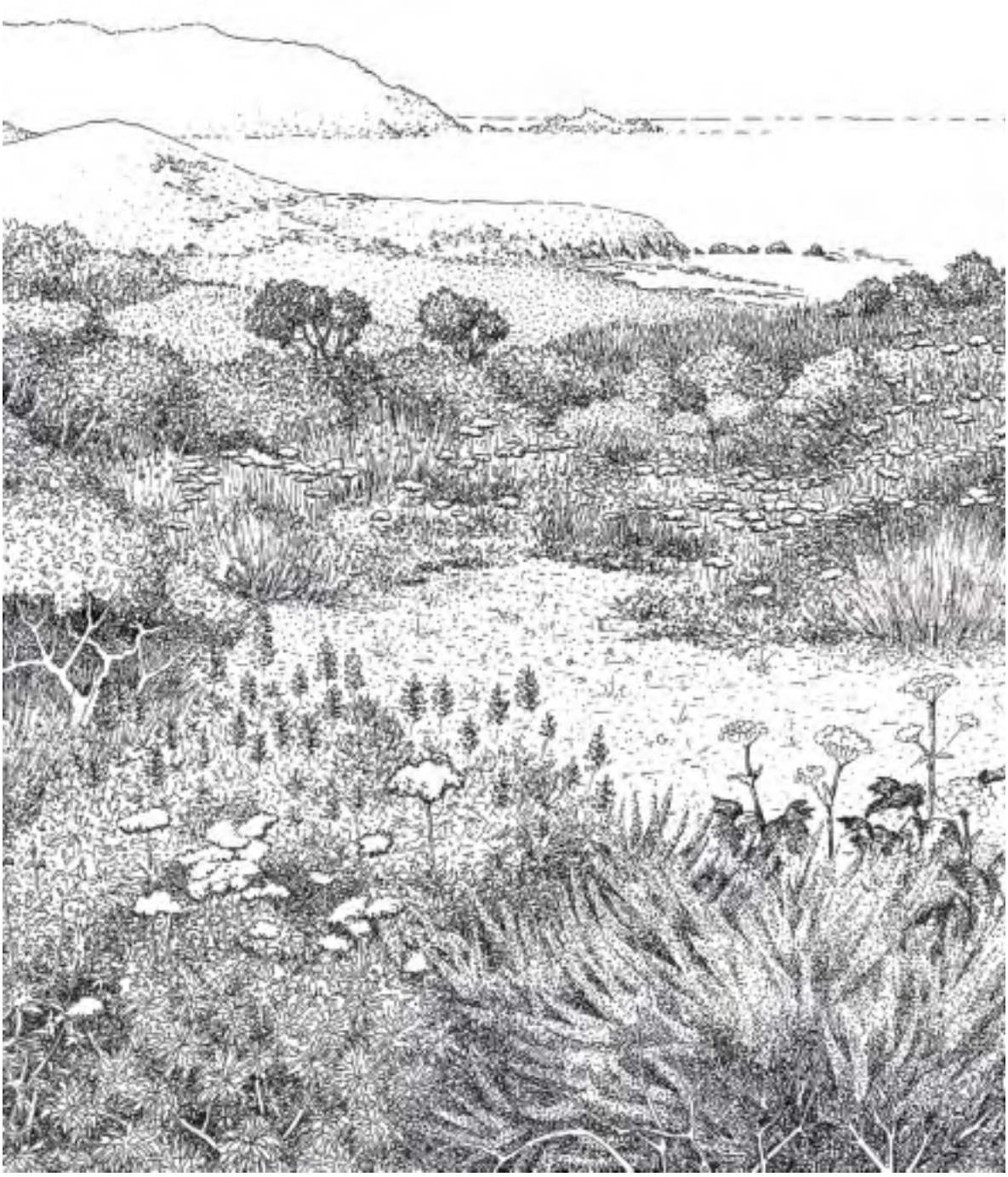
Section 1
Welcome



WELCOME

Thanks for joining us as a nursery intern. The Oceana High School Native Plant Nursery is one of six native plant nurseries in Golden Gate National Recreation Area (GGNRA). The first nurseries were created at Fort Funston and Muir Woods in the late 1980s. Since then, thousands of natives have been **outplanted**, beginning the restoration of habitats throughout the park—from Milagra and Sweeney ridges near Pacifica at the south end of GGNRA to the Olema Valley near Tomales Bay at the north end. Our nurseries at Fort Funston, Presidio, Marin Headlands, Tennessee Valley, Muir Woods, and Oceana now grow about 120,000 plants per year. At Oceana, we hope to grow at least 3,000 plants annually. The other nurseries are on park land and are maintained by park staff. Oceana Nursery is the only one on a school campus, with students responsible for daily maintenance and keeping the plants healthy!

The nurseries have grown many of the species for the park's various plant communities. Dune plants have been a focus at Fort Funston and the Presidio. The coastal scrub community has been reestablished at Milagra and Sweeney Ridges at the south end of the park. At Wolfback Ridge around Waldo Tunnel (also known as the Rainbow Tunnel), north of the Golden Gate Bridge, Mission blue butterfly habitat restoration is an ongoing project. The restoration of Redwood Creek (from the head-waters above Muir Woods to Muir Beach), historic habitat for the threatened coho salmon and steelhead trout, is also in progress. Much has been accomplished, but there is much, much more to do.

As a nursery intern, you have an opportunity not only to **propagate** and grow the plants in the nursery, but also to participate in other parts of the **restoration cycle**, including **outplanting** at Milagra Ridge during the winter. We hope you'll get a chance to experience the entire restoration cycle while you are a student at Oceana High School. We're sure that you will learn a lot about **ecological restoration** and about our **native plants** and **habitats** during your internship. Perhaps your training and experience here will prepare you for future work in the fields of **biology**, **ecology**, or **horticulture**. Please ask questions and be sure to let your mentor know how we can help you learn and improve your skills throughout your internship. We want this to be a job you feel good about!

The Oceana nursery is part of a larger part program called *National Park Labs at Golden Gate* offered at Milagra Ridge in partnership with Oceana High School, and at the Presidio of San Francisco in partnership with the San Francisco Unified School District. High school interns also assist with nursery operations and public programs at the Presidio native plant nursery. *National Park Labs at Golden Gate* also includes field studies, a web site, and special teacher workshops.

National Park Labs at Golden Gate is a program of the National Park Service, National Park Foundation, and Toyota USA Foundation. The program is the first of its kind to provide high school students with experiences that enhance the quality of science and mathematics and foster stewardship of National Park resources. Five national park sites were competitively selected to participate in this exciting endeavor. The other NPL sites are Carlsbad Caverns National Park (NM) and Guadalupe Mountains National Park (TX), Lowell National Historical Park (MA), National Capital Region Parks (DC), and Santa Monica Mountains National Recreation Area (CA).

1.1 MISSION AND GOALS

Mission Statement

The native plant nurseries of GGNRA exist to support the ecological restoration in the park, to build a sense of community **stewardship** for the park, and to teach young people the themes of environmental **sustainability** and restoration by participation in the process in a spirit of quality, joy, and teamwork.

Goals

The GGNRA Native Plant Nursery Program works with other park programs to restore and preserve the native ecology of parklands and to build a strong and vibrant community of park stewards. The nursery program has three goals:

❶ Produce high-quality plants of appropriate native species as called for by park restoration projects.

❷ Create and foster a volunteer program that serves community needs for ecological recreation and builds a constituency around an ethic of ecological restoration and stewardship.

❸ Teach people, especially young people, concepts of community, ecology, and horticulture, utilizing the nurseries as hands-on experiential classrooms.

1.2 GUIDING PRINCIPLES

Parklands have been impacted by human use and need **ecological restoration**. Examples at Milagra Ridge include activities that took place during the military- and agricultural-use years. Land was bulldozed; roads, bunkers, and Nike missile sites were built; and weeds were introduced. As a result, native plants and animals lost important habitat.

■ The purpose of ecological restoration is to restore **biodiversity** and ecological function. Our goal is to restore natural processes that support many native plant and animal species, including those currently listed as rare or endangered. One way we can restore natural processes is by removing **invasive weeds** and planting native plants to recreate critical habitat for native animals.

■ The most effective long-term ap-

proach to restoration is **community stewardship**. The park sets restoration priorities with meaningful community participation before, during, and after the planning process. We involve the community as much as possible in the planning, implementation, and monitoring of revegetation plans. This means we welcome your input in our planning for Milagra Ridge. We hope that you will attend our meetings; make the acquaintance of community members who are involved; and invite your family, neighbors, and friends to join us. Please speak up when you have ideas!

■ Outplanting of native container plants achieves the highest **probability of success**. We are growing plants at the Oceana Native Plant Nursery for Milagra Ridge because revegetation of a disturbed area is more likely to be successful if we plant plants rather than seeds in these areas.

■ Seeds are collected as locally as possible, preferably within the watershed of the project. We grow plants at Oceana Native Plant Nursery from seed collected only at or near Milagra Ridge. The plants are well adapted to the conditions of Milagra Ridge because they have evolved here over many centuries.

■ **Biological and genetic diversity** are critical to the continuation of the **evolutionary process**. To get the greatest diversity or variety in our plant material, we collect seed from many species from all over the ridge and do not grow plants from **cuttings** if we can successfully grow them from seed. When we take cuttings, as we do with strawberries and sometimes **woody shrubs**, we are growing **clones**, plants with the exact same genetic material as the parent plant. On the other hand, seed is usually genetically different from the parent plant, since the flowers were fertilized by pollen from a different plant.

■ Nurseries are ideal centers for teaching the importance of stewardship and ecological concepts. Your role will include running the nursery and also teaching other students what we do, why we do it, and how this work is part of the stewardship of Milagra Ridge.

■ All volunteers, staff, and students are to be treated with respect and dignity. Please help us to be sure that nursery workdays and other activities feel respectful to you and other students, staff, and volunteers.

■ People from all communities have an opportunity to contribute. The direction and operation of the nursery program evolve in a spirit of teamwork. We want your input. Bring your friends, family, and neighbors to workdays. Let us know how we can improve the program for you, other participants, the nursery, and the restoration of the ridge!

1.3 THE CREATION OF GOLDEN GATE NATIONAL RECREATION AREA

Milagra Ridge, The Presidio of San Francisco, Marin Headlands, Tennessee Valley, Fort Funston, and Muir Woods are part of one park, Golden Gate National Recreation Area (GGNRA), one of over 378 areas within the **National Park System** of the United States, Department of the

Interior. The areas within the National Park System cover more than 83 million acres in 49 states, the District of Columbia, American Samoa, Guam, Puerto Rico, Saipan, and the Virgin Islands. Each site has certain ideas or themes that distinguish it. They are of such national significance as to justify special recognition and protection in accordance with various acts of Congress. California has 23 national park sites,more than any other state. The National Park Service is responsible for protecting all these sites.

The concept of a national recreation area that officially linked together the green and open spaces of the Bay Area was proposed in 1971 by both of San Francisco's congressmen, William S. Maillard and Phillip Burton. However, these lands have a history that reaches far beyond their relatively recent addition to the National Park System.

The lands within and beyond this park have been used for many thousands of years by **indigenous peoples**, most notably the Coast Miwok and Ohlone, who have inhabited the northern California coast for as long as 10,000 to 15,000 years. Imagine the richness and depth of their knowledge of the plants and animals of the area. **Preservation** of the immeasurably rich cultural history of the indigenous people in what are today parklands is one of GGNRA's primary missions.

When the Coast Miwok and Ohlone first arrived, the sea level was far below where it is today. The coastline may have been as far out as today's Farallon Islands. The inland areas (the area now within the boundaries of GGNRA and Point Reyes National Seashore) may have had great redwood stands. Geologically, the coastal area is extremely active. Changes in coastal topography occur each year as the ocean erodes the coastal bluffs and cliffs, and earthquakes and winter storms shift and pound the unstable **bedrock**.

The Coast Miwok are the people Sir Francis Drake would have encountered in 1579, when Europeans set foot on this coast for the first time. Drake was on the run with a pirated shipload of twenty-six tons of silver and sought safety in or near the bay, somewhere in what is now Marin County. Two hundred years later, the Spanish had pushed the limits of their New World empire as far north as the San Francisco Bay.

Mexico, including Alta (or northern) California, gained independence from Spain in 1822. The outposts of San Francisco and Sonoma had very little contact with Mexico City and were very lightly fortified. With the Bear Flag Revolt in 1846, John C. Fremont captured the San Francisco Bay Area for the United States. The new owners wanted no such military vulnerability, and in 1850, U. S. President Millard Fillmore signed an executive order setting aside "for public purposes" land on both sides of the Golden Gate—what are now the Presidio and Fort Mason in the south and the Marin Headlands to the north. Some of the land, particularly on the northern side, was privately owned. For instance, much of the Headlands was used for dairy farms owned for several generations by Portuguese families.

Beginning in 1890, American military installations around the Golden Gate were strengthened. These improvements continued throughout until the end of the Spanish-American War (1898), but growth slowed during the era of World War I (which ended in 1918). In 1935, San Francisco's forts again came to prominence with threats of a possible invasion from Japan. New batteries were built and old ones upgraded; they stood guard through World War II (which ended in 1945). The Cold War brought Nike antiaircraft missiles and radar towers, remnants of which are still visible throughout

the park. Many of these lands eventually became surplus to the military's needs.

President Truman's 1945 offer of the Presidio as a potential United Nations headquarters planted the idea that these military lands were expendable. The City of San Francisco pushed to develop the Presidio for housing, but this effort was successfully resisted. In the 1960s, the government began selling off pieces of property. The Marin Headlands, site of a proposed new town called Marincello, was saved by internal disagreement and a legal hold-up that eventually halted the project after public outcry and the efforts of conservationists were ignored by Congress.

By the early 1970s, the concept of a **greenbelt** stretching from the South Bay north to Point Reyes had emerged, and Maillard and Burton vigorously pushed the legislation that created GGNRA through Congress. The political climate of the day allowed an increase in the federal budget, especially for the National Park System. President Richard Nixon visited the Bay Area in 1972 to see first-hand the grand vision of the new urban National Park. He signed a bill later that year authorizing funds for GGNRA.

The lands comprising the park were gradually acquired from a number of sources, beginning with former military bases (Forts Cronkhite, Baker, Mason, Funston, and Miley, and in 1994, the Presidio of San Francisco). Alcatraz, a tiny island in the middle of the bay and home of the infamous federal penitentiary between 1934 and 1963, had been closed by Attorney General Robert Kennedy and was considered excess to the needs of the Department of Justice when it was incorporated into GGNRA. The City of San Francisco decided that some of its beach and park properties were too costly to operate and gave them to the National Park Service (Aquatic Park, Lands End, Ocean Beach, and Sutro Heights Park). One of the most recent acquisitions is the Phleger Estate in Woodside. Today, the total number of acres within the authorized boundaries of the park is approximately 76,000, distributed among San Francisco, Marin, and San Mateo counties. It is the world's largest urban national park.

1.4 INTRODUCTION TO MILAGRA RIDGE

Natural History

Milagra Ridge includes a relatively flat ridge top, two hills on the southeast and northwest sides of the ridge with peak elevations of 710 and 672 feet respectively, and steep slopes draining into Milagra Creek on the northeast and into an unnamed drainage basin on the southwest. There is also a settling pond in the eastern portion of the ridge that was created by the military for sewage treatment. The **settling pond** has since developed into an important wetland habitat for many species, including the endangered red-legged frog.

Coastal scrub and **coastal prairie** are the major plant communities found on the windy, often-foggy, exposed slopes of Milagra Ridge. Coastal scrub dominates the slopes, and **assemblages** of mixed scrub and prairie (grassland) species occupy the ridge top. Common indigenous species on Milagra Ridge include coyote bush, bush monkey flower, California sagebrush, California poppy, coffee berry, California blackberry, several species of strawberry, toyon (Christmas berry), twinberry, elderberry, Indian paintbrush, Phacelia, gumplant, and several native

grasses. Silver leaf lupine (*Lupinus albifrons*) is a small and uncommon plant that supports a population of the federally listed endangered Mission blue butterfly (*Plebejus icarioides missionensis*). Sedum, a succulent plant found in rocky outcroppings, supports the federally listed endangered San Bruno elfin butterfly (*Callophrys mossii bayensis*).

Indigenous animals found on Milagra Ridge include the gray fox, bobcat, skunk, raccoon, gopher, mice and vole, black tailed deer, coyote, garter snake (possibly including the rare San Francisco garter snake), gopher snake, and Western fence lizard. Many types of birds, including American kestrels, red-tailed hawks, scrub jays, hummingbirds, and ravens can be seen here. (For a detailed description of the endangered animal species of Milagra Ridge, see page 80.)

Human History

Native Ohlone people inhabited the land we now call Milagra Ridge and Pacifica for thousands of years. Their lives probably included seasonal harvesting of seed, greens, and fruits and hunting for local animals. In the late 1700s, the Spanish mission of San Francisco de Asis established farms in the area, and the hills of Pacifica became part of Rancho San Pedro. Livestock grazing began an agricultural era that lasted until the mid-1900s. Artichokes were grown atop Milagra Ridge until 1938, and the furrows can still be seen today.

In the late 1930s, the U.S. Army acquired Milagra Ridge as part of a project to defend the San Francisco Bay. Several batteries were proposed but never built. In 1948, 6-inch guns were mounted at Milagra Ridge, only to be removed between 1949 and 1950.

In 1956, Nike Missile Site SF-51 was established at Milagra Ridge. The Nikes were surface-to-air missiles used during the Cold War era to defend against attacking aircraft. The original Nike-Ajax system used conventional explosives and had a twenty-five-mile range.

In 1958, the site was converted to the nuclear-capable Nike-Hercules system, whose missiles had a ninety-mile range. The site included the missile launch site with elevators, a helipad, and bleachers for visitors to view the elevation of missiles to firing position. Guard dogs were kenneled and trained, troops were housed, and administrative offices were operative in the area now known as Spyglass Ridge. For this military site, much of Milagra Ridge was flattened and paved. The entire area was fenced with barbed wire and patrolled by guards with dogs.

In 1963, the U.S. Army turned the area over to the National Guard, and in 1974, use of the site was discontinued. The buildings were demolished, launcher pits buried, and asphalt removed. The National Guard gave the land, then valued at $180,000, to the City of Pacifica as an open space park. Local people began to use the park for walking, hunting, and running their dogs.

In 1987, GGNRA acquired Milagra Ridge and began to work with the community to restore the land while retaining its recreational value.

1.5 PARTNERSHIP BETWEEN OCEANA HIGH SCHOOL AND GGNRA

Milagra Ridge, a 240-acre parcel of land located directly above Oceana High School, became part of the GGNRA in 1987. Noting that the area was home to rare and endangered species, including

the Mission blue butterfly, the National Park Service focused its efforts on the ecological restoration of the ridge. Several large-scale projects to remove invasive pampas grass that had formed a **monoculture** over much of Milagra Ridge were initiated.

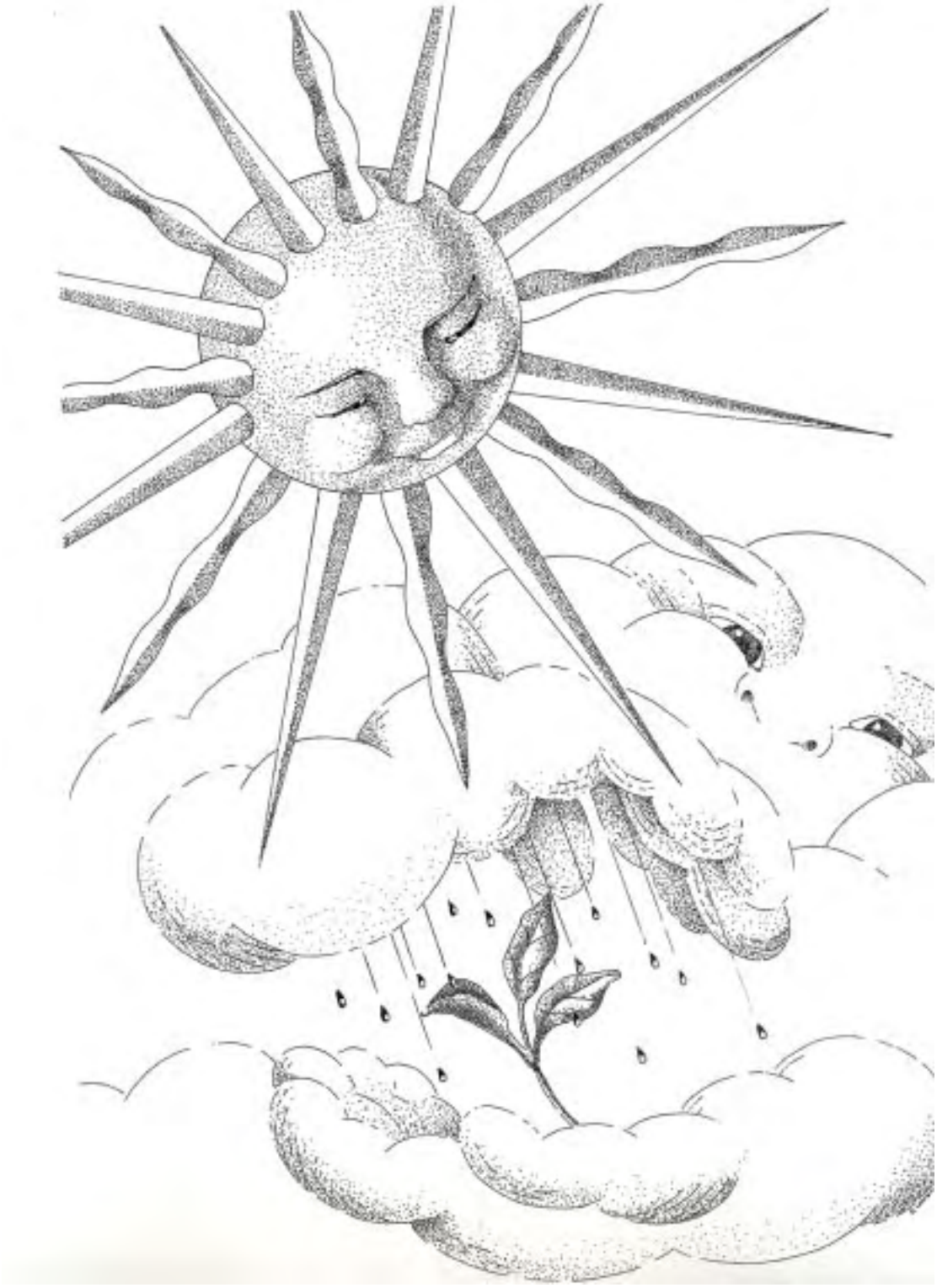
In 1993, Milagra Ridge became one of the restoration sites overseen by the Site Stewardship Program (SSP), which is dedicated to working with communities to restore high-priority, ecologically sensitive sites within GGNRA. After several years of working with the Pacifica and ridge communities and Sharp Park Elementary School, dialog developed between Oceana High School and GGNRA, and a plan emerged.

