellow | Jul-Sep | Full sun | 9-12 | 12-21 |
| *Lupinus sparsiflorus* | Mojave lupine | Perennial | Blue | Mar-Apr | Full sun | 7-11 | 10-24 |
| *Nolina bigelovii* | Bigelow's nolina | Succulent | Green-tinged white | May-Jul | Full sun | 7-11 | 7-24 |
| *Olneya tesota* | Desert ironwood | Tree | Pale lavender | May-Jun | Full sun | 8-11 | 8, 9, 11-14, 18-23 |
| *Opuntia engelmannii* | Cactus apple | Cactus | Yellow | Apr-Jun | Full sun | 8-11 | 8-10 |
| *Parkinsonia microphylla* | Yellow paloverde | Tree | Pale yellow | Apr-May | Full sun | 9-11 | 10-14, 18-20 |
| *Penstemon parryi* | Parry's beardtongue | Perennial | Pink to purple-pink | Feb-Apr | Full sun | 8-11 | 12-14 |
| *Prosopis velutina* | Velvet mesquite | Tree | Greenish-yellow | Mar-Aug | Full sun | 9-11 | 12-13 |

# Coastal Ranges

| Botanical Name | Common Name | Type | Flower Color | Flower Season | Sun | USDA Zones | Sunset Zones |
|---|---|---|---|---|---|---|---|
| *Achillea millefolium* | yarrow | Perennial | White | May-August | Sun | 3-9 | All |
| *Aquilegia formosa* | Western columbine | Perennial | Red and yellow | April-June | Sun | 3-8 | 4-9, 14-24 |
| *Arbutus menziesii* | Pacific madrone | Tree | White | April-May | Sun to partial sun | 7b-11 | 3-9, 14-18, 23, 24 |
| *Arctostaphylos spp.* | Manzanita | Shrubs & small trees | White | Dec-May | Sun | Species dependent | Species dependent |
| *Aster chilensis* | Western aster | Perennial | Violet | July-Nov | Sun | 6-10 | 4-10, 14-24 |
| *Ceanothus spp.* | Ceanothus | Shrubs and trees | Blue, some white | March-June | Sun to partial sun | Species dependent | Species dependent |
| *Collinsia heterophylla* | Chinese houses | Annual | Purple-pink | March-June | Shade to sun | 7-10 | 5-11, 14-24 |
| *Dicentra formosa* | Pacific bleeding heart | Perennial | Pink | March-April | Partial shade to shade | 4-8 | 4-9, 14-24 |
| *Eriodictyon californicum* | Yerba Santa | Perennial | Lavender pink | April-June | Sun | 5-10 | 7-9, 14-24 |
| *Eriogonum spp.* | Wild buckwheats | Perennial | White, pink or yellow | May-Nov | Sun | Species dependent | Species dependent |
| *Eriophyllum lanatum* | Wooly sunflower | Perennial | Yellow | May-August | Sun to partial sun | 3-10 | 5-9-14 |
| *Eschscholzia californica* | CA poppy | Annual/Perennial | Orange-yellow | March-Nov | Sun | 6-11 | All |
| *Fremontodendron californicum* | Flannel bush | Shrub | Yellow | April-May | Sun to shade | 6-10 | 4-12, 14-24 |
| *Gilla capitata* | Bluehead gillia | Perennial | Blue | April-May | Sun | All | All |
| *Heteromeles arbutifolia* | toyon | Shrub/small tree | White | May-June | Sun to partial sun | 9-11 | 5-9, 14-24 |
| *Iris missouriensis* | Western blue flag | Perennial | Blue | May-July | Sun to partial sun | 3-9 | 1-7, 9-11, 14-21 |
| *Lupinus polyphyllus* | Large-leaved lupine | Perennial | Blue | May-July | Sun to partial sun | 4-8 | 1-7, 14-17 |
| *Nemophila menziesii* | Baby blue-eyes | Annual | Blue | Feb-May | Partial shade | All | 7-24 |
| *Penstemon heterophyllus* | Foothill penstemon | Perennial | Blue-violet | April-July | Sun | 6-10a | 7-24 |
| *Prunus virginiana* | Chokecherry | Tree | White | March | Sun to partial sun | 3-8 | 1-3-10 |
| *Ranunculus californicus* | California buttercup | Perennial | Yellow | Feb-July | Sun to partial sun | 6-9 | 2-9, 14-24 |
| *Rhododendron occidentale* | Western Azalea | Shrub | White | June-July | Shade to sun | 5-9 | 3-7, 14-17, 19-24 |
| *Ribes roezlii* | Sierra gooseberry | Shrub | Red-purple | May-June | Sun to partial sun | 5-9 | 1-7, 14-21 |
| *Rosa californica* | Wild rose | Shrub | Pink | May-June | Sun to partial sun | 4-8 | 5-10, 14-21 |
| *Rudbeckia californica* | California coneflower | Perennial | Yellow | March-July | Sun to partial sun | 6-11 | 1-10, 14-19 |
| *Sambucus mexicana* | Blue elderberry | Shrub/small tree | Light yellow | May-Oct | Sun to partial sun | 4-8 | 3-7, 14-17 |
| *Sidalcea malviflora* | checkermallow | Perennial | Pink | March-June | Sun to partial sun | 5-9 | 4-9, 14-24 |
| *Sisyrinchium bellum* | Blue-eyed grass | Perennial | Blue and yellow | Feb-July | Partial shade to shade | 8-11 | 3-11, 14-24 |
| *Solidago californica* | California goldenrod | Perennial | Yellow | July-Oct | Partial sun to shade | 6-10 | 1-9, 14-23 |
| *Triteleia laxa* | Ithuriel's spear | Perennial | Purple | April-June | Partial shade to sun | 6-10 | 5-9, 14-24 |

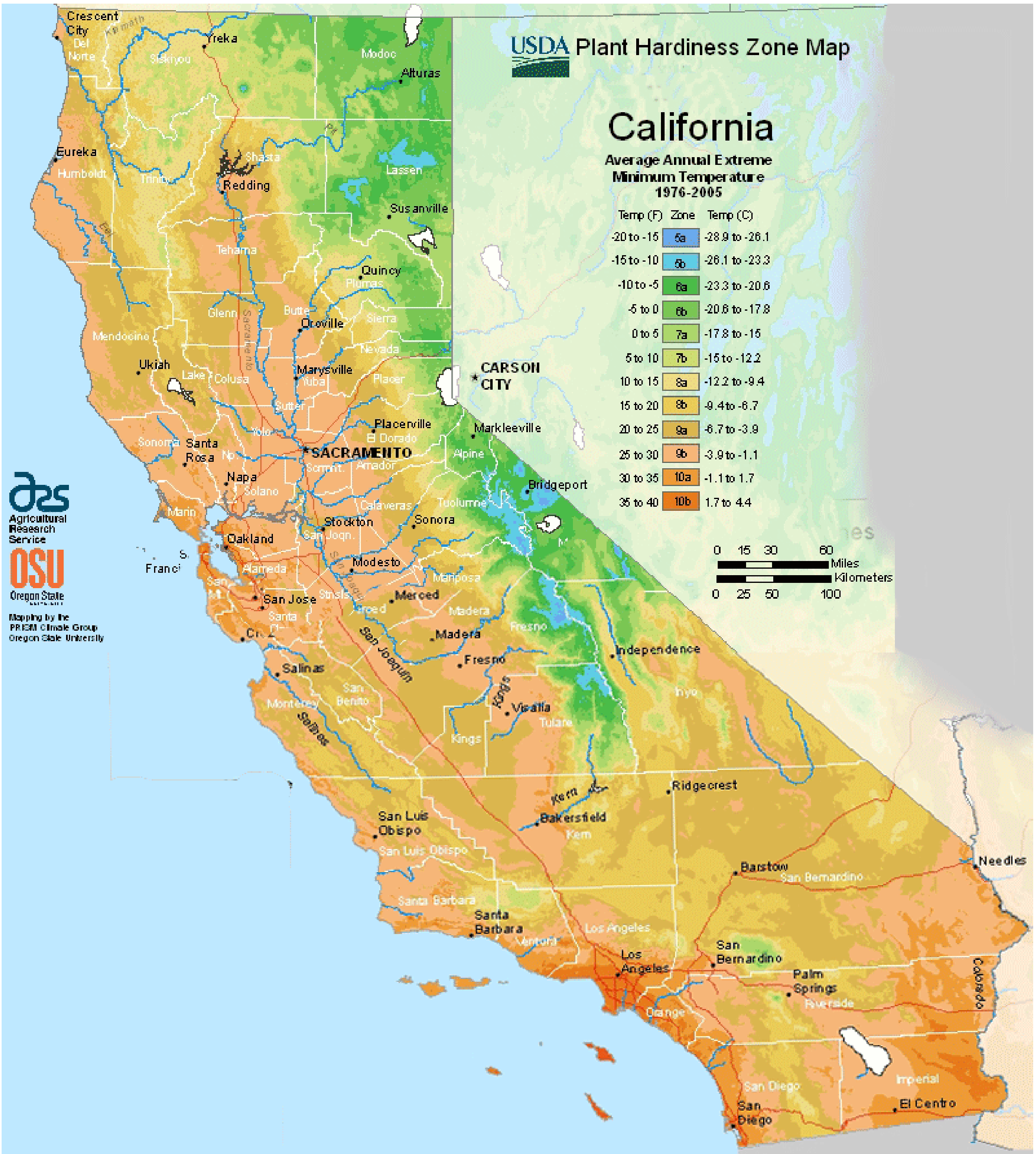
# Coastal Steppe

| Botanical Name | Common Name | Type | Flower Color | Flower Season | Sun | USDA Zones | Sunset Zones |
|---|---|---|---|---|---|---|---|
| *Acer macrophyllum* | bigleaf maple | Tree | Greenish yellow | March-June | Sun to partial shade | 6-9 | 1-9, 14-24 |
| *Amelanchier alnifolia* | serviceberry | Shrub/small tree | White | April-June | Sun to partial shade | 2-10 | 1-10, 14-24 |
| *Arbutus menziesii* | pacific madrone | Tree | White | April-May | Sun to partial shade | 7b-11 | 3-9, 14-18, 23, 24 |
| *Baccharis pilularis* | Coyote brush | Shrub | White | July-October | Sun | 8-10 | 5-9, 14-24 |
| *Ceanothus thyrsiflorus* | blue blossom | Shrub/small tree | Blue | April-June | Partial shade | 8-10 | 6-9, 14-24 |
| *Dichelostemma ida-maia* | Firecracker flower | Perennial | Red | May-July | Sun to partial sun | 6-10 | 4-7, 14-24 |
| *Fragaria chiloensis* | Beach strawberry | Perennial | White | March-August | Sun to partial shade | 5-9 | 4-24 |