Early in 1996, a series of meetings between the park and the school resulted in a plan for the involvement of students and teachers in the restoration of Milagra Ridge. Objectives included the reconstruction of the native plant nursery on the school campus, the formation of an environmental studies class to learn about ecological concepts as part of the science curriculum, the formation of a diverse core group of students committed to stewardship of Milagra Ridge, and the creation of a convenient way for students to earn community service hours needed for graduation.

In 1997, the program began with a new environmental studies class (taught by Rachel Kalish) and the reconstruction of the nursery. Students, school, and park staff worked side-by-side to construct the greenhouses and a shade house. Paid high school student internships began in 1998, when the project received a grant from the Toyota USA Foundation to create the National Park Labs program at five national parks across the country. Like their peers at Carlsbad Caverns National Park (NM) and Guadalupe Mountains National Park (TX), Lowell National Historical Park (MA), National Capital Region Parks (DC), and Santa Monica Mountains National Recreation Area (CA), Oceana students began to participate in the restoration and planning for national park sites. At Milagra Ridge, they worked in the nursery and participated in all phases of the restoration cycle. Students became involved in plant propagation, nursery maintenance, planting native species on the ridge, weeding, monitoring, and seed collection.

In the beginning, student interns worked with student volunteers to build and improve the nursery facilities. The GGNRA and Site Stewardship staff and interns planned weekly nursery workdays and monthly classroom activities. Now, new interns are hired every six months. We hope that student volunteers will continue to become interns and that many students will attend restoration workdays, both to earn community service hours and because they want to participate in the stewardship of the land.

Section 2
Restoration



RESTORATION

2.1 THE RESTORATION CYCLE

Our goal, **restoration** of Milagra Ridge, will be achieved by supporting the ridge's indigenous plants, animals, and processes. Restoration follows a seasonal cycle; to restore an area, we work with nature to support the natural systems.

We plant native plants for several reasons: to repair eroded or trampled/disturbed areas; to restore areas where weeds have been removed, leaving bare ground; and to support endangered species by increasing their host plant populations, see page 91.

In **winter**, when the rains have soaked the soil, we outplant the native plants we have grown in the nurseries. These plants need to establish their roots before the soil dries out. Generally the best months for planting on Milagra Ridge are December through February. If the winter is dry, we supplement nature's rain as much as possible by hand-watering so the plants can survive this initial period. We hope that by the end of winter, the plants will have well-established roots that will enable them to survive the dry summer months.

In **spring**, new plants - including weeds - are sprouting. We **remove the invasive weeds** before they drop their seed, which typically begins in late spring and continues through summer. We prioritize, first removing the fastest-spreading weeds, those that may threaten endangered species habitat or large areas of the ridge.

Invasive exotic plants is one of the greatest current threats to Milagra Ridge. These plants, originally brought here by people or animals, have spread out of control. They often grow over native plants or bare ground, reducing or eliminating other species' chances of survival. We perform weed removal throughout the year, especially at times when the weeds are about to set seed.

Another spring activity is **monitoring**. We do several types of monitoring. For endangered species monitoring, we take a systematic approach, looking at specific endangered species to see if their populations are increasing or decreasing. The Mission blue butterfly, San Bruno elfin butterfly, and red-legged frog are all active in the spring, which makes the season an important time to look for them. We use **transects** to search the same spots year after year. Using transects is a

Figure 2.1 Restoration Cycle

sampling technique that enables us to quantify population trends.

We **monitor our plantings** to see what percentage of the plants we put in the ground survive. Additionally, we have **photomonitoring** points, places to which we return each year and photograph. With the photos, we can record the restoration of natural habitats or the expansion of weeds in a given location over time. Monitoring is one way we track changes over time; it also helps us understand the natural systems and the impact we are having at Milagra Ridge.

Spring is also the beginning of **mapping** season. In order to plan our restoration work throughout the year, we need accurate maps for each weed species. Since species spread throughout the year, or decrease if we remove them, the maps are updated annually.

In spring, with the wildflowers blooming, we share the ridge in all its glory with the public. **Wildflower walks** are a relaxing way to provide an opportunity for people to see and appreciate the natural beauty we are working with and trying to protect.

Late spring and summer are the beginning of **seed collection**, an activity that lasts into fall. Remember your botany? As flowers are pollinated, they form seed in their ovaries. Each species has a different time of flowering and seed ripening, and restoration interns follow the plant cycles to collect seed for each species we grow. We only collect up to 5 percent of the seed per plant or per population, leaving most of it to **germinate** naturally where it lands.

Once we have collected seed, we **propagate** it in the nurseries. As each species has its own timing, the period when it grows best, we start to **sow seed** in May or June and continue throughout the summer, following each species' cycle. In the nurseries, we **keep good propagation records**; they are the basis for our understanding of individual plants and systems. We learn the best way to grow plants by trying different timing and methods and noting successes and failures. The information we get by analyzing our work is important because this information

isn't readily available otherwise. Our experiences and information are shared to help others learn how to successfully grow indigenous plants.

Summary of the Restoration Cycle

- **Winter** is a time of intense outplanting. For example, in the winter of 1999-2000, we put more than 10,000 native plants in the ground at Milagra Ridge.

- **Spring** is wildflower season and a time of monitoring, the beginning of seed collection, and propagation.

- **Summer** is a continuation of seed sowing and collection, mapping, and monitoring.

- **Fall** is a time of major seed collection effort and making sure that nursery plants stay alive until we can outplant them.

Throughout the year, we plan our restoration efforts and remove invasive weeds.

2.2 OCEANA NATIVE PLANT NURSERY CALENDAR

January

Outplanting season - keep the plants alive in the nursery until they go into the ground. There is not much sun, so don't overwater.

Nursery Activities for Interns

- Pot washing.
- Inventory plants frequently, report counts to SSP staff for planning outplanting workdays.
- Daily crop monitoring and walk-throughs.
- Inventory supplies; make sure there's enough bleach, brushes, tools, rubber gloves, and basins (wheelbarrows, etc.) for pot washing. Purchase supplies if needed.
- Weed front and back circles and the demonstration (demo) garden.

Group Workday Activities

- Pot washing.
- Outplant on the ridge.
- Plant into parking lot circles.
- Weed front and back circles and the demo garden.

February

Outplanting season - Plants are usually still going in the ground at Milagra Ridge. Meanwhile, keep them healthy in the nursery.

Nursery Activities for Interns

- Continue daily walk-throughs; consolidate dead or dying plants. Keep an eye out for bugs and disease on the plants and their roots. Water only when soil is dry (see watering instruction cards).
- Coordinate pot-washing parties with students from class.
- Manage compost pile, adding the dirt from the plants that have been consolidated.
- Inventory plants weekly for outplanting planning.
- If you have time, weed front and back circles and demo garden.

Group Workday Activities

- Consolidate plants. Compost dead/dying plants (do not use the compost for next year's crop-it might have weeds or disease).
- Outplant on the ridge.
- Winter rains bring a lot of weeds in and around the nursery-pull out weeds underneath benches, in the greenhouse, or coming up through the mulch.

■ Start cleaning out the nursery for the next growing season. Empty benches, tables, and pallets need to be hosed off and scrubbed down with a bleach solution. (Get a scrub brush from the pot-washing kit, add 1 tablespoon of bleach per gallon of water-do not use more than 1 percent bleach). Wear old clothes, safety glasses, and rubber gloves! This could take two to three students the better part of an afternoon.

■ Pot washing: Two groups of three to five students is the maximum number of people who can do this activity at a time.

■ Keep up with weeding the front and back circles and the demo garden.

March

Outplanting season should be over by now and the nursery should be empty of plants. Most of this month's work is maintenance and pot washing.

Nursery Activities for Interns

■ Be sure February activities are completed.

■ Coordinate pot washing with the environmental science class.

■ Pick up any trash around the site.

■ Pull any weeds that have come up through the mulch or gravel in and around the nursery and greenhouses.

■ Continue nursery checks and inventories for any remaining plants.

■ Complete a thorough inventory of nursery materials by the end of the month.

■ Make sure there are enough soil and pots on hand (or on order) for the coming season. If there aren't enough pots of the right sizes, you can swap with the Presidio or Fort Funston nurseries or order from park suppliers.

■ Assist with publicity for upcoming Milagra Ridge activities by posting flyers in Pacifica and at school.

■ Weed front and back circles and demo garden.

Group Workday Activities

■ Wash and sterilize pots (see instruction card).

■ Continue outplanting if needed, or begin weeding on Milagra Ridge.

■ If appropriate, start seed collection of early-flowering herbs at Milagra Ridge.

■ Weed front and back circles and demo garden.

April

Springtime - get ready to plant in the nursery! April is about making sure all the pots are clean and sterile and the irrigation system is set up and functioning. Compost pile can be given away to students and parents.

Nursery Activities for Interns

■ Inventory seeds at Fort Funston and Headlands native plant nurseries for Oceana plants and determine when to start propagation.

■ If appropriate, assist SSP intern with seed collection on Milagra Ridge.

■ Attend SSP wildflower walk and workdays on Milagra Ridge.

■ Assist with publicity for Milagra activities by posting flyers in Pacifica and at school.

■ Weed front and back circles and demo garden.

Group Workday Activities

■ Finish pot washing and sterilizing.

■ Assemble racks of pots (whack them into collars with a board or piece of PVC pipe - this takes longer than you think). A group of eight to ten students could do this each week. Keep the pots and racks off the ground - they can be contaminated by fungus spores!

■ Wildflower walk! Classes go out with the SSP Intern at Milagra Ridge.

■ Weed and possibly collect seed on Milagra Ridge.

■ Weed front and back circles and demo garden.

May

Springtime! Time to start planting.

Nursery Activities for Interns

- Get species list and Oceana propagation goals for this growing season from SSP. This is printed out from the nursery database, file name: Reports/Nursery Reports/Propagation Requirements by Nursery/Oceana.
- Discuss plans/attend training with Nursery Specialist and SSP Restoration Coordinator for beginning propagation.
- Pick up PHCA (*Phacelia californica*) and ERLA (*Eriogonum latifolium*, Coast buckwheat) seeds from Fort Funston or Headlands nurseries.
- Coordinate work groups from science classes.
- When propagating, **make sure the propagation and transplanting records** (in the white binder located in the shed) **are filled out and given to SSP intern** to enter in nursery database.
- Make sure each rack has two tags; if one falls out, we'll still know what's in the rack. Use pencil to write on tags, as ink washes/fades off and becomes illegible.
- Start regular walk-throughs of the nursery.
- Make sure trash is picked up around the nursery.
- Assist with promotion of summer nursery workdays and Milagra workdays by posting flyers at school and in Pacifica. Spread the word!
- Water front and back circles and demo garden several times each week, or implement a drip watering system.

Group Workday Activities

- Assemble racks of pots (see April for instructions).
- Sow PHCA; **see species propagation cards** and plan appropriate numbers for each month.
- Sow ERLA (see above). These activities need to be well coordinated, and work best with small groups of three to five students. If pots are already cleaned, sterilized, and assembled, it should take two to three afternoons to finish sowing all these seeds.
- If appropriate, sow other species.

June

Keep on sowing! Plant, plant, plant! It's the end of the school year and we will need extra help when most of the students leave the program for summer—bring your friends, spread the word.

Nursery Activities for Interns

- Fill out planting/propagation records.
- Continue regular crop monitoring, report any diseases/pests to SSP intern ASAP.
- If appropriate, help SSP staff collect seeds at Milagra Ridge.
- Assist with promotion of summer nursery workdays and ridge workdays by posting flyers at school and in Pacifica. Spread the word!
- Water and monitor irrigation, greenhouse plants, etc. Adjust venting as needed.
- Inventory soil supplies and purchase as needed from Sloat Garden Supply.
- Weed if time permits.

Group Workday Activities

- Pull extra seedlings in the pots of PHCA and ERLA that were sowed last month; leave one shoot per pot (choose randomly—don't just leave the biggest one).
- Three to four weeks after sowing PHCA and ERLA, consolidate pots and re-sow any pots in which seed hasn't germinated. Retag the newly seeded pots.
- Move plants into shade house once well-established in greenhouse.
- Sow ACMI (*Achillea millefolia, yarrow*), BRCA (*Bromus carinatus*, California brome grass), and FERU (*Festuca rubra*, red fescue). See species propagation cards and

propagation goals for numbers.

- Mix potting soil and store in yellow bins.

July

Summer is here! Keep an eye on irrigation and temperatures to be sure the greenhouse stays warm but not hot. Adjust irrigation timer as needed. If temperatures go above 95 degrees, open door/vents more widely and call SSP staff.

Nursery Activities for Interns (and Small Groups)

- Four weeks after sowing all the seeds, re-sow any pots in which seed has not germinated. Keep up with pulling out extra seedlings in the pots. Avoid competition—leave one shoot per pot (choose randomly, don't just leave the biggest one).
- Move plants into shade house once well-established in greenhouse.
- Continue daily walk-through of greenhouse and shade areas. Pay special attention to the watering regime and report any diseases or insects you observe.
- Sow remaining seed as soon as it comes in.
- If appropriate, help SSP staff collect seeds.
- Attend SSP Milagra Ridge workdays and planning meetings.
- Water and weed front and back circles and demo garden.

August

Nursery Activities for Interns (and Small Groups)

- Continue July activities.
- Consolidate any dead/dying plants, inventory, and keep records.
- Prune plants if necessary (see instruction card).
- Fertilize PHCA and ERLA with Nutricote three months after sowing (see instruction card).
- Take strawberry cuttings: see instructions on page 58.

September

A new school year! SSP intern gives a thorough tour of the nursery and Milagra Ridge to nursery volunteers and participating science classes.

Nursery Activities for Interns

- Crop monitoring is a must! Pay close attention to the watering regime and report any diseases or pests on the plants.
- Move plants into shade house once well-established in greenhouse.
- Prune plants that have gotten too big for their pots (see instruction card).
- Fertilize BRCA, FERU, and ACMI and any other species with Nutricote after three months of growth (see instruction card).
- Coordinate group activities with the science classes and SSP.
- Assist with seed collection on Milagra Ridge.
- Water and weed front and back circles and demo garden.

Group Workday Activities

- Site Walk—explore Milagra Ridge, take a tour of the native plant nursery.
- Consolidate plants that have died, reinventory plants.
- Wash any pots that have accumulated from consolidation or from accidentally being dropped on the ground.
- Coordinate group activities with the science classes and SSP.
- Transplant strawberry cuttings from flats to 4-inch pots, using Sloat mix with perlite.
- Weed Milagra Ridge.

October

The days are getting shorter and growing season is coming to a close.

Nursery Activities for Interns

- Continue daily monitoring and nurs-

ery walk-through, move any diseased plants away from healthy plants as soon as you notice a problem.

- Monitor water content of soil, change watering regime (schedule) if necessary due to varying weather conditions.
- Weed around greenhouse, under benches, in shade area.
- Prune any plants that have grown too big for their pots (see instruction card).
- Fertilize (very lightly) any plants that were sown three months ago and have not been top-dressed with Nutricote (see instruction card). At this time of year, we just want to keep the plants healthy, not encourage new growth.
- Weed the front and back circles and demo garden.

Group Workday Activities

- Prune, weed, pick up trash, or consolidate plants. No urgent activities requiring big groups take place this month.

November

Winter is coming and the plants have probably stopped growing. The crop is "hardening off," or getting used to the more severe weather and shorter days.

Nursery Activities for Interns

- Plants that will be outplanted this year are in the home stretch. Keep them alive until January! Continue daily walk-throughs, pay attention to watering regime. Make sure plants aren't too wet. Watch for snails and slugs, diseases and pests.
- Prune, if necessary, keeping in mind that plants are basically finished growing for the year (see instruction card).
- Create and post flyers to recruit volunteers for December's outplanting season at Milagra Ridge.
- Pick up trash around the site.
- Weed front and back circles, demo garden, and in/around nursery.

Group Workday Activities

- Weed Milagra Ridge.
- Take inventory in nursery and do any necessary upkeep.
- Weed front and back circles, demo garden, and nursery area.

December

Outplanting season will start if the rains have begun. There should be about 3,000 plants in the Oceana Native Plant Nursery now.

Nursery Activities for Interns

- Continue daily walk-through and crop monitoring, checking closely for diseases and pests and proper watering regime.
- Consolidate and inventory plants available for outplanting.
- Evaluate each crop (species). On the back of the Species Information Sheet for each species, write how the crop grew during the season and what you would do differently next year.
- Assist in getting appropriate plants up to Milagra for work days.
- Pot washing begins again.

Group Workday Activities

- Start washing and sterilizing those pots (see instruction card).
- Outplant your beautiful crop of plants!

2.3 INVASIVE EXOTICS

Much of the restoration work we perform in the park is required because of the destruction of the indigenous plants by invasive exotics that have come into our habitats in many ways. Most have come from our own yards. Many are popular **landscape plants** that thrive because they came from Australia, South Africa, the Mediterranean, or other places with

climatic conditions similar to those of the Bay Area. They arrive without their natural enemies, the fungal spores, bugs, or slugs that keep them in check.

The indigenous plants cannot compete with the invasive plants because the natives have natural enemies and have adapted to the area in balance with the rest of the species. When exotic invasive plants are **introduced**, native habitats are often completely destroyed. The mammals, insects, reptiles, amphibians, birds, and fungi that are dependent on the native plant community lose their home. Studies in the park and elsewhere show a significant drop in number of animal species in most exotic plant areas. The first step in most of our projects, therefore, is the removal of invasive exotic plants. (You can help with this essential step in the re-establishment of vibrant indigenous habitats by removing invasive plants at SSP workdays on Milagra Ridge, or with Oceana Native Plant Nursery groups doing weed removal on the ridge.)

Each species grows and spreads differently, and we use different tools and methods to remove each one. When you participate in removal projects, you may use picks, weed wrenches, saws, pulaskis, and other tools that help you get the roots out. Some species, such as Cape ivy and iceplant, must not be left in contact with bare ground or they will resprout. We leave the waste piles on tarps, or on concrete where possible. For most species, we make every effort to remove the plants before they drop seed for the next generation. With species such as pampas grass, we try to get the **seed plumes** out even if we don't have time to remove the whole plant. Removing weeds is easiest when the ground is soft and moist. However, if it's too muddy, removing weeds can be more difficult because mud sticks to the plant roots, shoes, and tools.

The Most Invasive Plants at Milagra Ridge

Even if you don't participate in removal, you can help by not planting any of the following plants in your yard.

- ☐ Bellardia (*Bellardia trixago*): A bit like a small Indian paintbrush with tiny white-pink flowers; grows in big patches (native to the Mediterranean).
- ☐ Cape ivy (*Delairea odorata*): Bright green vine with small yellow flowers, grows all over indigenous plants (native to Cape of South Africa).
- ☐ Cotoneaster (*Cotoneaster* sp.): Woody shrub, red berries in fall (native to China).
- ☐ Eucalyptus (*Eucalyptus globulus*): Tree with peeling bark and strong smell (native to Australia and Tasmania).
- ☐ Fennel (*Foeniculum vulgare*): Lacy leaves like a fern; strong, sweet smell; tall stalk with tiny yellow flowers, grayish seed head (native to the Mediterranean).
- ☐ French broom (*Genista monspessulana*): Upright shrub with bright yellow flowers and hairy leaves (native to the Mediterranean).
- ☐ Iceplant (*Mesembryanthemum* sp.): Succulent vine with bright yellow or pink flowers, spreads along coastal dunes and hillsides (native to South Africa).
- ☐ Monterey cypress (*Cupressus macrocarpa*): Common cypress tree, strong smell (native to Monterey, California).
- ☐ Monterey pine (*Pinus radiata*): Common pine, needles in bundles of three (native to Monterey, California).
- ☐ Mustard (*Brassica* sp.): Abundant weedy plant with small yellow flowers in spring (native to Europe).
- ☐ Napa thistle (*Centaurea melitensis*): Resembles yellow star thistle, with spiny flowers that appear purple and then yellow; grows in patches (native to the Mediterranean).

☐ Ox-eye daisy (*Leucanthenum vulgare*): White daisy on a stalk about 1 foot high, often growing in clumps (native to Europe and Asia).

☐ Pampas grass (*Cortaderia jubata*): Huge bunch grass with tall plumes of seeds and sharp-edged leaves (native to Peruvian Andes).

☐ Poison hemlock (*Conium maculatum*): Tall with green lacy leaves and stem speckled with red/maroon; tiny white flowers in flower heads—it resembles fennel (native to Europe).

☐ Radish (*Raphanus sativus*): Abundant weedy plant with small white/lavender flowers (native to China).

☐ Scotch broom (*Cytisus scoparius*): Similar to French broom but broader plant; leaves are often smaller, less hairy, and brighter green, stem more angular, and flowers even brighter gold (native to the Mediterranean).

☐ Tea Tree (*Melaleuca alternifolia*): Woody shrub planted above the bunkers (native to Australia).

☐ Tower of Jewels (*Echium wildpretti*): Tall spike of purple flowers in spring, often seen on coastal hillsides (native to Canary Islands).

Section 3
Getting Ready

GETTING READY

3.1 GROWING NATIVE PLANTS IN THE NURSERY: AN OVERVIEW

This section provides an overview of the main steps involved in growing native plants at Oceana Native Plant Nursery. In the sections that follow, instructions will be given to help you accomplish each step with ease and confidence.

- Start with (and maintain) a clean nursery.
- Collect seed or take cuttings at Milagra Ridge.
- Prepare potting mix and pots and/or flats.
- Process seed or cuttings:
  - Seed is usually dried, stored, accessioned (notes recorded on all seed gathered, entered in the data base), and sometimes treated in a variety of special ways so it will be ready for germination when it is sown.
  - Cuttings must be kept moist, trimmed, and cleaned, and then put into flats.
- Sow the seed (usually in pots) or place cuttings in flats with proper mix.
- Label racks/flats, water plants, place in greenhouse, record data in Propagation and Transplant Records.
- Keep the plants healthy with frequent misting and daily nursery checks for pests, disease, or watering problems.
- Thin out plants to one per pot where necessary.
- Transplant where necessary.
- Consolidate and re-sow empty pots or pots without live plants.
- When they no longer need frequent misting, transfer plants into shade house.
- Continue to check and water plants daily, usually in the morning.
- Prune plants as needed.
- Fertilize plants as needed (three months after initial sowing).
- Continue daily checks to spot and treat any pest, disease, nutrition, or watering problems.
- Consolidate when plants die.
- Outplant beginning in December!

3.2 NURSERY HYGIENE: TEN TIPS TO REMEMBER

Cleaning up: You just can't get away from it. At the nursery, as at home, we have to clean up after ourselves. We try to keep the seed and potting areas as clean as our home kitchens for the same reason: to prevent infection. Here, we are keeping our plants healthy rather than our families. Fungal spores, bacteria, or insect eggs can be hiding in the soil on the ground, on the bench, or in that used pot. We reuse our pots planting after planting, but in between, we wash and sterilize pots and flats. This is an important secret to success in growing California natives. They are very susceptible to fungal diseases carried in warm moist soils because they have evolved here in California, where soil is moist in the cold months of the year and dry during the warm months. We have to water the pots in the summer, and we reduce chance of infection by keeping the pots and working areas clean. It's not just aesthetics when we ask you to sweep up or wash pots. It's an essential step in raising healthy plants for your park.