| *Gaultheria shallon* | Salal | Shrub | White to pink | March-July | Shade to sun | 4-9 | 4-7, 14-17 |
| *Heteromeles arbutifolia* | toyon | shrub | White | May-June | Sun to partial sun | 9-11 | 5-9, 14-24 |
| *Nemophila menziesii* | Baby blue eyes | Annual | Sky blue | March-July | Sun | All | 7-24 |
| *Rubus spectabilis* | salmonberry | Shrub | Pinkish red | March-June | Shade to sun | 3-9 | 4-7, 15-17 |
| *Salix scouleriana* | Scouser's willow | Tree | Yellow | April-June | Sun | 5-9 | 1-10, 14-24 |
| *Sambucus nigra* | Blue elderberry | Shrub/small tree | Light yellow | May-Oct | Sun to partial sun | 4-8 | 3-7, 14-17 |
| *Scrophularia californica* | CA figwort | Perennial | Red | March-July | Sun to shade | 7-10 | 4-9, 14-24 |
| *Trifolium fucatum* | Bull clover | Annual | Yellow | April-June | Sun | 6-10 | 5-9, 14-24 |
| *Vaccinium ovatum* | Black huckleberry | Shrub | Pink and white | March-May | Shade to sun | 7-9 | 4-7, 14-17, 22-24 |