Many problems can be prevented with good **sanitation** practices. It's much more efficient and safe to prevent problems with your plants than to use chemicals trying to save plants once they've become diseased or damaged by fungus or other pests.

Here are ten tips for plant protection through good hygiene.

1 When you walk on the ground, you pick up fungal spores and bacteria on your shoes. Do not put your feet in the potting mix or piles of amendments, sand, redwood compost, etc., or you will transfer these "germs" into the potting mix.

2 Never let the hose nozzle touch the ground. Always hang it over the hose bib when finished watering. The nozzle can pick up spores from the ground and then you'll water them in to the plants.

3 Keep racks of plants, particularly seed and cutting flats, off the ground and off unsterilized tables and benches.

4 If a shovel or other tool has been used in field soil, sterilize before using in the potting mix pile.

5 Rinse empty benches with a high-pressure hose and a bleach solution to clean off spores, insect eggs, snails, and soil.

6 Once a year, after planting season when the nursery is basically empty, high-pressure spray the tops and undersides of the benches. Bugs and snails hide there, just waiting until you leave to party. Pick up all pallets and hose soil off. High-pressure hose the pallets.

7 Keep greenhouses and underside of benches free of weeds. Bugs and diseases hide in them, and weed seeds spread.

8 Put snail barrier pans or copper strips on benches to deter slugs and snails. They love those baby plants—lupines are snail ice cream.

9 If using a wheelbarrow, 5-gallon bucket, or soil pan for wetting soil mix or mixing cutting media, wash container and mixing tool in bleach solution first (use about 1 teaspoon of bleach per 1 gallon of water).

10 Handle the plants as you would handle food for your family, including **no smoking**.

3.3 SEED COLLECTION GUIDELINES

As a general rule, we collect seed from the watershed in which the new plants will be placed. Seed from plants adapted to a particular site is more likely to produce new plants that will also be successful in that site. Also, we don't want to pollute the population with outside genes that may have an adverse effect on the habitat. Just as exotic plants can be detrimental to a habitat, non-local indigenous plant genes could also cause problems.

In revegetation, we seek to create a self-sustaining habitat. In order for plants to successfully reproduce and continue to evolve as site conditions change, there must be sufficient genetic diversity within each species in the plant population at the site. Therefore, we strive for a balance of locally adapted plants, with as much genetic diversity as possible within those plants.

The rules that follow are designed to help us achieve these goals.

■ Seed may be collected only for an approved project. Please verify with the project manager that the project review or restoration action plan has been approved.

■ Each project manager or nursery manager must keep records of where seed has been collected, so that too much seed is not taken from an individual area.

■ Over the course of the collecting season, take no more than 5 percent of available seed from any species within an area (unless this is a site that will be completely destroyed due to development). This leaves sufficient seed for natural regeneration in the collection area and avoids reduction in the gene pool.

■ Seed should be collected from the watershed or site in which the project will be planted. If there is insufficient seed source in that watershed, permission must be obtained from the park's plant ecologist to collect from another area.

■ If a plant is to be reintroduced to an area in which it no longer exists, a reintroduction plan must be completed and approved before planting.

■ When possible, look at the soil at the site where planting will be done and keep it in mind when collecting. Try to collect from a similar soil type.

■ Collect throughout the geographic range of the plant within the collection area. Don't select only plants that are growing on flat ground when the project will be planted on a slope, for example.

■ Collect each species needed for the project several times throughout the seed ripening period to get early, mid-season, and late-ripening seed. We don't want all late-ripening seed. The late-ripening seed should be combined with the early- and mid-season seed so that when all are sown, they replicate natural ripening variation. This will maintain a variety of plants and seed for our site in the future.

■ Collect from as many plants of a single species as possible throughout the collection area, but never less than ten plants. Do not bother to collect from only one plant. If there are fewer than ten plants, check with the plant ecologist to decide whether to use the available plants or to go outside the watershed.

■ Complete required paperwork and return it to your mentor or the seed collector for the project:

- Seed collection record for each species collected within a collection

area (you may have multiple dates of collection on a record).

- Work record, with time spent collecting the seeds.

3.4 SEED FORMATION AND MATURATION

Pollination and Fertilization

Did you know that seeds develop where the flowers were? Of course you did. But you'd be amazed at how many people don't know that. Flower petals are there to attract **pollinators** such as bees, butterflies, birds, bats, and other insects. Flowers that are **wind pollinated** (grasses, coyote bush and oaks) usually have inconspicuous petals since they do not need to attract pollinators. A flower may be **self-pollinated** when the pollen from the **anther** of a flower brushes the **stigma** of the same flower. A flower may be **cross-pollinated** by a plant in the same genus, species or variety, if there is at least some variation in one or more genes.

Pollen floats or is carried from the **stamen** (the male part) of one flower to the **pistil** (the female part) of another (or sometimes the same) flower. The pollen grain contains a set of genes from the male parent plant. The top of the pistil (the stigma) is sticky to hold the pollen. The pollen germinates and grows a tube down through the **style** to the **ovary**, at the bottom of the flower. The **pollen tube** may be only 1/4-inch long, or it may be 12 to 15 inches long, as they are in an ear of corn (corn silks are styles). The pollen tube grows through the ovary towards one of the **ovules**.

There are two **sperm cells** in the apex of the pollen tube. Each contains an identical set of genes. One sperm cell combines with the egg cell in the ovule (which also contains a set of genes from the mother plant). This begins the **zygote** that will become the embryo of the new plant. The other pollen sperm cell combines with the female **endosperm** cell (which will soon feed the developing seed). This is "**double fertilization**." A different pollen grain must reach and fertilize each ovule. If it's not fertilized by a pollen grain, the ovule usually won't develop. That explains those little, skinny, white ovules in your water-

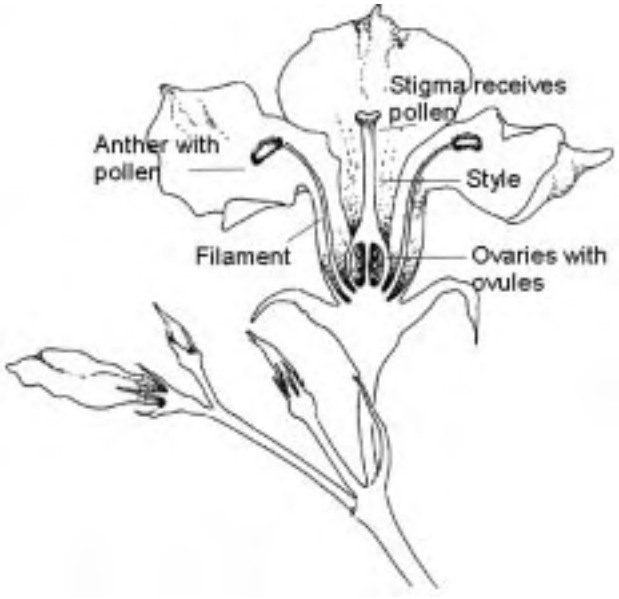


Figure 3.1. Reproductive parts of the flower

melon; they were never fertilized and are not viable seeds.

Maturation

After fertilization, the endosperm develops before the zygote and feeds the developing seed. The endosperm is the milk or dough squeezed from an immature seed. The zygote begins developing into the **radicle** (which will become the roots), the **plumule** (which will become the leaves and stem), and the **cotyledons** (seed leaves). Finally, the **integuments** of the ovule turn into hard seed coats in a mature seed. When the seed is mature it gains no further dry weight and the endosperm is depleted. When the mature seed germinates, the first true leaves will begin manufacturing food to feed the new plant.

Fruit Development

The ovules grow into seeds and the ovary grows into the fruit. When you sink your teeth into a juicy peach, you are eating the mature ovary. This ovary or fruit is part of the mother plant, with the same genetic makeup as the mother plant. But the seed inside the ovary is a combination of genes from the father plant and the mother plant. That's why we like to use seeds to grow plants for our projects-because each one is genetically unique, and will maintain the natural diversity of the species.

Seed Types

Many types of fruits have evolved over time. Here are the scientific terms for a few you may be familiar with or find:

- **Legume** or pod. Formed from a single carpel, **dehisces** (splits open) along both sides; examples include lupines and other plants in the Pea Family.
- **Follicle**. Formed from one carpel, but opens on only one side; magnolia has this type of fruit.
- **Capsule**. From a compound ovary, having more than one carpel; iris, poppy, and plantain form capsules.
- **Silique**. Like a pod or legume but with two carpels, dehisces into three portions; wallflower and many plants in the Mustard Family form siliques.
- **Achene**. These do not dehisce, usually have multiple dry fruits on a head;

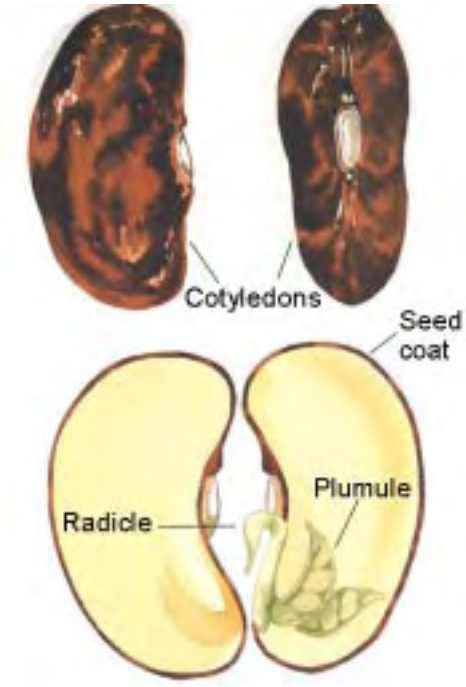


Figure 3.2. Mature Seed Structure

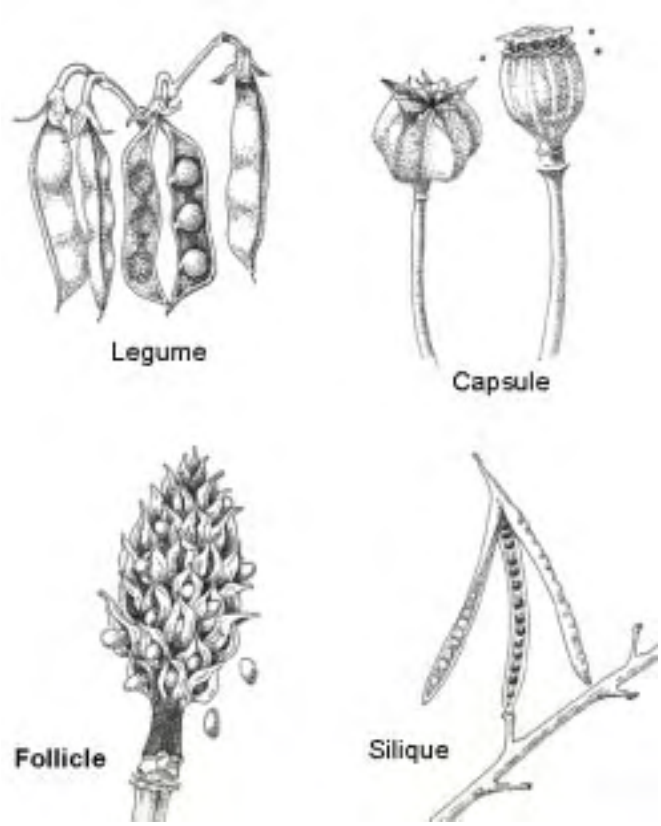


Figure 3.3. Different fruit types

strawberry, buckwheat, and sunflowers form achenes.

- **Grain**. Dry fruits of the grass family; one-seeded and indehiscent.
- **Samara**. Winged, dry, indehiscent; big leaf maple forms samaras.
- **Schizocarp**. Dry fruit of two carpels that split in the middle to two one-seeded indehiscent halves; poison hemlock is one example of many in the Carrot Family.
- **Nut**. One-seeded, indehiscent dry fruit with a hard or stony shell; hazelnuts and acorns are local native examples.
- **Drupes, berries, pomes, pepos and aggregates** make up the fleshy fruits.

3.5 SEED COLLECTION TIMING

There is no one magic answer to the question, “How do I tell when it’s ripe?”. Each species varies. See the Seed Collection Calendar (page 31) for general guidelines.

Confidence comes with experience. Usually, a seed is mature if it can be removed from the plant easily. If you have to tear it off, it’s usually not ripe. If you squeeze the seed and a milky or doughy substance oozes out, this is endosperm and means the embryo is not fully developed and will not germinate. If the seed is particularly tiny, light-colored, or thin, it’s not ready to be harvested.

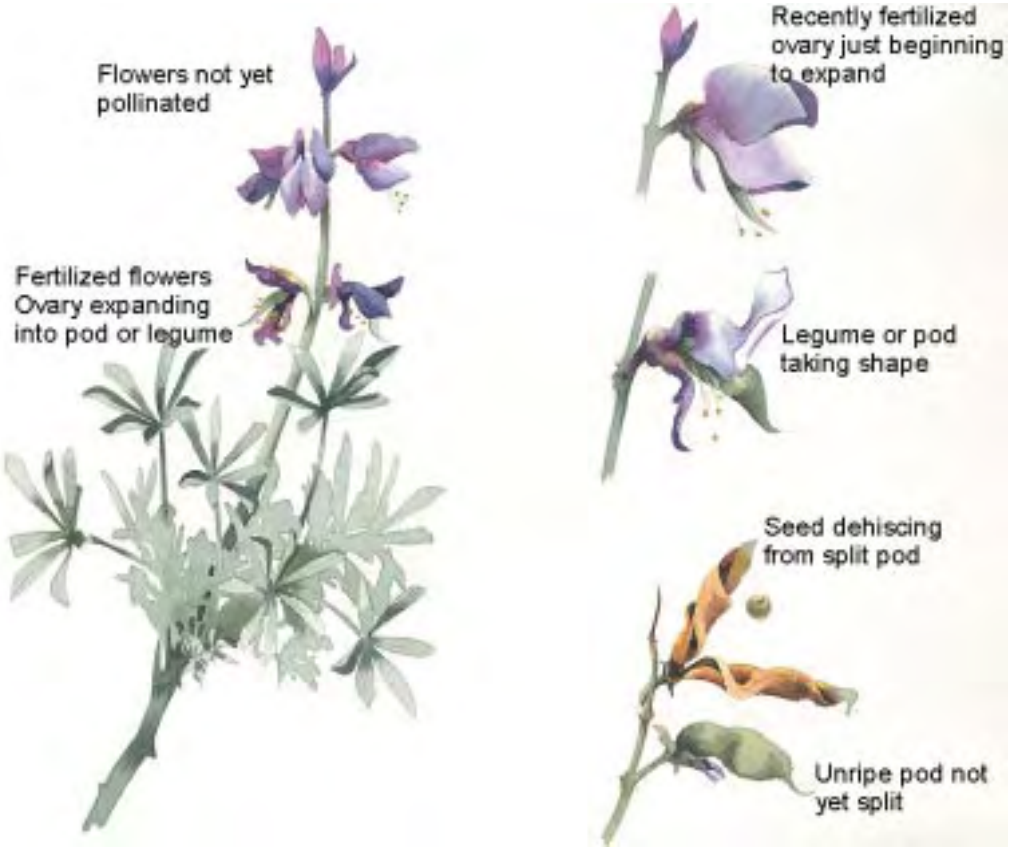


Figure 3.4. From fertilization to seed

In grasses and some dicots, seed goes through three stages:

- **Soft doughy stage**, indicated by the milk or dough that can be squeezed out. Seed gathered at this stage is immature and will not germinate.
- **Hard doughy stage**, which can be judged by biting the seed. If the seed does not extrude milk or dough, it is near maturity. Hardening of the seed coat is the last step in maturation of the seed.
- **Maturity**, indicated by a very hard seed coat and usually dark color or at least no green in the color of the seed.

For grasses, seed should be collected during the hard doughy stage. For annuals and herbaceous plants, seed is generally ripe about one month after flowering. In woody plants, seed maturation can take several months to many years. For example, black oaks take two years and orchids take seven years.

Germination rates are much higher if the seed is fully mature. In plants with dehiscent seeds (California poppy and lupines, for example), collection must be done a little early before the seeds pop open, blow away, or the critters beat you to them. When ripe, the pods should still be dry and stiff. If you are not sure if the seed is fully ripe, collect several inches of stem with the inflorescence. The stored food in the stem will promote a further maturation.

It is best to collect early- and late-maturing seed within the collection area. This assures the broadest genetic mix in the

plants to be outplanted. Seeds on a single plant can mature at different rates. Collect only the seeds that are ready; come back for the late-ripening seed.

How well the seed germinates and grows depends not only on its maturity at time of collection but on other factors, including genetics, handling during collection, cleaning and storage, insect damage and disease. Any of these factors can decrease the number of healthy plants obtained from the seed collected. See the next section, "Seed Collection Hints," for more details on handling seed.

3.6 SEED COLLECTION HINTS

When collecting, avoid infected plants or those under attack by insects. Keep seeds out of the sun and in a cool, shady place both during and after collection. For dry seed such as grasses, collect in the afternoon when the plants are the driest.

Grasses and dry, papery seed

- As a general rule, dry, papery, or hard shell seed should be collected in a paper bag.
- Grasses (*Nasella pulchra*, *Bromus carinatus*, *Elymus multisetus*) can be collected by *gently* pulling the spike between thumb and forefinger; position the palm of your hand below to catch falling seed. Ripe seeds separate easily, unripe seed does not.
- Seeds of other grasses (*Koelaria macrantha*, *Elymus glaucus*, *Hordeum brachyantherum*, *Danthonia californica*) are firmly attached to the stem and are best collected by taking off the entire spike.

Composites-daisylike plants

- Some, like coyote bush, are easiest to collect by gently taking a handful of seed and placing it in a paper bag, or by putting a paper bag over the branch and shaking.
- The ripe seed will fall into the bag or float away. Look closely at the fuzz - the seed is the tiny dark brown dot at the base of the fuzz, and it should be brown, not tan.
- For other composites, cut off the whole flower head when seeds do not shake free readily and put flower heads in a paper bag.

Shrubs and Trees

- If the plant has berries, pull them off and place in a plastic bag.
- Acorns should be picked from the tree; they are ripe when the acorn twists from the shell without tearing. Acorns and buckeyes are put in open plastic bags.
- A grocery bag with handles works well to carry moist seed. If you are collecting several species at once, you can carry smaller bags of seed in the grocery bag; hanging the bag over your arm leaves you with both hands free to collect more seed.
- Keep the collection bag out of the direct sun at all times.

Record Keeping

Label each bag with:

- Watershed and sub-watershed names (check map)
- Project name
- Common name, botanical name, or four-letter code
- Date collected
- Collector's name
- Description of area
- Time spent collecting
- Percent of seed collected from the area
- Comments

Aftercare

Each step in the seed-collecting process is vital. Hours of careful collection are wasted if seeds are improperly handled after collection.

- If you have any moisture at all in the seed, or if the volume is more than a handful, spread seed out to continue drying. Seed moisture content needs to be reduced to 5 to 10 percent for successful storage and to avoid fungal problems. Typically, seed contains 16 to 20 percent moisture when harvested.

- Seed should be stored in a cool shady place until it is given to nursery for cleaning and storage. The sun can literally cook the seeds.

- Berries or acorns must be cleaned within one to two days or they will mold. Store no more than one-half of a grocery sack full of acorns, otherwise they will start composting.

Cleaning and Storage

We do not clean and store seed at Oceana, but other nurseries in the park do. In general, seed is cleaned to remove berry skins, pulp, or dried flower parts. Seed is thoroughly dried and stored in airtight containers (jars, ziplock bags, or plastic boxes). It is refrigerated if the nursery has the equipment. This is done for the same reason you put perishables in the refrigerator at home: they last longer.

3.7 SEED TREATMENTS

Some seed can be sown fresh (without any special treatment), like many of our coastal **herbaceous** plants (yarrow, brome grass, Phacelia, and others we grow at Oceana) and woody plants (buckeyes). However, most seed will not grow if it is just stuck in a container with soil and watered. Many species require **stratification**, or cold treatment, prior to germination. Each species has its individual germination requirements, which may include fire, cold, consumption by a bird, etc.

We try to fulfill those germination requirements by doing something to the seed to imitate what usually happens in nature. Treatment time is determined by counting back from the date they should be sown. Depending on the species, seed is usually treated in fall or winter. If seed treatments are not happening at Oceana and you would like to participate in this activity, speak to your mentor about going to one of the other park nurseries to help with the process there.

For seed that would in nature be eaten by a bird, we put the seed in a rock tumbler with sandpaper or acid (strong coffee). For seed that requires fire for germination, we use either acid or hot or boiling water (**scarification**). For seed that would normally germinate in winter (but that we want to germinate earlier, in spring/summer/fall, so roots are already well established by winter), we put the seeds in moist media and into the refrigerator (stratification).

Seeds must be moist so they can **imbibe** water and the compounds inhibiting germination can be broken down into enzymes that induce germination. Many seeds require scarification and stratification. Ceanothus, for example, is put in boiling water for twenty seconds, allowed to soak overnight, and then stratified for sixty to ninety days. Bay and walnuts may need four to six months of stratification.

3.8 SEED COLLECTION CALENDAR

Start Date	End Date	Scientific Name & Common Name
April 1	June 30	*Lupinus chammissonis*/ lupine
April 1	July 15	*Festuca rubr*a /red fescue (grass)
April 15	June 15	*Elymus glaucus* ssp. *glaucus* (grass)
May 1	July 30	*Erysimum franciscanum*/wallflower
May 1	August 30	*Eschscholzia californica*
June 1	October 31	*Phacelia californica*
June 1	June 30	*Armeria maritima* ssp. *californica*
June 1	August 30	*Castilleja* sp./Indian paintbrush
June 1	July 30	*Caenothus thyrsiflorus*/blue bush
June 1	August 30	*Erigeron glaucus*/seaside daisy
June 1	September 30	*Mimulus aurantiacus*/monkey flower
July 1	October 31	*Achillea millefolium* /yarrow
July 1	August 30	*Eriogonum latifolium*/buckwheat
July 1	September 15	*Anaphalis margaritacea*/cudweed
July 1	August 30	*Dudleya farinosa*
July 1	August 30	*Lathyrus littoralis*/pea
July 1	September 30	*Scrophularia californi*a/bee plant
August 1	October 15	*Abronia latifolia*
August 1	October 30	*Artemisia pycnocephala*/sage
August 1	October 30	*Eriophyllum staechadifolium*/lizardtail
September 1	November 30	*Baccharis pilularis*/coyote bush
September 1	September 30	*Rhamnus californic*a /coffee berry
November 1	December 31	*Heteromeles arbutifolia*/toyon

Section 4
Growing Plants From Seed

Growing Plants From Seed

4.1 SOIL

Plants need a growing medium that provides physical support, water, air, and nutrients and is disease- and weed-free. Ideally, we would use native soil in the nurseries so the plants would not have to adjust to different soil when outplanted. However, most of our soil types will not grow healthy plants when used in a container. Why?

The soil throughout the park varies from sand to clay to gravel to serpentine and contains not only **sand**, **loam**, **silt**, and **clay**, but also **bacteria** and **fungi**. Some bacteria and fungi are beneficial, while others are **pathogenic** (disease-causing). Mature plants can usually resist these diseases; younger plants, with their thinner cell walls, often cannot.

At the Presidio and Fort Funston indigenous plant nurseries, many of the plants grown are native to the sand dunes, which contain virtually no nutrients. These plants compensate for this poor **substrate** by growing vast root systems that spread great distances for water and nutrients. Dune plants hold the sand in place with this network of roots. When starting seed in a pot, we must provide more nutrients due to the small space the roots have to explore.

Clay soils have very tiny particles; they drain slowly and will hold a high column of water. The tiny spaces between particles act like capillary tubes, drawing the water in and holding it tightly to the clay particles. In the field, a “head” of water builds up and the weight of the column of water (the effect of gravity) pushes water down through the soil. In a pot, the height of the water is not enough to overcome the suction (negative pressure) of the tiny particles and the pot stays saturated. We therefore use a medium with larger particles so water is not held in the pot but can drain and allow air to reach the roots.

We use soil with particles the size of medium-to-large grains of sand, (1/25 to

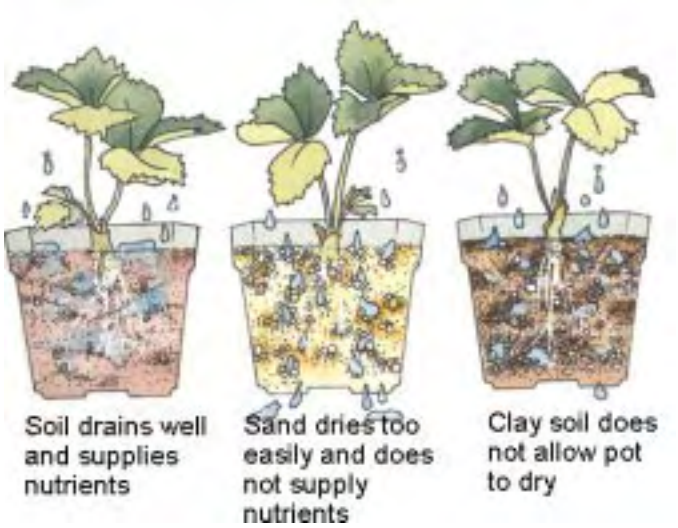


Figure 4.1. Soil types

1/12 inch) that are organic so they can provide not only good drainage but also hold nutrients for the plant. Organic matter contains organic polymers that bind clay, silt, and sand together. For example, it improves the drainage of a clay soil in the ground by gluing the tiny clay particles into larger, better-draining particles. In a pot or in the ground, organic matter provides lots of charged sites (**cation exchange capacity**), which hold charged nutrients like a magnet. Common nutrients (NO_3^-, PO_4^{-3}, NH_4^+, Ca^{++}, Mg^{++}, K^+) can be held temporarily until needed by the plant.

Soil particles must be of uniform size. If there are large and small particles in the potting mix, the small particles will fill in the air spaces between the large particles and again, the mix will hold water in the pot. At least 20 percent of the volume in a pot needs to be air-filled for good growth and healthy plants.

We want a mix with the following qualities:

- Light, somewhat fluffy consistency, indicating that there is sufficient air in the mix.
- Moderate nutrient holding capacity.
- Good water retention.
- Good drainage (perhaps most important, as indigenous plants are very vulnerable to disease in waterlogged soil).

The potting soil mix we create has these characteristics. It consists of fir bark ground to the proper size, peat moss, sand, Nutricote (a fertilizer, see Plant Nutrition section for details), and perlite. This is our basic mix and we use it for most plants (see following section, “Soil Mixing”).

Because we outplant in the winter and use small containers, there is not a great problem with the difference between the native soil and the container mix. As there is little room in the original rootball for additional root growth, roots grow quickly out into the native soil once they’re in the ground.

4.2 SOIL MIXING AND POT FILLING

Our regular potting mix is a special mixture of essential ingredients for starting plants. It is fairly clean, but if you step into the potting mix pile, you can contaminate it with a bad fungus. When we walk, we pick up microscopic fungi spores. We have

had problems with fungal diseases in some of our plants, probably due to poor sanitation practices. Be sure to sanitize shovels and wheelbarrows before mixing soil with these tools.

The soil recipe below is what we generally use, though sometimes, we make adjustments to our regular mix, adding sand for dune species or perlite for better drainage. We store extra soil in a covered yellow bin so it stays clean and moist.

Safety tips for shoveling

- Use the muscles in your upper legs to do the work.
- Bend at the hip and knee, never the waist.
- Try not to twist when shoveling. Back injuries most often happen when turning.

Soil Recipe for Oceana Plants

For 1 wheelbarrow of soil, mix 3 parts Sloat potting soil with 1 part perlite and 2 cups of Nutricote fertilizer (the gray pellets).

Supplies

Square-point shovel
Wheelbarrow
Dust mask
Measuring cup
Bag of Sloat potting soil
Bag of perlite
2 cups Nutricote

Procedure (Soil Mixing)

- Get supplies out of sheds.
- Clean the tools with water, bleach, and brushes, then rinse.
- Put on dust masks when using perlite.
- Add 3 shovelsful of Sloat potting soil mix to the wheelbarrow and 1 shovelful of perlite.
- To minimize dust, moisten the perlite layer with a bit of water before mixing.
- Continue to make layers, 3 shovelsful of soil to 1 of perlite, 3 more soil to 1 more of perlite, etc. This will help the pile mix faster and more thoroughly.
- Add the Nutricote when you have a full wheelbarrow, or add a little with each layer.
- Using the square-point shovel or your hands, mix thoroughly until the soil mix is consistent throughout.
- Use the soil to fill pots (see following).
- Store extra soil in the yellow bin. Keep lid closed so mix retains some moisture. It is difficult to dampen after it has completely dried out.

Procedure (Pot Filling)

- Line up four racks of pots close together.
- Scoop mix into pots; be sure to fill the pots at the edges and corners of the rack. **Fill the pots to the brim.** Use the edge of the scoop to move the mix that piles up to the edges and corners.
- Give the pots a tap on the bench and refill to the top. **Don't use your hands to pack the mix down.** Smooth the soil level and fill any low spots.
- Alternatively, you can place one rack of pots atop the wheelbarrow full of soil and fill it right there, so the extra soil falls back into the wheelbarrow. **Remember to tap the racks so the soil settles and can be refilled to the top and smoothed before sowing.** We want fairly full pots so plants will have enough soil to develop good roots and thrive until they are ready to be outplanted in the rainy season.

4.3 SOWING IN TUBES OR POTS

Most herbaceous plants are sown from summer to early fall, the time in the field when seeds are naturally dispersing.

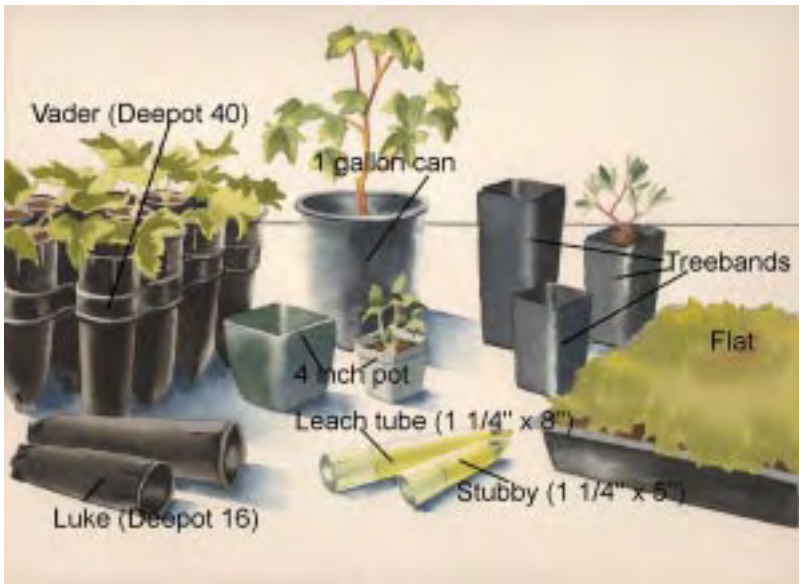


Figure 4.2 Various planting containers

Crops are timed to be ready to plant in the winter when rain waters the plants for us. This also gives the roots a chance to become established before the top of the plant begins to grow in the spring.

Then it's spring and time to sow. When the seeds are sown depends on how fast the species grows. Slow growers are planted earlier in the season, and fast growers, later. The size of the pot (tube) each species needs is also considered. Seeds are only sown on a **flat** if they are tiny or germinate poorly, or if we are experimenting. At Oceana we generally sow plants directly in tubes because the plants we grow are good germinators. This eliminates problems like kinked roots that have hit the bottom of a seed flat and damage when transplanting.

Because Milagra Ridge is a harsh, unirrigated site, we outplant pruned plants. This gives a high root-to-shoot ratio, one in which the roots are more developed and can bring up scarce water and nutrients to the above-ground part of the plant. A plant pulls up water in direct relation to the leaf surface area—the more leaves, the more water needed. The less leaf area, the less water needed. For most shrubs, we usually use **lukes** and **vaders** (10-inch-deep pots) to encourage 10-inch-long root systems that grow straight down. The standard gallon can or pot is only 6 inches deep. Six-inch-deep roots cannot supply a large plant with the water it needs.

4.4 SOWING PROCEDURE

Supplies

Racks of clean tubes
Hose and fanhead nozzle
Seed
Small, shallow tray
Potting mix (soil)
Pencils
Labels
Propagation forms
Scale
Colander

Procedure

- Fill pots or tubes with the regular potting media (see "Soil Mixing" and "Pot Filling" sections for procedure).
- Gently water pots or racks of tubes with fanhead nozzle, which won't compact

the soil. You should see dark soil in the openings at the bottom of the tube, indicating that the soil is moist all the way through.

- Put rack on bench in front of you.
- Weigh the seeds you will be using so you can determine how much (by weight) seed you sowed when you are done.
- Put enough seed in a shallow tray for three to five seeds per tube.
- Put tray on top of rack or next to it.
- Work down the rows, one at a time, putting three to five seeds in each tube.
- Continue until each tube has seed.
- Cover the seed with a thin layer of extra potting mix, using a colander. Use only enough soil to barely cover the seeds. Covering too heavily is one of the main causes of poor germination.
- Make two labels for the rack, using a pencil (pen wears off with watering). Labels include: four-letter species code, date sown, and site where seed was collected.
- Using the fine spray nozzle on hose, gently water racks to settle soil and moisten seed.
- Place in greenhouse. Be sure mist is on the timer.
- Weigh remaining seed, calculate weight of seed used.
- Fill out propagation forms.

4.5 AFTERCARE OF NEW SEEDLINGS

Recently sown racks of pots need special attention. The soil surface and seed itself need to be kept moist so the seed can germinate and survive the initial period before roots are developed. If the seed germinates and then dries out, it will die. Be sure the misting system in the greenhouse is keeping all pots moist throughout the day. This means frequent short misting (30 seconds to 1 minute, every 1/2 to 1 hour). Weather makes a big difference: if it's sunny and hot, the soil surface will dry much more quickly than if it's foggy and cold. This is why we do daily checks and regulate the heat in the greenhouse by venting, opening the door, and putting shade cloth over the greenhouse during the warm months when necessary.

With the exception of grasses, after germination, any extra seedlings in a pot are removed, leaving only one plant per pot. When we remove seedlings, we can transplant them into pots where none of the seeds germinated. We use simple tools like pencils and chopsticks to carefully remove extra seedlings and replant them in neighboring pots. We save a variety of seedlings, not just the biggest or the first to germinate; the variety enhances genetic diversity.

How do I know if my extra seedlings are ready to be transplanted into new pots?

Seedlings are ready to be transplanted when they have two sets of true leaves (four leaves) and appear to have a healthy root system.

Why do the seedlings look like they have two different types of leaves?

The lowest set of "leaves" that appear first are not actually leaves at all, they are **cotyledons**. There are either one or two cotyledons (grasses and all **monocots** have one; most other plants we grow are **dicots** and have two). These are the food storage structures that nourish the seed embryo until it grows the true leaves that produce their own food through photosynthesis. True leaves look different from the cotyledons and usually emerge in sets above them. Transplanting can be done

once there are two sets of true leaves.

Procedure (Thinning and Transplanting Seedlings)
The goal here is to remove the seedling with minimal damage to the tender new roots and to disturb remaining seedlings as little as possible.

- Carefully loosen soil around one seedling with chopstick, pencil, or other tool, and gently lift it out by holding the cotyledon. Try not to handle the true leaves.
- Dig a small hole in the center of one of the empty pots. Holding the seedling by a cotyledon (below the true leaves), lower it into the hole so that the roots hang freely. The surrounding soil should come to the same level on the seedling as it did in the seedling's previous pot, or right around the crown of the plant.
- Put the displaced soil back into the hole around the newly transplanted seedling. Be sure all the roots are covered.
- Once a rack of pots is completed, water it gently but completely until water runs out of the bottom of the pots.

4.6 FILLING A FLAT WITH SEED MEDIA

Sunshine Plug Mix is only used when we sow into flats. (We rarely sow seed in flats at Oceana. We usually use tubes—it's quicker and we lose fewer plants because we don't have to transplant all of them out of the flat and into pots.)

Supplies
Flats
Hose
Sink/tub
Bleach solution
Newspaper
Sunshine Plug Mix
#5 Scoop
Fan-head Nozzle
20- to 26-inch leveling stick, lath, or yardstick

Procedure
Cleaning the flats:
- Hose off loose dirt from inside the flats.
- Fill sink with enough water to submerge the flats you will be using.
- Put on rubber gloves and safety glasses.
- Add about 1 teaspoon bleach per gallon of water.
- Submerge the flats; let them soak at least thirty seconds.
- Rinse thoroughly with clear water.

Filling the flats:
- Fold a piece of newspaper, use it to line the bottom of flat.
- Moisten Sunshine Plug Mix in a sterilized wheelbarrow.
- Scoop out enough Sunshine Plug Mix to completely fill flat.
- With your hands, spread out the mix so all edges and corners are filled to the top.
- Use the edge of a leveling stick to level the flat mix. Using a zigzag motion across the flat works more smoothly. Watch for light under the stick; fill in these low spots.
- Discard any flat mix that falls on the bench or floor.
- Using a fan-head nozzle, gently water the flat (a properly watered 16 inch x 18 inch flat should weigh about 11 pounds.).
- Let the flat drain, and the flat is ready to sow.

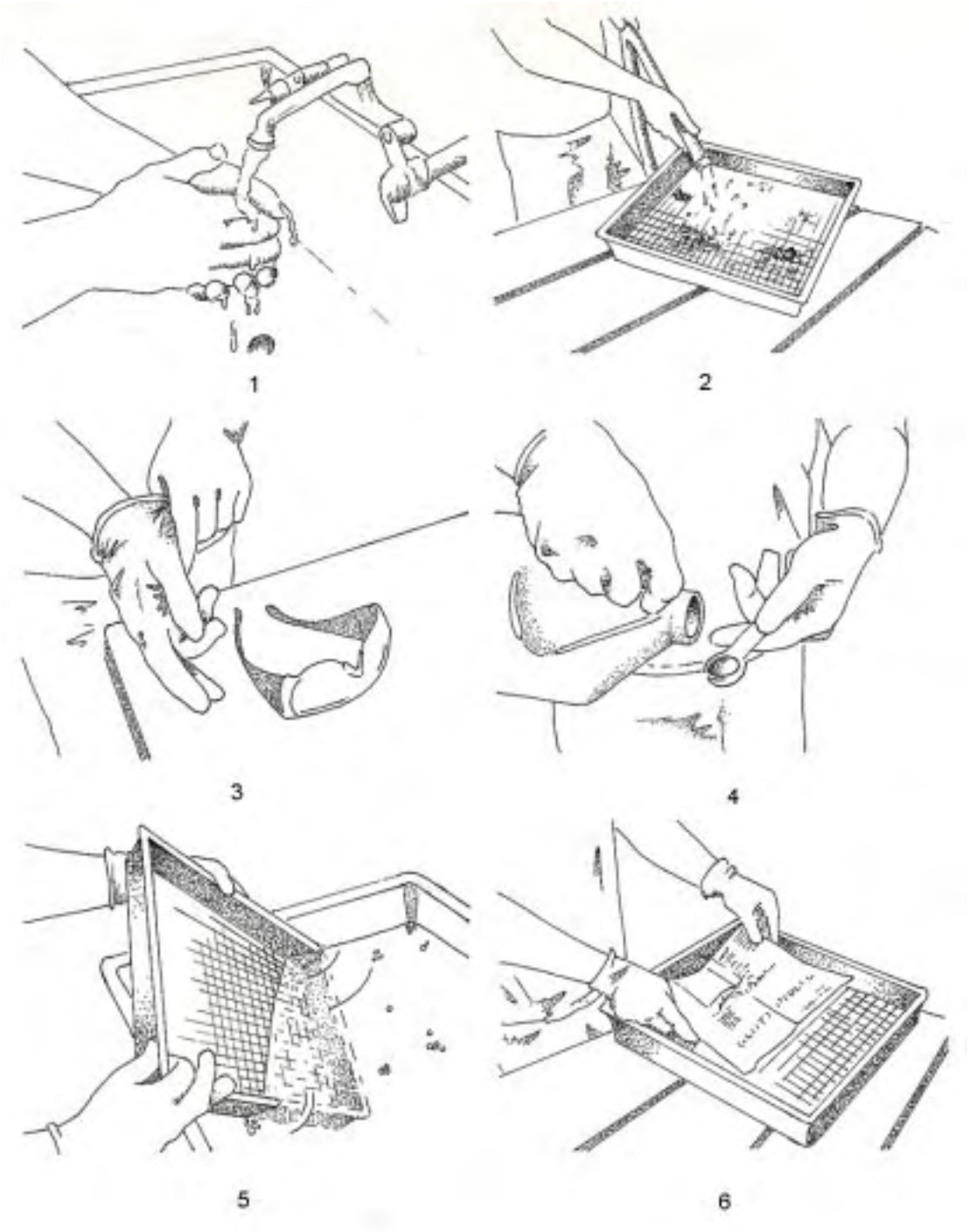


Figure 4.3 Cleaning a Flat

1. Wash hands and fill sink with enough water to submerge the flats.
2. Hose off loose dirt from inside the flats.
3. Put on rubber gloves and safety glasses.
4. Add about 1 teaspoon bleach per gallon of water.
5. Submerge the flats. Let them soak for at least thirty seconds. Rinse thoroughly with clean water.
6. Fold a piece of newspaper and use it to line the bottom of the flat

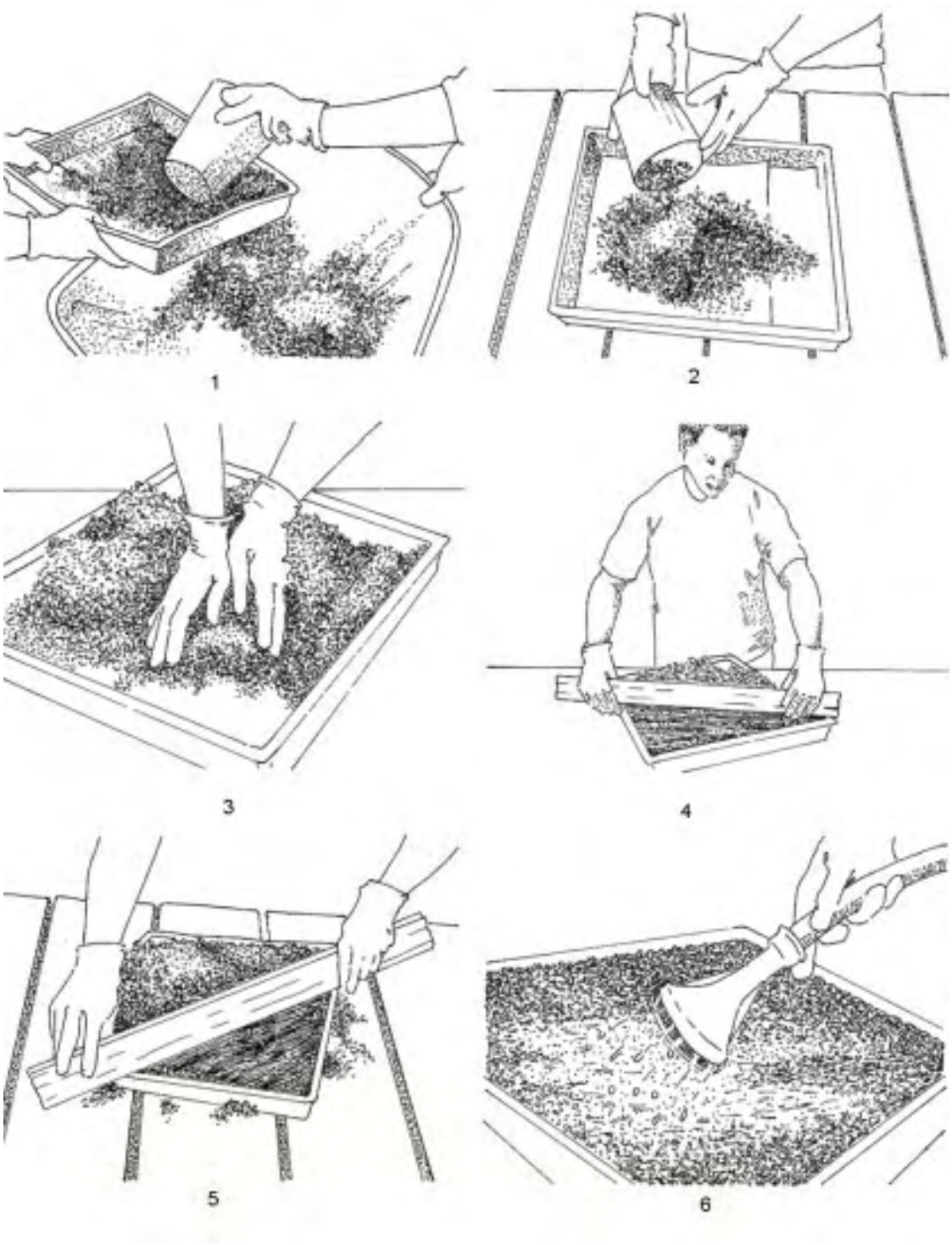


Figure 4.4 Filling the flat
1. Moisten Sunshine Plug Mix in a sterilized wheelbarrow
2. Scoop out enough Sunshine Plug Mix to completely fill the flat.
3. With your hands, spread out the mix so that all edges and corners are filled to the top.
4. Use the edge of a leveling stick to level the flat mix.
5. Using a zigzag motion across the flat works more smoothly. Watch for light under the stick and fill in those low spots. Discard any flat mix that falls on the bench or floor
6. Using a fan-head nozzle, gently water the flat (a properly watered 16 inch x 18 inch flat should weigh about 11 pounds). Let the flat drain, and the flat is now ready to sow.