# Semideserts & deserts

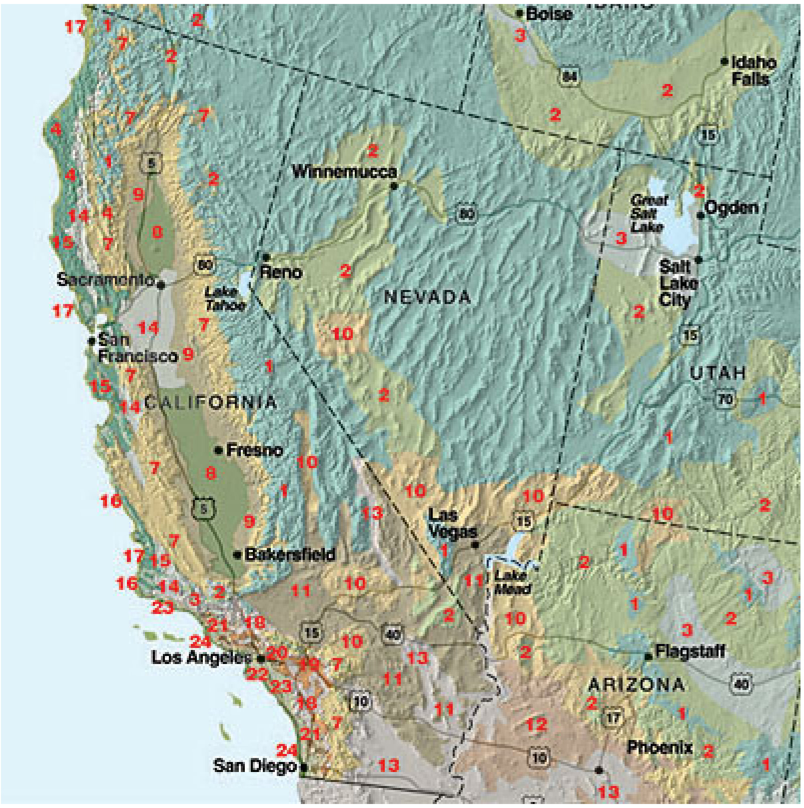
| Botanical Name | Common Name | Type | Flower Color | Flower Season | Sun | USDA Zones | Sunset Zones |
|---|---|---|---|---|---|---|---|
| *Acacia greggii* | catclaw acacia | Tree | Pale yellow | May-Jun | Full sun | 9-10 | 7-24 |
| *Agave parryi* | Parry's agave | Succulent | Yellow | Jun-Aug | Full sun | 7-10 | 6-24 |
| *Calliandra eriophylla* | fairyduster | Shrub | Pale to deep pink | February | Full sun | 7-11 | 10-12 |
| *Carnegiea gigantea* | Saguaro | Cactus | White | May-Jun | Full sun | 8-11 | 12, 13, 18-21 |
| *Cucurbita foetidissima** | Missouri gourd | Vine | Yellow | May-Aug | Sun | 5-10 | 7-24 |
| *Cylindropuntia bigelovii* | Terrybear cholla | Cactus | Yellow | Feb-May | Full sun | 8b-11 | 10-13, 19-24 |
| *Dasylirion wheeleri* | Common sotol | Succulent | White | May-Aug | Full sun | 6-10 | 10-24 |
| *Ferocactus wislizeni* | Candy barrel cactus | Cactus | Orange-yellow | Jul-Sep | Full sun | 9-12 | 12-21 |
| *Lupinus sparsiflorus* | Mojave lupine | Perennial | Blue | Mar-Apr | Full sun | 7-11 | 10-24 |
| *Nolina bigelovii* | Bigelow's nolina | Succulent | Green-tinged white | May-Jul | Full sun | 7-11 | 7-24 |
| *Olneya tesota* | Desert ironwood | Tree | Pale lavender | May-Jun | Full sun | 8-11 | 8, 9, 11-14, 18-23 |
| *Opuntia engelmannii* | Cactus apple | Cactus | Yellow | Apr-Jun | Full sun | 8-11 | 8-10 |
| *Parkinsonia microphylla* | Yellow paloverde | Tree | Pale yellow | Apr-May | Full sun | 9-11 | 10-14, 18-20 |
| *Penstemon parryi* | Parry's beardtongue | Perennial | Pink to purple-pink | Feb-Apr | Full sun | 8-11 | 12-14 |
| *Prosopis velutina* | Velvet mesquite | Tree | Greenish-yellow | Mar-Aug | Full sun | 9-11 | 12-13 |