4.7 SOWING SEED ON A FLAT

Supplies

Filled and moistened flat
Extra growing media
Small scoop to spread seed
Scale
Seed
Shallow pan to mix seed
Tamper (cement trowel works well)
Colander

Procedure

- Fill flats with growing media (to calculate how many flats you need, remember that no more than approximately 1,000 small or 500 large seeds should be sown per flat).
- Water flats and allow them to drain.
- Place filled, leveled, and moistened flat on bench.
- Weigh seed to be used so weight of seed sown can be calculated at the end of the day.
- Put enough seed for each flat in a shallow pan.
- Using the colander, sift some of the extra dry media over the seed in the pan.
- Mix seed and media evenly.
- Pour half of the seed mix in a small (1 cup) scoop.
- Sprinkle over flat.
- Give the flat a one-quarter (90 degree) turn.
- Pour the rest of the seed mix in the scoop and sprinkle in the other direction. This helps distribute the seed evenly.
- Don't cover the seed with media if the seed cannot be easily seen with the naked eye. If the seed is large enough to see, use the colander to sift media over the flat until the seed is covered completely and is no longer visible.
- Using the tamper, lightly press the seed into the media. Be sure each seed is in good contact with the media.
- Check to see that seed is still covered; if not, sift more media over flat.
- Label flat, using pencil. Include four-letter code, date sown, and site where seed was collected.
- Using the mist nozzle, gently water the seed. Hold nozzle at a right angle to the flat so spray is falling vertically and not at an angle. Otherwise, seed can be washed off the flat.
- Put flat in the greenhouse. Be sure mist system is functioning.
- When all flats are sown, weigh unused seed. Record weight of seed used and other required information on the propagation form.

4.8 TRANSPLANTING SEEDLINGS FROM FLAT TO POTS

How do I know if my seedlings are ready to be transplanted?

Seedlings are ready to be transplanted from flats to pots when they have two sets of true leaves (four leaves) and appear to have a healthy root system.

What size pot do I transplant into?

This depends on the species, but seedlings are generally transplanted from the flat to 2- to 4-inch pots, lukes or occasionally vaders. Strawberry plants go into 4-inch pots.

Why do the seedlings look like they have two different types of leaves?

The lower set of "leaves" that appear first are not actually leaves at all, they are cotyledons. There are either one or two cotyledons (grasses and all monocots have one; most other plants we grow are dicots and

have two). These are the food storage structures that nourish the seed embryo until it grows the true leaves that produce their own food through photosynthesis. The true leaves look different from the cotyledons and usually emerge in sets above the cotyledons. Transplanting can be done once there are two sets of true leaves.

Supplies

Flats of plants to be transplanted
Racks or flats of pots
Potting soil
Hose with misting nozzle
Plastic fork
Tags, pencils
Propagation and Transplant Record

Procedure

- Separate flats of different species on the work table.
- Fill appropriate-sized pots (in flats or racks) with potting soil.
- Dampen soil in pots if it is very dry.
- Study plants in the flat to be sure that they are all ready to be transplanted. If they are not all ready, let your crew know which ones are ready and why.
- Remove seedling from flat using a plastic fork. Create a circle around the seedling and scoop deeply beneath it. The goal here is to remove the seedling with minimal damage to the tender new roots and to disturb nearby seedlings as little as possible.
- Dig a small pit in the center of one of the pots. Holding the seedling by a cotyledon (below the true leaves), lower it into the hole so that the roots hang freely. The surrounding soil should come to the same level on the seedling as it did in the flat, right around the crown of the plant.
- Put the displaced soil back into the hole around the newly transplanted seedling. Be sure all the roots are covered.
- If the roots on some seedlings are too long to hang freely when transplanted according to the above method, do the following: fill a pot one-third to one-half full of potting soil. Hold the plant by the cotyledon and lower into the pot.
- Fill the rest of the pot with soil while holding the seedling at the level you want. Be sure to fill in carefully but thoroughly around the roots.
- Once a flat or rack of pots is completed, water it gently but completely until water runs out of the bottom of the pots.
- Tag flats with appropriate information (add transplanting date to existing tags) and fill out propagation record.
- Place flats in greenhouse.

Figure 4.5 Transplanting seedlings

Section 5
Keeping Plants Healthy

KEEPING PLANTS HEALTHY

5.1 WATERING CONTAINER PLANTS

These instructions apply to plants in pots that are being grown in a greenhouse or shadehouse. They do not apply to seed flats, with or without seedlings.

What is the single most important technique to learn in order to grow healthy plants?

Proper watering! How much water do we want to give our plants? Just the right amount!

The general idea with watering is to give plants enough water to thrive but not so much that they suffocate, rot, or become susceptible to fungal attack. Plants can suffocate if they are always saturated, as no air is available to the roots. The following guidelines are very general, and some species may need special watering regimes. If you have a question about a specific species, ask your mentor. After studying these directions, water the plants once or twice with someone who has already been trained before doing it on your own. The directions should work whether you are using a hose or an irrigation system to apply water to the pots.

Directions

1. Check the plants in the morning to see if they need water. This is the most important part of the process. A plant needs water if the top one-quarter of the soil column is dry.

If you are checking vaders, which are 10 inches tall, the top 2 1/2 inches should be dry before you water.

Why do we let the top of the soil column dry out?

Fungi thrive in constantly moist conditions. If the soil around the crown of the plant stays moist, it allows fungal spores to germinate and attack the plant.

Does this dry soil on top harm the plant? No, after the plant is established the roots draw water from the lower parts of the soil column.

2. Apply the water if needed.

Water in the morning. Our goal is to let the leaves and stem of the plant dry off during the day so that fungi don't form at

night (fungal spores need standing water in which to germinate).

How much water?

Enough to fill the air spaces in the pot. A good potting soil contains about 20 percent air by volume. When we water we are trying to fill up this whole 20 percent with water. Some of the water then drains off, but some of it remains behind, bound to soil particles that hold it until the roots suck it up.

What does this 20 percent mean, practically?

A vader, for example, is 10 inches tall and approximately the same diameter for its entire length. If we know that the soil column is 10 inches tall, then 20 percent (or 1/5) of this length will be 20 percent of the volume. So we want to apply that much water. In the case of a vader, this would be 2 inches (10 x 1/5 = 2).

How do you measure 2 inches of water?

Using either your hose or the irrigation system, put a straight-sided container marked with inches under the stream of water. Measure the time it takes to fill the container to the 2-inch mark. Apply the water for that amount of time when you water.

Or the simple way. Basically we want to saturate the soil column. You can be sure you've done this by checking the holes in the bottom of the pot to see if the soil there is wet. When water starts dripping out of the holes, you have watered enough.

When watering with a hose, apply a smaller amount of water twice rather than the whole amount at once. This way you will avoid puddling, which sometimes can seal the top of the soil.

Use a gentle stream of water. If the stream of water is battering the plants, knocking off leaves, or splashing soil out of the pot, find another nozzle or turn down the water pressure.

Be aware of dry spots. They can be caused by a gap in your irrigation system, patterns of shade and sunlight, or plants that use water at different rates. Check as many individual plants as you need to in order to notice the wet and dry areas of your nursery. If the irrigation system seems to be clogged or stuck in certain areas, see if you can clean out the little

Figure 5.1 When to water - finger comes out of pot dry, soil is transparent, and holes at bottom of pot are light colored

filter basket or adjust the system to fix the problem. If you can't, get help from your mentor as soon as possible and hand-water the plants in the meantime.

Some plants are so leafy (especially grasses) that the water cannot reach the soil. These plants may need to be pruned; check with your mentor and hand-water in the meantime to be sure they get a good soaking and don't die. Another strategy for super-leafy plants is to space them out in the racks so that every other hole is empty, giving more space for water to reach each plant in the rack.

3. Let plant dry until top one-quarter of soil is dry again.

Anticipate. If you know it's going to rain in the afternoon, don't water in the morning. If you know the weather is going to be exceptionally hot for a few days, water sooner than you normally would and check the plants more frequently.

5.2 CROP MONITORING

Crop monitoring is what you do each day to check on your plants and to record and deal with any problems you find. (For more information about identifying the causes of problems and treating common plant diseases and pests, see the sections "Diseases" and "Pests" and ask your mentor or the park nursery specialist.) These challenges can threaten the survival of much of our crop of plants, so please act immediately!

Supplies

Clipboard or notebook with Crop Monitoring Record Form
Hand lens
Pruning shears
Ziplock bags

Procedure

- Observe the weather. Record the temperature both outside and in the greenhouse, using the minimum-maximum thermometer in the greenhouse to get high and low temps.
- Walk through the greenhouse and shade structures and really look at the plants. Go up every aisle, look at both sides of each bench and pallet.
- If plants need thinning, pruning, fertilizing, or transplanting, record this on the Crop Monitoring Form. Be sure to take care of necessary tasks or remind your mentor to help you do needed work as soon as possible.
- Using a hand lens, examine any plants that look odd. Look for bugs and disease. Note any evidence of bugs: honeydew, eggs, curled or distorted leaves, holes in leaves. Make notes of what you find and record numbers of insects or mites (even if it's just "a few," "some," or "lots") and exactly where they are found.
- Note how much of the crop (species) is affected by disease.
- Are natural enemies present? Are they gaining control? Note this and call your mentor if it seems like the plants are dying.
- Take samples. Shake bugs into ziplock bags. If the plant is diseased, prune it just below where infection can be seen and put pruned section in a ziplock bag.
- Identify or give to nursery specialist, and take responsibility for treating the problem.
- Make a note of action to prevent spread. If you don't know what to do, call the nursery specialist. That's why we have one!
- Remember: Take action the day you discover a problem.

5.3 IN THE SHADE HOUSE

Once the young plants go into the shade house, what do we need to do to keep them healthy? How do we organize the plants in the shade house?

Pots must be kept up off the ground so **air pruning** of the roots can take place. A root will not grow out into free air. If the tubes are on the ground, the roots may grow right into the soil. Plants can be severely shocked or killed if these roots are torn off when the pot is picked up.

There can be a problem with air circulation and light reaching the middle of a rack. Plants in racks are very close together. Space permitting, the racks should be spread out and sun-loving species put into the sun as soon as possible. If possible, plants can be spaced out so there is a tube in every other hole, with alternate holes left empty to let air, sun, and overhead water into each pot.

The top of the plant will sometimes stretch to get more sun if the tubes are too close together. Sunlight cannot reach the bottom of the plant if it has many leaves on the top. The cells on the main stem of the plant will elongate ("reach for the sun") and this can weaken the plant, making it limp or floppy. When we space the tubes out so sunlight can get to all the leaves, we also prevent fungal problems. Air circulation around the plants dries moisture that would encourage the germination of fungal spores.

Remove any weeds and any dead, diseased, or unhealthy native plants from the nursery. Weed seed, fungus, bacteria, and virus can spread to healthy plants. Carry a 5-gallon bucket with you to hold the plants and tubes you are dumping. A small plant isn't necessarily unhealthy or diseased, it's just small; don't dump it! We retain small, healthy plants to diversify the gene pool of the plants we are growing. All types of plants are to be planted, large or small. The small plant may be more disease- or drought-resistant and may be the one to survive if drought or disease occurs.

Good pest and disease control must always be carried out. By keeping pots, tables, greenhouses, and shade houses clean, we prevent most problems with native plants. If plants are stressed—root-bound or not getting necessary nutrients—cell walls thin and crack and sugars may leak out and attract fungus or insects.

Natural enemies and competitors are usually present, helping control the pests so they don't take over the nursery. We grow relatively small numbers of plants of each species, so pests do not thrive to the extent that they do in commercial nurseries. **Monocultures**, or huge crops of a single species, create a haven for pests because if they are well adapted to thrive on the single species being grown, they can multiply exponentially (and very quickly).

To keep our plants healthy and able to resist invaders, we fertilize them periodically. Keep an eye on the tags for each rack and flat of pots to see when fertilizer should be added. Three months after seed is sown, add 1 teaspoon of Nutricote to each pot. When you do this, note it on the tags and in the records.

If you succeed in keeping your plants healthy, they will be in perfect condition to plant after the rains begin in December. Your plantings will establish, survive, and become a haven for native birds, mammals, and insects. The plants will reproduce not just for one year but for our lifetimes, our grandchildren's lifetimes, and beyond.

5.4 PRUNING

In herbaceous non-woody plants, we pinch or **prune** back the top of the plant. In plants, growth begins from the buds. The buds contain tissue (**meristem**) that has not yet **differentiated** into stems, leaves, or roots. Usually the **terminal bud**, the one at the top of the plant, will grow first, especially if that is the area receiving the most sunlight. At the base of each leaf there is an **axillary**, or **lateral**, bud, also containing meristematic tissue. By removing the terminal bud, the lateral or axillary buds are induced to grow. If the terminal bud is pinched or pruned, usually one or two lateral buds will sprout just below. If the plant is pruned further down the stem, lower buds will begin growing and branching will take place from the base of the plant.

As a general rule, when pruning, we leave the bottom three buds or sets of leaves on the plant and remove everything above that. This will result in strong bushy plants. The cut should be made just above the third bud or set of leaves from the bottom.

If a long stem is left above a bud, it will die back, since there are no leaves to feed its growth. If we prune just above a bud, the bud will break and grow a branch with leaves that send food (**photosynthates**) back down the stem.

We don't prune the trees we grow, as we want to retain the single main stem or trunk.

How do I know when to prune?
As you do your daily crop monitoring, clip off any seedheads or flowers on your plants. Be sure to clean the shears with rubbing alcohol in between plants to prevent the spread of disease.

During the summer, until the end of August, plants should be pruned heavily. Generally, when we outplant, we want the tops of the plants to be no taller than the height of the pot. (A luke is 8 inches deep, so the plant's leafy top should be no more than 8 inches high.) Until the end of

Figure 5.2 Node with leaf and bud. Leave three nodes on plant when pruning

August, plants can be cut back by half, or to three nodes. They will regrow before going dormant. After September 1, only light pinching (no more than 1 to 2 inches removed) should be done. This prevents the plants from making a lot of soft new growth that would be damaged when the cold weather arrives.

As a general rule, a plant should not get much taller than the depth of its pot. For species that spread laterally, each plant should be contained for the most part to its own pot and should not be so dense that water cannot penetrate the foliage to reach the soil. Lots of foliage means the plant is using more water and nutrients, which can stress the plant and lead to disease. In the nursery, native plants should have big strong roots and a moderate amount of greenery on top; this gives them a better chance of surviving outplanting.

Pruning Guidelines for Species Commonly Grown at the Oceana Nursery

ACMI (yarrow)
This species is hardy. You can cut yarrow back to about 2 to 3 inches. Leave some but not the entire leaf. Just clip like grasses; it should go really fast since there are no nodes to worry about.

PHCA (phacelia)
Leave a rosette at the base of the plant. Clip off any leaves or flowers above that. If the plants are huge, you can cut them back to just a few leaves at the base and they should recover.

ERLA (buckwheat)
Cut them to about two nodes.

FERU (red fescue)
Grasses are easy. Make sure you keep the seed heads clipped back. Use the shears and like a lawnmower, down to about 2 to 3 inches.

BRCA (California brome)
Same as red fescue.

5.5 PLANT NUTRITION

Just as we provide children with good nutrition, basic nutrition must be given to plants. You can't raise a healthy child—or plant—on water and air. When plants are grown in tubes, some nutrients will be missing from the potting soil medium. To provide better nutrition to the growing plants, we add a balanced fertilizer (Nutricote) to our potting soil, and then **top dress**, or sprinkle 1 teaspoon per pot on top of the soil every three months. After September, only 1/8 teaspoon should be added; this keeps the plant healthy without encouraging new growth. With most of our species, slow-release fertilizer is all that is needed.

Nutrient Cycle

Plants take in basic elements and convert them to the sugars and carbohydrates on which we depend for nutrition. Plants are the foundation (or **primary producers**) of all food chains because they produce food that includes all the basic vitamins and nutrients that animals (including humans) need to survive. With sixteen elements plus sunlight, plants can manufacture everything they need to stay healthy. By far the most necessary elements for the plant are oxygen and carbon; hydrogen ranks third. These elements are easily attained from the atmosphere as carbon dioxide (CO_2) and water (H_2O). Plants also need many other elements to grow, and are inhibited by the lack of one or more of these elements.

Nitrogen, potassium, calcium, magnesium, phosphorus, and sulfur are the main elements in a plant. However, minute quantities of chlorine, iron, boron,

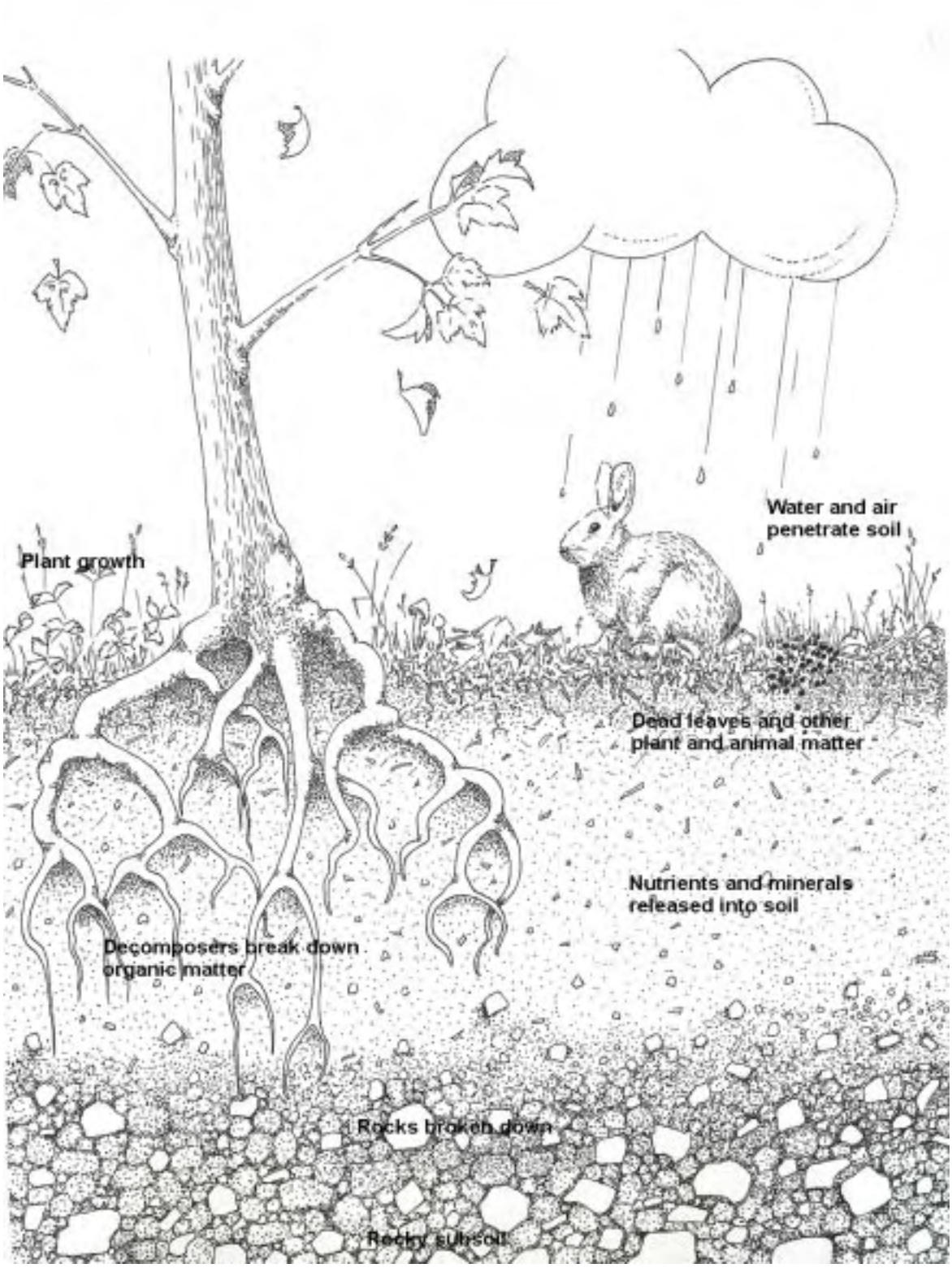


Figure 5.3 The Nutrient Cycle

Figure 5.4 Web of life

manganese, zinc, copper, and molybdenum are also needed. The relative amounts of each element needed vary greatly. For example, a typical corn plant contains 450,000 times more carbon or oxygen than molybdenum.

Nitrogen (N) is taken up by the plant as NO_3^-, NH_4^+. Our soils are commonly deficient in nitrogen because it is water soluble and washes away with irrigation and rain water runoff. It readily moves around inside the plant. **Plants without sufficient nitrogen grow slowly** and tend to be pale green to yellow, while stems may be red to purple. Too much nitrogen and they will have many large, lush, very dark green leaves. We do not want this in our plants, as they will survive better if the top of the plant is smaller than the root mass (high root-to-shoot ratio). We must provide enough nitrogen to have healthy plants, but not so much that growth gets out of hand.

Phosphorus (P) stimulates good root growth. It also speeds maturity, flowering and seed formation. Plants lacking phosphorus are stunted and can be dark green (as opposed to nitrogen-deficient plants that are light green). Also, **phosphorus-deficient plants often show red or purple** (**anthocyanin** pigment) in the older leaves, as the plant takes P from the old leaves to be used by the new leaves, flowers, and seed.

Potassium (K) is the other element usually lacking in our soils. It helps develop strong cell walls, which maintain the plant's resistance to the entry of fungal spores, bacteria, or virus. It also moves from the older to younger leaves in the plant, and **deficiency symptoms show up first in the older leaves, which become pale green or yellowish and often have scattered dead spots on them**.

The other elements are usually in sufficient supply in the soil, depending on the pH (**relative acidity**). For more details on specific nutrients, see the "Plant Nutrition" section (page 66).

We use a **controlled-release fertilizer** (Nutricote or Osmocote) to provide N, P, and K, and minute quantities of other essential elements. These products are resin-coated pellets that release nutrients in tiny amounts when wet; they usually last about ninety days (the fertilizer bag will indicate the length of time the nutrients are available to the plant). The content of the pellets will also be shown on the bag (e.g., 14-14-14). These numbers represent the percent of nitrogen, phosphorous, and potassium. If a bag weighs 100 pounds, it has 14 pounds of nitrogen, 14 of phosphorus, and 14 of potassium. The bag also lists the micronutrients in the pellets. Generally, we use a formulation in which the percentage of nitrogen is equal to or less than the percentage of phosphorous. This low ratio of nitrogen will encourage good root development with a leaf area that is in proportion to the roots.

Since it is made up of decaying plant parts, **compost** contains the necessary elements for good plant growth. Sometimes compost can be low in nitrogen, which is often lost as a gas, N_2, during decomposition. Other elements may be in short supply if the compost is not fully broken down to useable elements. Sometimes, fertilizers like Nutricote or bone- or blood meal need to be added if the compost does not provide all essential elements. Your compost mix can be tested at a special lab to determine if it has everything needed.

Compost could be used in our media if it could be held at 150° F for several weeks. If the compost pile does not heat to 150°F, the compost can harbor disease organisms. Consistent high temperatures are also necessary to kill weed seed. If you

would like to use compost in potting mixes, check with your mentor or the nursery specialist to determine how you can maintain your compost pile at these high temperatures.

5.6 RECORD KEEPING

Why is it important to keep records?

Though there are volumes of instructions on the topic of growing and maintaining popular landscape plants, very little information is available on how to propagate indigenous plants. In the native plant nurseries, we are trying to build a solid base of information about the best techniques for propagating, growing, and outplanting in the park, figuring out what works and what doesn't. We have a very long way to go before we know all—or even most—of the answers.

You can help with this very important effort by recording all the information about the plants you work with in the nursery. Seed-sowing dates and germination dates from the previous year tell us how long to wait for the seeds to germinate this year. Knowing how many seeds we sow, how many germinate, and how many die after being transplanted tells us exactly how many seeds we need to collect for the following year. This is important, as we have to be sure we've collected enough to grow the plants we need without over-collecting, which decreases the plants' ability to reproduce naturally.

To gather this information, the nursery has forms, Propagation and Transplant Records, and Species Information Sheets. The nursery staff will show you how to fill them out. Only by keeping these records can we learn what we did wrong (so that we can correct it in the future), or what we did right (so we can repeat it).

At the end of the calendar year (November or December), look at each crop and make final notes on the Species Information Sheets.

- Were the plants too big? If so, we may need to sow them later in the year or use less fertilizer.

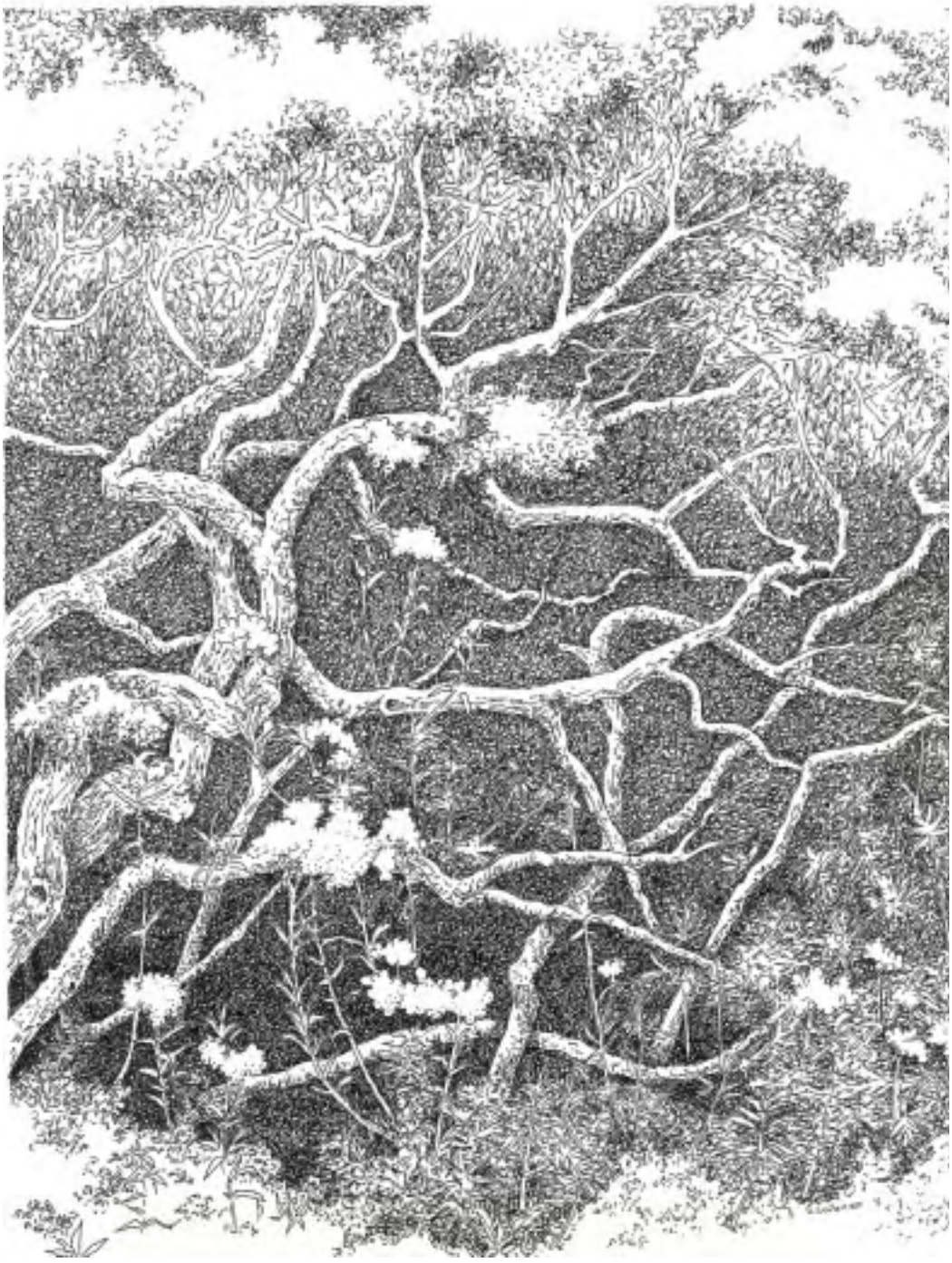
- Were the plants too small? If so, we should sow them earlier, use more fertilizer, or they may need better drainage (more perlite in the potting mix).

- Insects? What were they? What condition were the plants in when they were attacked?

- Were roots rotted and brown? The plants may need better drainage (more perlite).

The importance of keeping records cannot be overestimated.

Section 6
Growing From Cuttings



Growing From Cuttings

In the wonderful world of plants, we can grow a complete plant from only a small piece! Whenever we can, we use seeds for our projects to maintain the greatest genetic diversity possible. But if seeds are unavailable or we haven't found the secret to making them germinate, we use plant cuttings. We take cuttings from as many plants as possible, again, to maximize genetic diversity.

How does a piece of a stem turn into a new plant? There are **meristematic** (undifferentiated) cells just under the bark or skin (**epidermis**) of the stem, and undifferentiated cells at the buds. These cells haven't decided what part they want to be. By applying hormones to the bottom of a cutting, we can induce those undifferentiated cells to turn into roots. Plants make hormones for flowering and seed formation, a hormone for leaf drops in the fall, and a hormone for rooting. The rooting hormones have been duplicated in the lab and we can buy them in different concentrations.

A weak hormone (Rootone, Hormex #1, Dip and Grow at a 1:20 dilution) is used on green soft wood. Stronger concentrations are used on more woody stems. We usually take **hardwood** cuttings in the winter, using **dormant wood**. From late spring to mid-summer, we do cuttings using the current year's growth, which is a little woody but still bendable (**semi-hardwood cuttings**).

Ideally, we take cuttings in the morning, when they contain the most water. We keep them moist and cut into the appropriate-size pieces. We clean them in a dilute bleach solution, then treat them with the hormone and stick them in a flat with a very light, well-drained mix of perlite and vermiculite. At Oceana, the only plants we grow from cuttings are strawberry plants. They root readily, which means that we do not have to use rooting hormones. For more information about hardwood and semi-hardwood cuttings, see page 64.

6.1 MAKING THE CUTTING MIX

Perlite and **vermiculite** work well as growing media**.** Perlite is mined from natural lava flows, crushed, and screened to a uniform size. It is then put in a furnace at 1400°F (760°C). The small amount of moisture in the rock changes to steam and expands the particles, like popping popcorn. This leaves microscopic holes that provide air in the rooting medium (and for the base of the cutting, which retards rotting). Perlite can hold three to four times its weight in water, but does not contain any nutrients.

Vermiculite is related to mica. Mined in Montana and North Carolina, it looks like mica, but when it is heated to 2000°F (1090°C), the water trapped between the layers turns to steam and expands the layers to create a spongy porous kernel. It has charged sites (**high-cation exchange capacity**—ask your chemistry teacher) that will hold nutrients to be released to the plant as it grows. Vermiculite provides calcium and magnesium to the plant and holds water in its layers.

Perlite and vermiculite are both sterile and will not transmit any diseases to the plants unless they are contaminated in handling. The normal ratio for a good flat mix is 3 parts perlite to 1 part vermiculite.

Supplies

Hose
Dilute bleach water (1/2 teaspoon per gallon of water; wear safety glasses when mixing the bleach water and dipping cuttings)
Wheelbarrow, large tray, or tub
Shovel or scoop (You can make a scoop out of a bleach bottle or commercial cleaner gallon bottle, which is usually heavier duty; cut to shape, keeping the handle intact. About 4 1/2 of these scoops fills one regular flat.)
Perlite
Vermiculite
Dust mask
Goggles
Nutricote (for strawberry cuttings)

Procedure

- Wash off mixing tub and shovel or scoop with water; then sterilize with bleach solution.
- Wearing a dust mask, put 3 scoops of perlite in tub. Spray with water to cut down on dust.
- Add one scoop of vermiculite (**don't wet this**, as water tends to compact the layers in the particles and it will lose its desirable properties).
- Repeat until you have enough mix for the project.
- Add 1/4 cup Nutricote per flat, or 2 cups Nutricote per wheelbarrow if mix is for strawberries.
- Clean up.

6.2 FILLING FLATS WITH CUTTING MIX

Supplies

Flats
Scoop
Cutting mix in clean bin
Leveling edge (at least 20 inches long)
Dust mask
Bleach and hose with fan head

Procedure

- Wash hands; sterilize supplies.
- Check to see if perlite/vermiculite mix in storage bin is moist. If it's dry, wear a dust mask and spray mix with just enough water to moisten.
- Scoop mix into flat so it is mounded higher than the top of the flat.

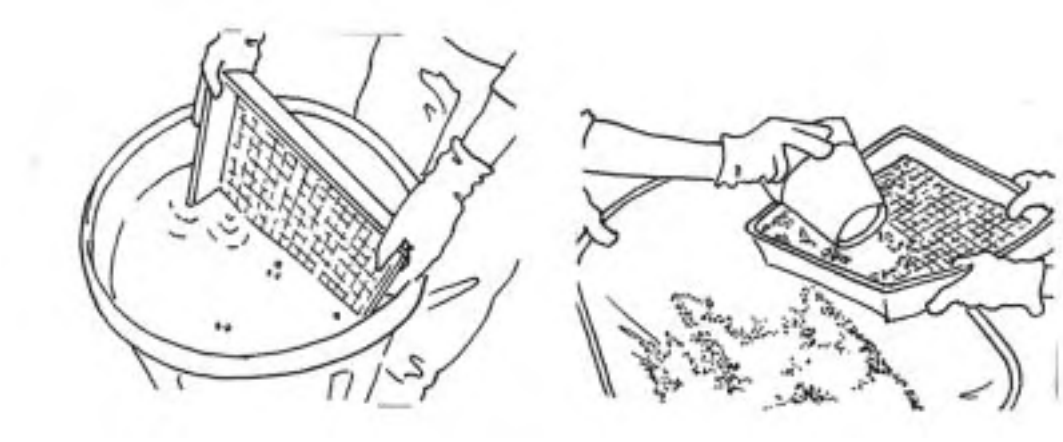


Figure 6.1 Washing and filling a flat

Figure 6.2 Runners trimmed in the field

Figure 6.3 Runners cut into individual plantlets

Figure 6.4 Plantlet ready to stick in flat

Figure 6.5 Flat filled with plantlets

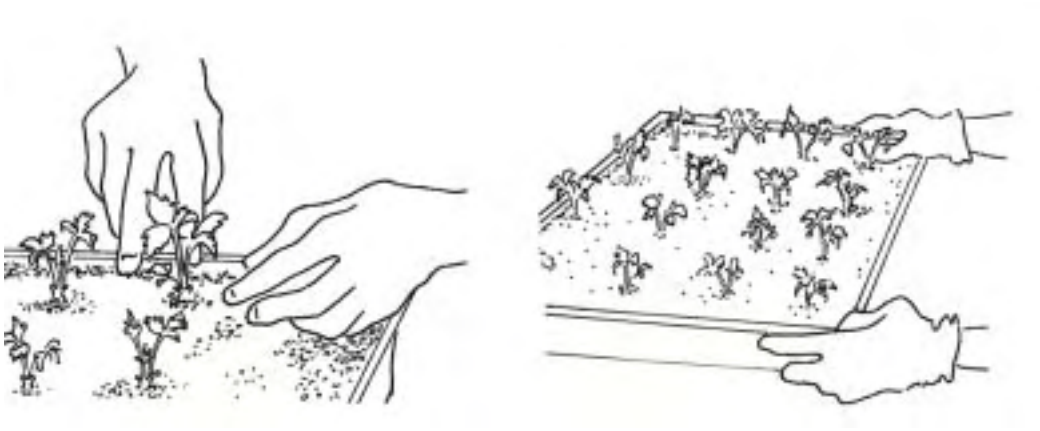


Figure 6.6 Sticking plantlets in flat ready to be labelled. Then take flat to mist house

- Smooth mix out to edges of the flat until it is even with the top of the flat.
- Add or remove mix, as needed. Discard any mix that falls on table or floor.
- Use leveling edge to zigzag across flat so surface is very level; fill in where light shows under edge of leveler. Put the extra mix that piles up in front of leveler back into bin.
- Put on cart or table outside. Water in gently with fan head. Let flats drain while cuttings are being obtained from the field.
- Clean up.

6.3 STRAWBERRY CUTTINGS

Strawberries grow by sending out **stolons** (above-ground runners) from the main plant. Once the runner is far enough from the mother plant to have room to grow, it produces a plantlet and begins rooting. Strawberries have pre-formed, or **latent, root initials** at the base of each plantlet. Since this is their normal method of propagation, the strawberry plant has evolved to root readily from these plantlets. They root quickly because the meristematic tissue at the base of the plantlet develops into the initial root cells as the plantlet develops. Once the plantlet is cut from the stolon, all it needs is contact with a growing medium and moisture. The latent root initials are then stimulated to grow into roots.

Cuttings need very clean, light media (fungus is the big enemy), 100 percent humidity (to compensate for the lack of roots), moisture around the base of the cutting, air around the base of the cutting (to prevent fungus), low light (to cut down on water need), and a medium that will physically support the cuttings.

To collect cuttings, take a group to Milagra to gather strawberry runners. Each person should have a pair of shears and a white plastic grocery bag to carry the cuttings in so they don't wilt (use rubbing alcohol to sterilize shears between uses). Each collector keeps track of approximately how many plantlets (s)he collects so the leader can determine when the group has met its collection goal. Collect from a variety of habitats, removing only a few runners from each area. All material collected should be disease- and insect-free. When collection goal has been met, return to the nursery.

Supplies

Prepared flats (filled with flat mix, leveled,

and watered)
Dilute bleach water (1/2 teaspoon bleach per gallon of water) in a clean bowl or basin
Colanders
Lath (or other straight edge) just under 16 inches long

Procedure

- Cut the runners into individual plantlets, using shears. Leave about 1 inch of runner on either side of each plantlet; discard the remaining runner.
- Place plantlets in colanders.
- Sterilize by submerging the colanders full of plantlets in the dilute bleach water for about 30 seconds.
- Set up one prepared flat for every fifteen strawberry cuttings.
- Mark each flat with five rows, using a straight edge. Each plantlet needs about 3 square inches to grow. The flats are 16 inches x 16 inches. Therefore, five rows of plantlets with five in each row, or fifteen strawberries per flat, will give plenty of room for each plant to develop.
- Place the plantlets into the flat. It's easiest to stick them in by holding one end of the runner and poking the other end into the flat mix.
- Be sure that each plantlet is in good contact with the rooting medium. The root initials will not develop if in contact with the air.
- Label flats and record data on propagation forms.
- Place completed flats in the greenhouse and gently water until water comes out from the bottom of the flat.
- Be sure the mist system is set to provide frequent misting until roots have formed.
- Transplant each rooted strawberry to a 4-inch pot and place outside to mature.

6.4 AFTERCARE OF CUTTINGS

After flats of cuttings are taken to the greenhouse, they should be watered in with a fan-head nozzle. Run the water between each row of cuttings. This settles the soil in around the roots and fills any holes around the roots. Every two or three days, the cuttings should be checked for signs of infection. If infected, leaves will usually be dull-colored and possibly starting to wilt. If leaves appear wilted even though the flat is moist, or if leaves or stems are a dull brown or black, pull the cutting and check stem for black areas (root rot). If evidence is seen, the cutting should be disposed of and cuttings sur-

Figure 6.7 Strawberry plant

rounding it should be carefully checked.

Moisture level in the cutting flat is critical. *Phytophthora* sp. (root rot) spreads only in a saturated medium. Media should feel moist but not wet when rubbed between the thumb and fingers. Flat should be light enough to easily picked up (not over 5 pounds).

Mist only the leaf surface; it should not run long enough to drip onto the media. Check the flats' weight each day to see if they need extra water.

Watering nozzles must be kept off the floor. There are fungal spores in the soil and in dust or dirt on the ground. The nozzle will pick them up and spread them to the cutting with the irrigation water.

When roots begin to show through the bottom of the flat, stop misting. This hardens off the cuttings and encourages roots to grow deeply into the medium.

After a week or so, cuttings can be transplanted to the appropriate-size pots. If transplanting is delayed, sprinkle about 1 tablespoon Nutricote over the flat (if Nutricote was not added in original flat mix), as there are no nutrients in the perlite/vermiculite media.

6.5 TRANSPLANTING CUTTINGS

Supplies

Clean pots, half-filled with potting mix and watered

- Lukes or tubes for herbaceous upright plants
- 4-inch pots for spreading herbaceous plants (including strawberries)
- Lukes for slow-growing shrubs
- Vaders for fast-growing shrubs or trees

Potting mix, moist but not wet
Flats of rooted cuttings to be transplanted
Fork in each flat of cuttings
Small tray to hold eight to ten cuttings
Labels
Nursery markers or pencils
Propagation and Transplant Records

Procedure

- For the sake of the plants, work in the shade.
- Clean the bench with dilute bleach water.
- Put rack or flat of partially filled pots on the bench on one side of you.*
- Put cutting flat on the bench on the other side.
- Put soil in front of you if it's in a pan, or next to you on the ground if it's in a bin or wheelbarrow.
- Insert fork or fingers into flat, at least 1 inch away from any stem. Dig to the bottom of the flat and gently ease out eight to ten cuttings. Don't remove too many, the roots will quickly dry out and die from prolonged contact with air or direct sun.
- Put cuttings on a small tray.
- With one hand, hold a rooted cutting up in a pot. Remove some soil from the pot if necessary so roots are not bent in the bottom.
- With the other hand, scoop up some soil to pour around the roots.
- Continue until pot is filled to the top.
- Give the pot a tap on the bench to settle soil around the roots.
- Put in flat.
- When rack is filled, tap it on the bench to settle all the pots.
- Label the flat or rack; put a label in two opposite corners and include transplanting date.
- Put racks or flats of pots on a cart and water, using a fan-head nozzle on the

end of the hose (no wand).

- When the cart is filled, bring plants into greenhouse.
- Check to be sure pots are well-watered. Water again, if needed.
- Record work accomplished in Propagation and Transplant Records.

*If working with lukes, start on the side of the rack farthest from you, and follow the same procedure.

Section 7
Learn More About ...

LEARN MORE ABOUT...

7.1 PROPAGATION HINTS FOR COMMON OCEANA PLANTS

California brome grass/*Bromus carinatus*/BRCA
Sow: May/early June
Pot Size: Leach tubes/lukes
Survival Rate: 75 to 80 percent (to have 750 plants at the end of the growing season, sow 750/0.75 pots with seed, or about 1,000 pots; ten or eleven racks of Leach tubes or forty racks of lukes)

Coast buckwheat/*Eriogonum latifolium*/ERLA
Sow: May/early June
Pot Size: Vaders if sown May/early June; lukes if sown later
Survival Rate: 80 to 85 percent (to have 750 plants at the end of growing season, sow 750/0.80 or 937.5 plants. Round up to 1,000 plants; forty racks of lukes or fifty racks of vaders)

Phacelia/*Phacelia californica*/PHCA
Sow: June
Pot Size: 4-inch pots or vaders
Survival Rate: 70 percent (to have 600 at the end of the growing season, sow 600/0.70, or about 900 pots; forty-five racks of vaders or about fifty-six flats with 4-inch pots)

Red fescue grass/*Festuca rubra*/FERU
Sow: May/early June
Pot Size: SC10 (Leach tubes) or D-16 (lukes)
Survival Rate: 75 to 80 percent (to have 750 plants at the end of the growing season, sow 750/0.75 pots with seed, or about 1,000 pots; ten or eleven racks of Leach tubes or forty racks of lukes)

Yarrow/*Achillea millifolia*/ACMI
Sow: May/early June
Pot Size: Vaders if sown May/early June; lukes if sown later
Survival Rate: 70 to 80 percent (to have 200 plants at the end of the growing season, sow 200/0.70 pots with seed, or about 285-300 pots, twelve racks of lukes)

7.2 SEMI-HARDWOOD OR SOFTWOOD CUTTINGS FOR PLANTS: STEPS FOR SUCCESS

These cuttings are usually taken late spring to late summer and are not usually done at Oceana.

- Clean surface on which cuttings will be prepared.

- Wash hands.

- Decide how much material needs to be obtained from the field and how many cuttings are to be taken.

- Obtain material from the field, disease- and insect-free.

- For most softwood or semi-hardwood cuttings, a 3- or 4-node cutting works well.

- Go through all the material making the proper size and number of cuttings; don't remove leaves and trim yet.

- After making all the cuttings the right size, remove leaves from the bottom half of cutting if nodes are very close together, or from the bottom two nodes. Be careful not to strip the epidermis by pulling the leaves off the cutting.

- If a shrub species, pinch out the tip of the cutting (it will usually wilt anyway because it is so soft). Pinching will also encourage branching in the plant.

- Cut the bottom of the cutting at a 45-degree angle.

- Keep prepared cuttings in a plastic bag so they don't wilt. Keep them out of the sun.

- When all cuttings are prepared, put them in a colander and dip the colander in a bleach solution (very dilute, 1/2 teaspoon per 1 gallon of water); let soak for 30 seconds, no more than 1 minute.

- Pull out and rinse well.

- Obtain flat filled with cutting mix that has been watered in and allowed to drain.

- Use a clean piece of lath just shorter than the width of the flat to make ten lines (indentations) in the flat, using the thin edge.

- Put small amount of hormone in a small shallow container (1/2 pint deli container works well and lid can be put on to store excess). Never dip stems in original hormone container, as you will contaminate it. When finished, do not put excess back into original container-cover and label container with strength (#1, etc.) and put in refrigerator.

- Touch the bottom of cutting in the hormone (if a powder) or dip 5 seconds (if a liquid).

- Stick cutting in the first row in the flat; 20 cuttings per row, 200 per flat.

- When flat is full, tap on table to settle mix around each cutting.

- Label each flat, include number of cuttings and number of hormone (e.g., 200cc #3).

- Record in Propagation and Transplant Record Book.

- Take flat to location as instructed and gently water in, until water comes out from bottom of flat.

- Be sure the mist system is working.
- Clean up your mess.

7.3 HARDWOOD CUTTINGS: STEPS FOR SUCCESS

This process is not usually done at Oceana.

Preparation

- Clean pots or deep flats with dilute bleach water, remove dirt, let soak 30 seconds, remove from solution, and rinse with clear water.
- Make media of perlite and vermiculite:
  - Normally 5 scoops perlite to 1 scoop vermiculite.
  - For riparian plants (willows, cottonwood, dogwood, snowberry), mix 3 to 1.
  - For coastal scrub plants (*Ceanothus*, coffeeberry, manzanita), mix 7 to 1.
- Fill pots or flats to the top with the mix and level off with a straight-edge.
- Water in with a gentle spray, using a fanhead nozzle.
- While containers are draining, collect cuttings.