# CA USDA HARDINESS ZONES




The USDA Hardiness Zones indicate the average annual minimum winter temperature for an area and help one determine which plants.

# CA SUNSET ZONES




- **ZONE 1. Coldest Winters in the West**
  Growing season: early June through Aug., but with some variation—the longest seasons are usually found near this zone's large bodies of water. Frost can come any night of the year. Winters are snowy and intensely cold, due to latitude, elevation, and/or influence of continental air mass. There's some summer rainfall.
- **ZONE 2. Second-coldest Western Climate**
  Growing season: early May through Sept. Winters are cold (lows run from -3 degrees to -34 degrees F/-19 degrees to -37 degrees C), but less so than in Zone 1. In northern and interior areas, lower elevations fall into Zone 2, higher areas into Zone 1.
- **ZONE 3. Mildest High-elevation and Interior Regions**
  Growing season: early May to late Sept.–shorter than in Zone 2, but offset by milder winters (lows from 13 degrees to -24 degrees F/-11 degrees to -31 degrees C). This is fine territory for plants needing winter chill and dry, hot summers.
- **ZONE 7. California's High Foothills**
  Growing season: May to early Oct. Summers are hot and dry; typical winter lows run from 23 degrees to 9 degrees F/-5 degrees to -13 degrees C. The summer-winter contrast suits plants that need dry, hot summers and moist, only moderately cold winters.
- **ZONE 8. Cold-air Basins of California's Central Valley**
  Growing season: mid-Feb. through Nov. This is a valley floor with no maritime influence. Summers are hot; winter lows range from 29 degrees to 13 degrees F/-2 degrees to -11 degrees C. Rain comes in the cooler months, covering just the early part of the growing season.
- **ZONE 9. Thermal Belts of California's Central Valley**
  Growing season: late Feb. through Dec. Zone 9 is located in the higher elevations around Zone 8, but its summers are just as hot; its winter lows are slightly higher (temperatures range from 28 degrees to 18 degrees F/-2 degrees to -8 degrees C). Rainfall pattern is the same as in Zone 8.