Collection

- Identify species of plant.
- Find a branch that is at least as big around as a pencil.
- Cut at the beginning of this year's growth, which can be identified by its lighter color and absence of rings around stem.
- Keep cut branches in the shade, in plastic.
- Cut the number of branches needed.
- Take to the nursery.

Making the Cuttings

- Remove any leaves on stems.
- Starting at the bottom of the branch, cut below the bottom node (where a leaf was) at a 45-degree angle (diagonally).
- Make the next cut above the next node up the stem at just a slight angle.
- Put cutting in a clean flat (or bucket of water if weather is hot), keep the growing end pointing up.
- Continue until the stem is no longer as big around as a pencil; discard the skinny portion.
- Keep track of the top and bottom of the cuttings (look for little buds at the nodes; they point up).
- If very difficult to root, wound the bottom by shaving off the bark on one side of the cutting.
- When all the branches are cut, you are ready to stick the cuttings.

Sticking the Cuttings

- Wear rubber gloves.
- Put cuttings in bleach water, 1 teaspoon per gallon, for 30 seconds, and rinse; keep them pointing the right way.
- Get a flat or pot and put on one side of you, cuttings on the other side.
- Get hormone (for willows, cottonwood, snowberry, use #1).
- Count out ten cuttings.
- Touch the bottom of the cuttings to the hormone powder.
- Stick cuttings in rows, ten rows per flat, twenty cuttings per row.

Finishing

- Make a label with:
  - four-letter species abbreviation;
  - date taken;
  - number of cuttings in flat;
  - number of hormone used.
- Water in gently with fanhead nozzle

to settle mix around cutting.

- Put on bench as directed. (Usually outside on a shaded bench. If cuttings are inside, in a greenhouse, the upper buds will break because the plant feels like it's spring; then the plant will use all the food stored in the stem before the roots can form.)
- Record total cuttings on Propagation Sheet.
- Clean up your mess.

7.4 PLANT NUTRITION

In order for a plant to grow and remain healthy, sixteen elements need to be supplied to the plant. If these elements are not present in necessary amounts, the plant will be stunted or display other problems. Macronutrients are needed in larger amounts; micronutrients are needed in smaller amounts.

The essential nutrients can be remembered using the saying, "C HOPKNS CaFe, managed by mine cousins, Mo and Clyde." (see if you can figure that one out!).

Carbon, hydrogen and oxygen are absorbed from the air through the **stomata** in the leaf or from water, and are needed for virtually every chemical reaction within the plant. They comprise the end product of **photosynthesis**: carbohydrates.

$CO_2 + H_2O \rightarrow C_6H_{12}O_6$ (sugars)

C H O + N S P → proteins also produced by plants

These two products feed the people of the world and, of course, other living things for which we are restoring habitat. The plants use them for growth and for storing energy for the following year.

Macronutrients	
Carbon	C
Hydrogen	H
Oxygen	O
Phosphorus	P
Potassium	K
Nitrogen	N
Sulfur	S
Calcium	Ca
Iron	Fe
Magnesium	Mg
Micronutrients	
Boron	B
Manganese	Mn
Copper	Cu
Zinc	Zn
Molybdenum	Mo
Chlorine	Cl

There is usually plenty of carbon dioxide (CO_2) and water (H_2O) around, so these are not limiting factors. Greenhouses growing high-value crops such as roses will sometimes pump in carbon dioxide to speed growth. Proteins make up **protoplasm** and are the main component of stored food in the plant. In one plant, carbon made up 45 percent of its dry weight;

hydrogen, 6 percent; and oxygen, 43 percent, accounting for all but 6 percent of the total weight of the plant.

Nitrogen (N) is an integral part of the protein molecule and is the element usually most lacking in a growing system. It is also a component of chlorophyll, nucleic acids (DNA, RNA), amino acids (building blocks of proteins), and hormones. Plants can absorb nitrogen through the roots only as nitrate (NO_3^-) or ammonium (NH_4^+). Larger organic molecules, like urea, must be broken down by soil microorganisms to these smaller molecules in order to be used by the plant. Nitrogen, as nitrate or ammonium, **translocates** easily in the plant. It also dissolves easily in water, and so **leaches** from the pot rapidly. It typically makes up 1 to 4 percent of the dry weight of a plant.

Too little nitrogen will cause a yellowing (**chlorosis**) of the leaves, especially older ones (since it translocates, it moves from old to young leaves in order to keep the plant growing), and a general stunting of the plant. The plant will be deficient in proteins and stored food. Too much nitrogen can be just as bad, especially in our nurseries, because it causes the top of the plant to outgrow the roots, creating a low root-to-shoot ratio. If nitrogen is supplied in high amounts or late in the season, the tops will keep growing rather than converting energy to stored food. Excess nitrogen will also delay flowering, fruit and seed development, and encourage lots of vegetative growth.

Phosphorus (P) is also a major component in proteins, sugars, RNA, and ATP (chemical energy source in the plant). Even though less than 1 percent of the dry weight of a plant is phosphorous, it is essential for cell metabolism. Sufficient phosphorus encourages good root development and speeds fruiting and seed development. It is needed early in the growing cycle for root development, which begins before shoot growth. Our mix has a superphosphate (natural crushed rock) in it, which has 20 percent phosphorous, also 18 percent calcium, and 12 percent sulfur.

Potassium (K) is needed during rapid growth. It translocates from older tissues to the growing points (meristematic regions) of the plant. It is an **enzyme** activator for cell division, synthesis and translocation of carbohydrates, synthesis of proteins, development of chlorophyll, and stomatal opening and closing. It also helps prevent infections such as root rot.

Potassium deficiencies will show up as dead spots (necrotic lesions) on the leaves as well as yellowing. California soils usually have enough potassium with high pH (basic soils), but it can be deficient in low pH (acidic) soils such as those in redwood or other conifer forests. Lime (calcium carbonate) is used to neutralize acid; chemically, it is close to baking soda or Tums.

Sulfur (S), found in many amino acids and vitamins, is needed for enzyme actions and in photosynthesis reactions. It is less mobile in the plant than nitrogen, potassium, or phosphorous. When deficient, the plant fails to synthesize proteins from the amino acids present. Sulfur is absorbed by the roots as SO_3 from the soil solution.

Calcium (Ca) builds strong bodies (structure) in plants. It is the essential constituent of cell walls. Needed early in the season and during rapid growth phases, it concentrates at the growing points. It is immobile and if not available in the **apical meristem**, the top of the plant will twist and deform and the tips will die; root growth will also be restricted. Eventually, the plant will die. It is required for cell division, **chromosome** stability, and **mitochondrial** production (energy stored

within the cells). Calcium is usually sufficient in California soils unless rainfall is very high or the soil is acid.

Magnesium (Mg) is the center of the chlorophyll molecule. Need we say more? Chlorophyll, which is essential for photosynthesis, converts CH and O to food. It is where all our food comes from, vegetables and/or meat from animals. Magnesium is involved in many enzyme reactions. Deficiencies show as yellowing of the older leaves and general sickliness of the plant.

Iron (Fe) plays a role in the conversion of energy from the sun into chemical energy in the plant (ATP). It is essential for chlorophyll formation but is not part of the end-product molecule. It is usually present in sufficient amounts in the soil but may be held tightly to the soil particles if the pH is too high or if the soil is poorly aerated. Iron deficiency shows as **intervenal chlorosis**. An adjustment in the pH or improving the drainage will usually make sufficient iron available to the plant.

Micronutrients are needed by plants in minute amounts and are usually sufficiently available. However, they may be deficient in a non-soil medium. Nutricote, a slow release fertilizer, and Plantex, a soluble fertilizer, have had micronutrients added to them.

So now we know what the plants need. How do we figure out what we need to give them, how to give it to them, and how much to give them? It's not easy or straightforward, especially for native plants. Optimum levels of the various nutrients have been established for species perceived to have economic value—most grains, vegetables, fruits, some high value ornamentals, and some timber species—but there has been no funding for research to establish optimum requirements for all the native plants.

However, even if we knew the optimum levels needed for every species we grow, it would not be practical to fertilize each species differently. Consequently, we have established a standard formula that works well on most species, varying it on the few species with very special requirements. This standard formula was discovered through experience and observation. Since plants will grow well within a relatively broad range of concentrations, we tend to give fairly high amounts of some nutrients in order to avoid a deficit of others. As we refine our knowledge of what our particular plants require, we can customize our procedures. We also continue to work on incorporating compost into our mixes and using organic, non-petrochemical-derived fertilizers.

Most landscape nurseries give a constant feed of N at 200 parts per million (ppm). We have found that 50 to 75 ppm N works well as a constant feed for most of our native plants. Nitrogen is usually the limiting factor to good growth; superphosphate in the potting mix gives adequate P for young growth. Superphosphate and the slow-release Nutricote are used up in about three months, which is why the pots are top-dressed with the slow-release fertilizer three months after transplanting. Herbaceous plants started later in the season need to be fertilized later. Fertilization stops after October 1, as our plants need to go dormant by November.

7.5 NATIVE PLANT NURSERY PESTS: IDENTIFICATION AND CONTROL

Horticultural and biological controls are our first lines of defense against nursery pests (usually snails, slugs, insects, and/or diseases). If these are not successful and the problem worsens, call the nursery specialist or the park's integrated pest management (IPM) specialist. No chemicals (including oils or soaps) or plant-derived treatments (like rotenone) can be applied without the IPM specialist's supervision.

Snails and Slugs

Like clams, snails are members of the mollusk family. Slugs, which are like snails without shells, are also mollusks. Our common brown garden snail is an escaped exotic, brought from Europe in the 1850s as a delicacy for American diners. Get rid of snails with no more regret than you experience pulling broom or Cape ivy. We do have a native snail that is solitary (doesn't congregate in groups) and not found in nurseries. The Decollate snail is a predator of the common brown snail and many other insects; if you see one, leave it alone.

Life cycle

Snails, which produce slime to move, take two months to four years to mature. They have two pairs of retractable tentacles; the long ones function as eyes and the short ones are for smelling. The mouth is below with a horn-like rasping organ that the snail uses to scrape away at leaves.

Though snails are **hermaphroditic** (having both male and female sexual organs), they do not usually fertilize themselves. They lay eggs in masses of about 100 white, round eggs; the egg mass is usually about 1 inch in diameter. (Slugs lay fewer eggs.) The eggs hatch when there is plenty of moisture.

Snails require abundant moisture throughout their life cycle. They feed at night; during the heat of the day they hide in cool, moist, dark places (like the bottom of plant racks or benches). Many use the same hiding place each night. If conditions are too dry, they pull into their shells and seal the opening with a mucus that hardens; this allows them to survive for up to four years! They overwinter in leaf litter, lumber, or other out of the way places (again, nursery pallets and benches), and are not usually active below 50°F.

Signs of Infestation

Snails will rasp (scrape) irregular shaped holes in leaf edges and middles. Slime trails are a dead giveaway.

Snail and Slug Control

Clean up. Get rid of hiding places. If lumber is stored at the nursery, put cross boards on the bottom so the pile dries out. Pull and dispose of tall weeds (especially vinca, ivy, or ice plant, which provide perfect hiding places). Debris and other hiding places should be cleaned up. The best cultural control for many pests and diseases is a neat and tidy nursery.

Hand pick (if there are only a few). This works only at night; two hours after sunset is the best time. How dedicated are you?

Traps. Use an overturned clay flower pot, a raised board, a large buried coffee can with beer in the bottom (this must be monitored every day). It's okay to squash them; even if there are eggs inside, they are immature and will dry out. Remember that our pot racks are great traps. If you see damage in a rack of plants, most likely the snail is hiding under the rack. Pick it

up and look on the bottom-side of the rack, between the pots.

Barriers. On our benches, copper strips are the most effective barrier. Wrap a strip around each bench leg and keep the strips clean (oxidation, green on the stips, will not affect the effectiveness of this method).

Predators. Ducks; chickens (do we want to go there?); or Decollate snails, which have been introduced in southern California from North Africa and feed on the brown garden snail. If you find a Decollate snail, it can be left to feed on the brown snails, but be sure it doesn't go to the field. The Decollate snail also likes seedlings, so beware.

Chemical controls. Snail bait can create new generations of resistant snails as well as poison dogs, cats, and other predators. If you want to use bait, call the nursery specialist first.

Insects

Insects have six legs and are divided into orders, a higher classification than families (commonly used with plants). They have chewing mouthparts or rasping-sucking mouthparts depending on their stage of development. A caterpillar chews leaves, a butterfly sucks nectar. Insects go through metamorphoses, both partial and complete. Insects that chew, leaving holes in leaves or cut stems, include grasshoppers, sowbugs, earwigs, crickets, and most beetles. Sucking insects include aphids, scales, true bugs, leafhoppers. and thrips. They insert their mouthparts into the **phloem** and remove sap or photosynthetic sugars; this causes leaves to curl, discolor, and drop.

Most of the insect problems in our nursery are from the *Hemipterans* and *Coleopterans*, true bugs (including aphids and scales) and weevils. When we consider how best to control insects, we must think about the ecosystem in which the pest lives, our nursery. That ecosystem must provide food and shelter. There may also be predators. Control usually means altering the food and shelter being provided for the pest.

Black vine weevil (strawberry root weevil)

Symptoms

Attacks roots of container plants. Plants suddenly look unhealthy, wilted, and dry. Examination of the root system shows that part or all of the roots have been eaten by the grubs. Plants can be easily pulled from the soil/container. Adult feeding gives a scalloped edge to the leaves.

Life Cycle

Black vine weevils cannot fly. They tend to stay within 30 feet of where they hatched; avoid grassy areas, preferring pavement or cleared walkways; and crawl under greenhouse doors or through vents. The adult feeds on the edge of leaves (thus, the scalloped effect). Feeding takes place only at night. They hide in the soil during the day. Weevils are all female; reproduction is parthenogenic. Egg laying begins about ten weeks after emergence from the pupal stage. The black vine weevil lays up to a thousand eggs between mid-May and mid-September. Eggs are laid in the soil and hatch in three weeks; the brown-headed white grubs feed on roots for two to three months before forming pupae. This stage lasts seven weeks.

Physical Controls

Physical barriers work for ants and weevils. Attach inverted pie pans to the legs of nursery benches; they must form tightly to the bench. Coat the underside with Tanglefoot or other sticky adhesive.

Seal the bottom of greenhouses with screen, weather-stripping, or caulking. Use screen vents.

Common Orders

Order	Example	Mouthparts	Metamorphosis	Antennae	Wings/Pairs
Odonata	dragonflies	chewing	complete	short	2 or none
Dictyoptera	cockroaches	chewing	gradual	segmented	2
Isoptera	termites	chewing	gradual	segmented	2
Dermaptera	earwigs	chewing	gradual	long	2
Orthoptera	grasshoppers	chewing	gradual	vary	2 or none
Phthiraptera	lice	chewing	gradual	short	none
Hemiptera, Homoptera	true bugs, aphids, scales, mealybugs	sucking	gradual or simple	vary	2 or none
Thysanoptera	thrips	rasping/sucking	intermediate	short-medium	2, fringed
Lepidoptera	butterflies & moths	sucking & chewing	complete	vary	2
Diptera	flies	sucking	complete	vary	1
Siphonaptera	fleas	piercing	complete	short	none
Neuroptera	lacewings	chewing	complete	look like sausage links	2
Coleoptera	beetles, weevils	chewing	complete	long	2
Hymenoptera	bees	chewing	complete	vary	2

Biological Controls

Nematodes, small, needle-nosed insects, often burrow into and feed on plant roots. However, two nematode species, *Stierernema carpocapsae* and *Heterorhabditis heliothidis*, are used as biological controls, burrowing into the weevil adult or grub in the soil. *H. Heliothidis*, which goes to greater soil depths, seems to be more effective.

Nematodes are mixed with water and applied as part of the irrigation process; they can be applied through a Syphonex or Dosatron injector (soil must also be moist before application). The nematodes, which live approximately three months, can begin laying eggs in May; one application is made then, followed by a second in August.

Once all weevils are killed, any nematodes remaining starve to death, so there should be no worry of contaminating a planting site with nematodes.

Aphids

There are over four thousand species of aphids, including green, black, blue, white, and woolly ones. They are all generally similar in appearance. An aphid injures plants by inserting its **stylet** and sucking plant juices. They often attack tender growing tips first.

Symptoms
Damage shows as curled, wilting, or deformed leaves; stunted growth; chlorosis; honeydew; and black sooty mold that grows on the honeydew.

Life Cycle
Aphids overwinter as shiny black eggs in bud scales or bark crevices. In spring, the mother hatches and proceeds to give live birth to only females; she does this through the spring and summer season (this is why aphid populations can increase so rapidly). In the fall, as days shorten, the females produce winged males that mate with females, producing the overwintering eggs. Depending on habitat condition, this cycle can vary from species to species.

Physical Controls
Screening: regular window screens will help exclude aphids from the greenhouse (manufacturers usually have "add-ons" for screening vents). Pinch or prune: pinch or prune off infested plant parts. Combine this with washing. Use a strong stream of water to remove much of the population. This will need to be repeated over several weeks. Soapy water may be used, but plants must be rinsed with clear water afterward to avoid having the soap kill the plant. Ant barriers: see description of barriers under weevil and snail sections.

Horticultural Controls
Reduce the nitrogen; aphids love soft, tender, new growth, which is increased by nitrogen. New growth has thin cuticle and cell walls, which make it easy for aphids to insert their mouth parts. Plants must be kept healthy. Plants stressed by overwatering or drying out can also fall prey to aphids.

Biological Controls
Maintain a native garden and encourage native predators, who will be there to eat the first aphids that hatch and keep populations in balance. Lots of insects eat aphids. Look for green lacewings, lady beetles, and gall midges. Midges are in the fly family; adults are small, fragile flies with very long legs, almost like small mosquitoes. They like members of the *Asteraceae* family and can often be found on dandelions and other composite flowers.

Collect midges from infested plants and bring into the greenhouse or shadehouse. To collect gall midges, place leaves and stem from a plant heavily infested with aphids in the field into a large clear-plastic bag. Blow up the bag like a balloon and close with twist ties. Put in a shady place for a day or two, then examine under a good light. Gall midges will be seen as tiny, orange, worm-shaped fly larvae clinging to the inside of the bag. Turn the bag over and more should come off the leaves and stick to the plastic. Use a fine paintbrush moistened with water to pick them up and transfer to your plants. The larvae take about five days to mature, and molt four times, killing aphids the whole time.

Scale
Two types, armored and soft, and in the same Order (*Homoptera*) as aphids. They can be controlled using the same methods, though scales' protective coating makes control more difficult than for aphids. Like the aphid, scale has a stylet that it uses to perforate the plant surface and suck out juices. They excrete honeydew, which does not harm the plant. However, it is soon host to black sooty mold fungus and ants.

Armored scale have scabs about 1/8 inch in diameter. They produce little honeydew. However, soft scale do produce honeydew and form a larger and darker shell. Ants eat the honeydew, so they actually farm the scale and cover them to protect them from harm.

Symptoms
Scale look like small bumps on leaves, twigs, and stems. Closer inspection reveals the shell cover. Scale and mealybugs normally do not move. Plant symptoms are the same as aphids: wilting, yellowing, possible distortion of leaves or stems, and a water-stressed look. When their shell is lifted, armored scale stay on the plant, but soft scale adhere to their shell.

Life Cycle
If the shell is turned over, eggs are revealed underneath. They hatch into crawlers with legs. For a few days they may walk around but gradually settle in one spot, molt, and form their shells. Scale will be found along the stem of a plant. Life cycles vary from species to species. Some have no males, some have male crawlers.

Monitoring is essential; a few scale will not harm a plant, but large populations can cause problems. If you are not sure if it is a plant bump or scale, use a penknife and scrape it; if it lifts up, it's a scale. Usually there will be honeydew on the leaf under the scale. Scale are protected by a shell at both the egg and adult stages, which makes control more difficult. The best time is at the newly hatched crawler stage, approximately a week after a mass of eggs is observed around the mother's body. When they hatch, they're most vulnerable to control methods.

Physical Controls
Rub them off by hand or with a cotton swab dipped in alcohol.

Horticultural Controls
Prune off infested parts and reduce nitrogen levels (scale love lush plants).

Biological Controls
Control ants. Parasitoids feed directly on scale; feeding is noted by tiny pin-size exit holes in shells. Mealybug destroyers, *Cryptolaemus montrouzieri*, also feed on scale and are commercially available. In their larval form, green lacewings feed on scale (adult lacewings feed on nectar and pollen only). The larvae look like little alligators and have a huge appetite.

Non-toxic Chemical Controls
Soaps are limited in effectiveness; horticultural oils like Sunspray or Volke, safe and more highly refined than oils in your kitchen, cover the scale and suffocate them and can be very effective. Permission of the IPM coordinator must be granted before using these oils.

Mealybugs
Close relatives of the soft scale; California has 193 species. In early infestations, they hide in leaf axils and snug places. Later, the colony's whitish, waxy covering make them very visible. Ants will pick them up and move them to a new site.

Symptoms
Same as aphids and scale.

Life Cycle
Each female produces up to a thousand eggs; there are as many as eight generations in a year, with instars after hatching (they molt three times and do not pupate); winged males live only a few days.

Physical Controls
Rub off by hand; control the ants with barriers, as ants will kill the natural predators. Rubbing alcohol and a swab on small infestations.

Horticultural Controls
Monitor plants frequently; control nitrogen levels. They will move to the roots or crown of a slow-growing plant; be sure to check this area when monitoring.

Biological Controls
Mealybug destroyers (as described for scales), which look like mealybugs in their larval stages; adults are small, red-and-orange ladybugs that tend to fly towards light when released, so they need to be enclosed. Green lacewings also eat mealybugs.

Non-toxic chemical controls. Mealybugs on roots can be treated by setting plant in soapy water until thoroughly wet; soil bacteria will break down the soap rapidly. Repeat in seven days. Check the root ball a week later; if mealybugs are still present, treat again. After control is achieved, leach the rest of the soap out of the soil with lots of water.

Horticultural oils, Sunspray or Stylet oils cover the pest or clog their stylets and can be very effective. IPM Specialist must grant permission before these oils can be used.

Arachnids

The Arachnid Class includes spider mites as well as spiders and ticks. Arachnids have eight legs.

Spider Mites

Symptoms
Stippling or tiny yellow or white spots on leaves. No brown or black spots. Leaves may turn pale green or yellow. Brown patches on the underside of leaves, webs formed if infestation is severe. Mites are tiny, about the size of this period. A hand lens is needed to see them clearly.

Life Cycle
An individual mite reaches adulthood in a few days, and they produce many generations per year. Live in colonies on the bottom of leaves. Immature mites resemble the adults. Adults hibernate in debris. Eggs are round and translucent, like tiny drops, turning cream color before hatching.

Physical Controls
They like hot, dry dusty conditions. Spray plants to raise humidity levels and keep clean. Keep plants out of direct afternoon sun. Shade to keep temperatures down.

Horticultural Controls
Keep plants in a non-stressed condition. Mites occur when plants are water-stressed, rootbound, or when plants are dusty and dry.