- **ZONE 10. High Desert Areas**
  Growing season: April to early Nov. Chilly (even snow-dusted) weather rules from late Nov. through Feb., with lows from 31 degrees to 24 degrees F/-1 degree to -4 degrees C. Rain comes in summer as well as in the cooler seasons.
- **ZONE 11. Medium to High Desert of California**
  Growing season: early April to late Oct. Summers are sizzling, with 110 days above 90 degrees F/32 degrees C. Balancing this is a 3 1/2-month winter, with 85 nights below freezing and lows from 11 degrees to 0 degrees F/-12 degrees to -18 degrees C. Scant rainfall comes in winter.
- **ZONE 14. Inland Northern and Central California with Some Ocean Influence**
  Growing season: early Mar. to mid-Nov., with rain coming in the remaining months. Periodic intrusions of marine air temper summer heat and winter cold (lows run from 26 degrees to 16 degrees F/-3 degrees to -9 degrees C). Mediterranean-climate plants are at home here.
- **ZONE 15. Northern and Central California's Chilly-winter Coast-influenced Areas**
  Growing season: Mar. to Dec. Rain comes from fall through winter. Typical winter lows range from 28 degrees to 21 degrees F/-2 degrees to -6 degrees C. Maritime air influences the zone much of the time, giving it cooler, moister summers than Zone 14.
- **ZONE 16. Northern and Central California Coast Range Thermal Belts**
  Growing season: late Feb. to late Nov. With cold air draining to lower elevations, winter lows typically run from 32 degrees to 19 degrees F/0 degrees to -7 degrees C. Like Zone 15, this region is dominated by maritime air, but its winters are milder on average.
- **ZONE 17. Oceanside Northern and Central California**
  Growing season: late Feb. to early Dec. Coolness and fog are hallmarks; summer highs seldom top 75 degrees F/24 degrees C, while winter lows run from 36 degrees to 23 degrees F/2 degrees to -5 degrees C. Heat-loving plants disappoint or dwindle here.
- **ZONE 18. Hilltops and Valley Floors of Interior Southern California**
  Growing season: mid-Mar. through late Nov. Summers are hot and dry; rain comes in winter, when lows reach 28 degrees to 10 degrees F/-2 degrees to -12 degrees C. Plants from the Mediterranean and Near Eastern regions thrive here.
- **ZONE 19. Thermal Belts around Southern California's Interior Valleys**
  Growing season: early Mar. through Nov. As in Zone 18, rainy winters and hot, dry summers are the norm—but here, winter lows dip only to 27 degrees to 22 degrees F/-3 degrees to -6 degrees C, allowing some tender evergreen plants to grow outdoors with protection.
- **ZONE 20. Hilltops and Valley Floors of Ocean-influenced Inland Southern California**
  Growing season: late Mar. to late Nov.–but fairly mild winters (lows of 28 degrees to 23 degrees F/-2 degrees to -5 degrees C) allow gardening through much of the year. Cool and moist maritime influence alternates with hot, dry interior air.
- **ZONE 21. Thermal Belts around Southern California's Ocean-influenced Interior Valleys**
  Growing season: early Mar. to early Dec., with the same tradeoff of oceanic and interior influence as in Zone 20. During the winter rainy season, lows range from 36 degrees to 23 degrees F/2 degrees to -5 degrees C—warmer than in Zone 20, since the colder air drains to the valleys.
- **ZONE 22. Colder-winter Parts of Southern California's Coastal Region**
  Growing season: Mar. to early Dec. Winter lows seldom fall below 28 degrees F/-2 degrees C (records are around 21 degrees F/-6 degrees C), though colder air sinks to this zone from Zone 23. Summers are warm; rain comes in winter. Climate here is largely oceanic.
- **ZONE 23. Thermal Belts of Southern California's Coastal Region**
  Growing season: almost year-round (all but first half of Jan.). Rain comes in winter. Reliable ocean influence keeps summers mild (except when hot Santa Ana winds come from inland), frosts negligible; 23 degrees F/-5 degrees C is the record low.
- **ZONE 24. Marine-dominated Southern California Coast**
  Growing season: all year, but periodic freezes have dramatic effects (record lows are 33 degrees to 20 degrees F/1 degree to -7 degrees C). Climate here is oceanic (but warmer than oceanic Zone 17), with cool summers, mild winters. Subtropical plants thrive.

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