Biological Controls
Predator mites keep spider mites in balance but must be introduced early in order to keep up with rapid population growth.

Non-toxic Chemical Controls
We have not found insecticidal soaps to be effective for spider mite infestations, but might be used on a small population; 2 percent horticultural oil is very effective but needs to be reapplied periodically; sulfur can be phytotoxic in some cases—use carefully and check with nursery—or IPM Specialist before using any chemical.

It's pretty obvious that good horticultural practices are the best insect and mite controls. Plants should have sufficient but not high nitrogen levels so that they grow slowly and do not become rootbound. If this happens, make a note and start the plant later the following year, or put in a larger pot. Move plants from the greenhouse to the cooler shadehouse as soon as possible. Monitor for pests at least once a week.

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7.6 NATIVE PLANT NURSERY DISEASES AND CONTROLS

Three major diseases affect the native plant nursery. All are fungal and can do a tremendous amount of damage.

Scab (*Spilocaea* spp.)

It affects toyon (*Heteromeles arbutifolia*). Toyon is a member of the rose family (*Rosaceae*), and scab is a common disease for this group of plants. A closely related fungus, *Venturia* spp. occurs on coffeeberry (*Rhamnus californica*).

Symptoms

On seedlings, bronzing then scabby, crispy leaves, especially newest ones; new growth curls, crinkles, and dies. On mature leaves, and older plants, scabby spots, scattered over leaves; shoots may die.

Life Cycle and Progression

Scab fungi overwinter primarily on fallen leaves or on lesions on twigs. Germinates in cool, wet winter and spring weather. Will not grow if the environment is hot or dry.

Spores on the ground, on infected plant leaves, or on dead leaves on the ground or in the pot.

Rain or irrigation water splashes the spores from plant to plant.

To germinate, spores must be continuously wet for fourteen hours at 50°F (19°C). They grow a **hyphae** (vegetative strands) that pierce the cuticle of the leaf (or flower or fruit). Hyphae multiply and grow between the cuticle and outer wall of the epidermis. It takes several days for an infection to show; symptoms appear as the infected cells die.

Spores survive dry weather as dormant **conidiospores** that remain on the plant and germinate when climate is cool and wet again.

Control

Germinate and grow toyon only in a warm greenhouse, or outside after weather warms up and rains stop. Any toyon still in the nursery in the fall should be brought back into the greenhouse before winter rains begin.

No disease spreads as fast as scab on toyon. **Sanitation, sanitation!** Keep your feet out of the soil mix. Cull infected plants mercilessly. Move any funny-looking seedlings or plants away from healthy plants, or the next day, the healthy ones will be infected.

Clean up any fallen dead leaves.

An application of sulfur application (considered an organic treatment) can help prevent scab, but so will good horticultural practices.

Root Rot (*Phytophthora* spp.)

It affects most plants and its spores are everywhere. The hyphae grow through plants' xylem vessels (water-carrying cells) and clog them up. Then plants can't take up water, even though the ground is wet. Seedlings can be killed in a few days to months; small secondary feeder roots

are killed first, and brown areas will show on larger roots.

Particularly susceptible plants are:
Box elder (*Acer negundo californicum*)
Buckeye (*Aesculus californicum*)
Alder (*Alnus* spp.)
Madrone (*Arbutus menziesii*)
Manzanita (*Arctostaphylos* spp.)
Coyote bush (*Baccharis* spp.)
Ash (*Fraxinus latifolia*)
Flannel bush (*Fremontodendron californicum*)
Toyon (*Heteromeles arbutifolia*)
Northern California black walnut (*Juglans californica hindsii*)
Cottonwood, poplars (*Populus* spp.)
Bay, bay laurel, myrtle (*Umbellularia californica*)

Symptoms
Plants wilt even though soil is wet; additional watering worsens the plants' condition. Plants are stunted and slow-growing. Leaves are a darker-than-usual green. Branches on large plants or whole seedlings wilt and die. When you peel the bark, the epidermis and xylem area will be brownish rather than a healthy green. On cuttings, black areas appear first on the stem. Roots are first brown or black and firm and brittle, then soften and decay.

Life Cycle and Progression
Overwinters as **mycelium** in infected roots in the soil, or as dormant spores (oospores or chlamydospores).

In the spring, dormant spores germinate and swim (zoospores) around in the soil water until a susceptible root is found.

Overwatering causes epidermis cells to swell, burst, and leak sugars, attracting the zoospores, which need sugars to live; they enter the roots through cracks.

Zoospores thrive in cool wet weather. In hot, dry or too cold (under 59°F) weather, spores survive in one of the dormant forms.

Control
Sanitation. Clean soil, clean pots. Keep feet out of soil mix. Keep soil mix pile clean.

Use light, well-drained mix.

Be sure cutting material is free of infection.

Damping-off Diseases (*Pythium* spp., *Rhizoctonia* spp.) affects redwoods and many herbaceous plants.

Also found in soil and water, damping-off diseases are related to root rot and are often indistinguishable from it.

Symptoms
Very young seedlings flop over at soil level and die.

Roots become soft, mushy, darkened, and decayed.

More mature plants grow slowly, gradually decline, exhibit terminal dieback, and then die.

Life cycle
Similar to root rot.

Control
Same as for root rot: sanitation; soak seed flats in bleach solution; keep soil mix clean; don't overwater.

Powdery Mildew
It is caused by many species of fungus, and affects roses and new oak growth. Powdery white or grayish growth on leaves of susceptible plants. Some species infect many types of plants, and some species only infect a single species or plant. *Sphaerotheca pannosa* var. *rosae* infects roses. Unlike other fungi, they do not need

free water to germinate.

Symptoms
Gray or white blotches on leaves. “Witches broom,” whitish covering on new oak growth. Leaves and shoots become distorted, dwarfed, discolored, and crinkly; infected leaves drop prematurely.

Life Cycle
Spores are windblown.

White or gray spots on the plant contain hyphae and spores, often in chains that can be seen with a hand lens.

Survives in plant tissue and dormant buds (not in the soil).

Control
These measures only help if they are initiated before the disease is too far along. Monitor crops and take action as soon as symptoms are noticed.

Unlike other fungal diseases, spores germinate in dry conditions. Water and direct sunlight inhibit powdery mildew germination, so put plants in the sun.

Most spores of this species are formed in the mid-afternoon, and spraying the plants with water at this time will prevent germination and kill germinated spores. However, be sure to spray early enough in the afternoon so that plants can dry before nightfall to prevent other diseases.

Good air circulation helps, so space plants out if you can.

Prune infected tissue and remove from the area.

Powdery mildew likes tender new growth; don’t overfertilize and stop fertilizing entirely in early fall.

Keep every aspect of the nursery free of exotic weeds-pots, greenhouse, shadehouse, and areas near the nursery. Weeds can carry eggs and adult insects, pests, and fungal spores.

Monitoring
The take-home lesson for disease prevention and reduction is to monitor your nursery closely. Do daily inspections, make notes of what you see on the nursery monitoring form. Take the form with you while monitoring, and when possible, do your nursery checks with another responsible person, so you’re sure not to miss anything! Make quantitative notes.

7.7 BOTANICAL NOMENCLATURE

Every known living thing has been classified and given a name according to strict rules. This enables anyone anywhere in the world to understand and communicate about a particular plant or animal without confusion. As an employee or intern member of the nursery staff, you need to understand how this system works and become comfortable with it.

This is basic biology. Each rank is more specific as you go down the list (see Table on page 78).

The particular variety of California rose used in the table is called *Rosa californica* var. *brevifolia*. Usually, the genus and specific name are all that are used for our purposes. If there is a unique population of a plant, that has been given a variety or sub-species name we will use that too.

The ranks down through **variety** are all used for plants occurring naturally in the wild. If the plant has been bred by humans

or selected for a certain trait and reproduced **asexually** (clones), it is usually given a cultivar (cultivated variety) name. This is indicated by single quote marks around the cultivar name or cv. before the cultivar name, e.g. *Rosa californica* 'Pinkie'. The genus and species names are italicized because they are always in Latin, but the cultivar is named in the language of the breeder and is not italicized.

In botany, horticulture, and ecology, we usually start with the Family to identify a plant. The plant name we use is usually the genus and species name. That is, it's Latin binomial. The genus is always capitalized; the spcies is never capitalized unless it is derived from someone's name. The botanical name is always in *italics* or <u>underlined</u> since it is a foreign langugage.

Rank	Name ends in	Example
Kingdom division	.phyta	Tracheophyta
Class	.ae	Angiospermae
Subclass	.ae	Dicotyledonae
Order	.ales	Rosales
Family	..aceae	Rosaceae
Subfamily	.aideae	Rosaideae
Tribe	.eae	Roseae
Genus	..us, a, um, es, on, etc.	Rosa
Subgenus		
Specific Name (Species)	agrees in Latin with the Genus	californicia
Subspecies		
Variety		brevifolia
Cultivar (cultivated variety)	in Common Language (English)	'Pinkie' or cv. Pinkie

Section 8
Life on Milagra Ridge

LIFE ON MILAGRA RIDGE

8.1 PLANT LIST

Classification and nomenclature after Hickman, et al. 1993. Updated by Peter Warner, 7/5/00.

FAMILY/ Division	Botanical Name	Subspecies / Variety (var.)	Common Name
Division **Sphenophyta**			
EQUISETACEAE - Horsetail Family (2 taxa)			
	Equisetum arvense		common horsetail
	E. telmateia	*braunii*	giant horsetail
Division **Pterophyta**			
BLECHNACEAE -- Deer Fern Family (1 taxon)			
	Woodwardia fimbriata		giant chain fern
DENNSTAEDTIACEAE - Bracken Family (1 taxon)			
	Pteridium aquilinum	var. *pubescens*	bracken
DRYOPTERIDACEAE - Wood Fern Family (3 taxa)			
	Athyrium filix-femina	var. *cyclosorum*	lady fern
	Dryopteris arguta		wood fern
	Polystichum munitum		western sword fern
POLYPODIACEAE - Polypody Family (2 taxa)			
	Polypodium californicum		California polypody
	P. scouleri		leather-leaf fern
PTERIDACEAE - Brake Family (2 taxa)			
	Adiantum jordanii		California maiden-hair
	Pentagramma triangularis	*triangularis*	goldback fern
Division **Coniferophyta** - Cone-bearing Plants			
CUPRESSACEAE - Cypress Family (2 taxa)			
	*Cupressus macrocarpa**		Monterey cypress
	Juniperus sp.*		juniper

PINACEAE - Pine Family (3 taxa)		
	*Pinus radiata**	Monterey pine
	Pinus sp.	pine
	Pseudotsuga menziesii	Douglas-fir
Division **Anthophyta** - Flowering Plants		
Class Dicotyledones		
ACERACEAE -- Maple Family (1 taxon)		
	Acer macrophyllum	bigleaf maple
AIZOACEAE - Sea Fig Family (1 taxon)		
	*Carpobrotus edulis**	Hottentot-fig
ANARCARDIACEAE -- Cashew or Sumac Family (1 taxon)		
	Toxicodendron diversilobum	poison-oak
APIACEAE - Carrot / Celery / Parsley Family (14 taxa)		
[aka UMBELLIFERAE]	*Angelica hendersonii*	angelica
	*Anthriscus caucalis**	bur-chervil
	*Conium maculatum**	poison hemlock
	*Daucus carota**	Queen Anne's lace
	D. pusillus	rattlesnake weed
	*Foeniculum vulgare**	fennel
	Heracleum lanatum	cow parsnip
	Lomatium caruifolium	hog-fennel
	L. utriculatum	hog-fennel
	Sanicula arctopoides	footsteps-of-spring
	S. bipinnatifida	purple sanicle; shoebutto
	S. crassicaulis	snakeroot
	S. laciniata	sanicle
	*Scandix pecten-veneris**	shepherd's needle
APOCYNACEAE - Dogbane Family (1 taxon)		
	*Vinca major**	periwinkle
AQUIFOLIACEAE - Holly Family (1 taxon)		
	*Ilex aquifolium**	English holly
ARALIACEAE - Ginseng Family (1 taxon)		
	*Hedera helix**	English ivy
ASTERACEAE - Sunflower Family (56 taxa)		
[aka COMPOSITAE]	*Achillea millefolium*	yarrow
	Agoseris grandiflora	California dandelion
	Anaphalis margaritacea	pearly everlasting
	Artemisia californica	California sagebrush
	A. douglasiana	mugwort
	Aster chilensis	aster

Baccharis pilularis		coyote brush
*Bellis perennis**		English lawn daisy
*Carduus pycnocephalus**		Italian thistle
*Centaurea melitensis**		tocalote; Napa starthistle
*Chamomilla suaveolens**		pineapple weed
Cirsium brevistylum		Indian thistle; cluster this
C. occidentale		cobweb thistle
C. quercetorum		brownie thistle
*C. vulgare**		bull thistle
*Conyza bonariensis**		horseweed
*C. floribunda**		horseweed
*Delairea odorata**		Cape-ivy
*Erechtites minima**		Australian fireweed
Erigeron foliosus	var. *franciscensis*	fleabane
E. glaucus		seaside daisy
Eriophyllum staechadifolium		seaside woolly sunflower
Filago californica		herba impia
*F. gallica**		herba impia
Gnaphalium californicum		cudweed
G. canescens		cudweed
*G. luteo-album**		cudweed
G. purpureum		cudweed
G. ramossisimum		cudweeed
Grindelia camporum		gumplant
G. hirsutula		gumplant
G. stricta		gumplant
Helenium puberulum		rosilla, sneezeweed
Hemizonia congesta	*congesta*	tarweed
*Hypochaeris glabra**		smooth cat's-ear
*H. radicata**		rough cat's-ear
*Lactuca biennis**		lettuce
Layia hieracioides		
*Leucanthemum vulgare**		ox-eye daisy
Madia gracilis		tarweed
M. sativa		coast tarweed
Microseris acuminata		microseris
M. bigelovii		
*Picris echioides**		bristly ox-tongue
Senecio aronicoides		butterweed
*S. vulgaris**		groundsel; ragwort
*Silybum marinum**		milk thistle
Solidago canadensis	elongata	Canada goldenrod
*Soliva sessilis**		soliva
*Sonchus asper**	asper	prickly sow-thistle
*S. oleraceus**		common sow-thistle
*Taraxacum officinale**		dandelion
*Tragopogon porrifolius**		salsify; oyster plant
Uropappus lindleyi		silver puffs
*Urospermum picroides**		urospermum

	Wyethia angustifolia		mules' ears
BERBERIDACEAE -- Barberry Family (1 taxon)			
	Berberis pinnata		Oregon-grape
BETULACEAE -- Birch Family (1 taxon)			
	Corylus cornuta	var. *californica*	hazelnut
BORAGINACEAE - Borage Family (4 taxa)			
	Amsinckia menziesii	var. *intermedia*	fiddleneck
	Cynoglossum grande		hound's-tongue
	*Echium pininana**		pride-of-Tenerife
	Plagiobothrys nothofulvus		popcorn flower
BRASSICACEAE - Mustard Family (13 taxa)			
[aka CRUCIFERAE]	*Arabis blepharophylla*		rock cress
	A. glabra	var. *glabra*	tower mustard
	Barbarea orthoceras		
	*Brassica rapa**		field mustard
	*Capsella bursa-pastoris**		shepherd's purse
	Cardamine californica		milk maids
	C. oligosperma		winter cress
	*Coronopus didymus**		swine cress
	Erysimum franciscanum		San Francisco wallflower
	*Hirschfeldia incana**		mustard
	*Lobularia maritima**		sweet alyssum
	*Raphanus sativus**		radish
	Rorippa nasturtium-aquaticum		watercress
CAPRIFOLIACEAE - Honeysuckle Family (5 taxa)			
	Lonicera hispidula	var. *vacillans*	honeysuckle
	L. involucrata		twinberry
	Sambucus racemosa	var. *racemosa*	red elderberry
	Symphoricarpos albus	var. *laevigatus*	snowberry
	S. mollis		creeping snowberry
CARYOPHYLLACEAE - Pink Family (6 taxa)			
	Cerastium arvense		field chickweed
	*C. glomeratum**		mouse-ear chickweed
	*Polycarpon tetraphyllum**		four-leaved allseed
	*Silene gallica**		windmill pink
	*Spergularia rubra**		sand-spurrey
	*Stellaria media**		chickweed
CHENOPODIACEAE --Goosefoot Family (2 taxa)			
	Chenopodium californicum		pigweed
	Chenopodium sp.		pigweed
CONVOLVULACEAE - Morning-glory Family (4 taxa)			

	Calystegia purpurata	*purpurata*	morning-glory
	C. subacaulis	*subacaulis*	morning-glory
	*Convolvulus arvensis**		field bindweed
	Dichondra donelliana		dichondra
CORNACEAE -- Dogwood Family (1 taxon)			
	Cornus sericea	*sericea*	creek dogwood
CRASSULACEAE - Stonecrop Family (6 taxa)			
	*Aeonium arboreum**	var. *arboreum*	
	*Crassula argentea**		jade plant
	C. connata		sand pygmy weed
	Dudleya farinosa		live-forever
	Parvisedum sp.		stonecrop
	Sedum spathulifolium		stonecrop
CUCURBITACEAE - Gourd Family (2 taxa)			
	Marah fabaceus		California man-root
	M. oreganus		coast man-root
DIPSACACEAE - Teasel Family (1 taxon)			
	*Scabiosa atropurpurea**		pincushion flower
ERICACEAE - Heather Family (1 taxon)			
	Vaccinium ovatum		blue huckleberry
EUPHORBIACEAE -- Spurge Family (1 taxon)			
	*Euphorbia peplus**		petty spurge
FABACEAE - Legume Family (32 taxa)			
[aka LEGUMINOSAE]	*Acacia longifolia**		Sydney golden wattle
	*A. melanoxylon**		blackwood acacia
	Astragalus gambelianus		milkvetch
	A. nuttallii	var. *virgatus*	milkvetch
	*Cytisus scoparius**		Scotch broom
	*Genista monspessulana**		French broom
	*Lathyrus cicera**		pea
	*L. latifolius**		perennial sweet pea
	L. vestitus		hillside pea
	*Lotus corniculatus**		bird's-foot trefoil
	L. humistratus		lotus
	L. micranthus		lotus
	L. wrangelianus		lotus
	Lupinus albifrons	var. *collinus*	silver lupine
	L. arboreus		bush lupine
	L. bicolor		dove lupine
	L. latifolius	var. *dudleyi*	lupine
	L. nanus		sky lupine
	L. variicolor		vari-colored lupine

	*Medicago polymorpha**		bur-clover
	*M. sativa**		alfalfa
	*Melilotus indica**		sourclover
	*Trifolium campestre**		hop clover
	*T. dubium**		little hop clover; shamroc
	*T. hirtum**		rose clover
	T. macraei		clover
	*T. pratense**		red closver
	*T. repens**		white clover
	T. willdenovii		tomcat clover
	Vicia americana	var. *americana*	American vetch
	V. gigantea		giant vetch
	*V. sativa**	*sativa*	spring vetch; common v
FAGACEAE - Beech Family (3 taxa)			
	Quercus agrifolia		coast live oak
	Q. berberidifolia		scrub oak
	Q. chrysolepis		canyon live oak
GARRYACEAE - Silktassel Family (1 taxon)			
	Garrya elliptica		silktassel bush
GENTIANACEAE - Gentian Family (1 taxon)			
	Centaurium davyi		centaury
GERANIACEAE - Geranium Family (4 taxa)			
	*Erodium botrys**		filaree; crane's-bill
	*E. cicutarium**		filaree; crane's-bill
	*Geranium dissectum**		geranium
	*G. retrorsum**		geranium
GROSSULARIACEAE -- Gooseberry Family (1 taxon)			
	Ribes menziesii		canyon gooseberry
HIPPOCASTANACEAE - Buckeye Family (1 taxon)			
	Aesculus californica		California buckeye
HYDROPHYLLACEAE - Waterleaf Family (3 taxa)			
	Phacelia californica		phacelia
	P. distans		fernleaf phacelia
	P. malvifolia		phacelia
LAMIACEAE - Mint Family (8 taxa)			
[aka LABIATAE]	*Lepechinia calycina*		pitcher sage
	Mentha arvensis		mint
	*M. spicata**	var. *spicata*	spearmint
	Monardella villosa	*franciscana*	coyote-mint
	Prunella vulgaris	var. *vulgaris**	self-heal
	Satureja douglasii		yerba buena

	Stachys ajugoides	var. *rigida*	hedge-nettle
	S. chamissonis		hedge-nettle
LINACEAE - Flax Family (1 taxon)			
	*Linum bienne**		flax
LYTHRACEAE - Loosestrife Family (1 taxon)			
	*Lythrum hyssopifolium**		loosestrife
MALVACEAE - Mallow Family (2 taxa)			
	*Malva parviflora**		cheeseweed
	Sidalcea malvaeflora	*malvaeflora*	checker mallow
MYOPORACEAE - Myoporum Family (1 taxon)			
	*Myoporum laetum**		
MYRICACEAE - Wax Myrtle Family (1 taxon)			
	Myrica californica		wax myrtle
MYRTACEAE - Myrtle Family (2 taxa)			
	*Eucalyptus globulus**		bluegum
	*Leptospermum laevigatum**		tea tree
OLEACEAE -- Olive Family (1 taxon)			
	*Olea europaea**		olive
ONAGRACEAE - Evening-primrose Family (5 taxa)			
	Camissonia ovata		sun cups,
	Clarkia rubicunda		clarkia
	Epilobium brachycarpum		fireweed, willow herb
	E. ciliatum	*watsonii*	fireweed, willow herb
	Fuchsia sp.*		ornamental fuchsia
OROBANCHACEAE -- Broom-rape Family (1 taxon)			
	Orobanche sp.		broom-rape
OXALIDACEAE - Oxalis Family (3 taxa)			
	Oxalis albicans	*pilosa*	oxalis
	*O. corniculata**		
	*O. pes-caprae**		Bermuda-buttercup
PAPAVERACEAE - Poppy Family (2 taxa)			
	Eschscholzia californica		California poppy
	Platystemon californicus		cream cups
PITTOSPORACEAE - Pittosporum Family (2 taxa)			
	*Pittosporum crassifolium**		pittosporum
	*P. undulatum**		Victorian box; mock oran

PLANTAGINACEAE - Plantain Family (3 taxa)			
	*Plantago coronopus**		plantain
	P. erecta		dwarf plantain
	*P. lanceolata**		English plantain
POLEMONIACEAE - Phlox Family (2 taxa)			
	Navarretia squarrosa		skunkweed
	Phlox gracilis		phlox
POLYGONACEAE - Knotweed Family (6 taxa)			
	Eriogonum latifolium		coast buckwheat
	*Polygonum arenastrum**		prostrate knotweed
	P. punctatum		smartweed
	*Rumex acetosella**		sheep sorrel
	*R. conglomeratus**		dock
	*R. crispus**		curly dock
PORTULACACEAE - Purslane Family (2 taxa)			
	Calandrinia ciliata		red maids
	Claytonia perfoliata		miner's-lettuce
PRIMULACEAE - Primrose Family (2 taxa)			
	*Anagallis arvensis**		scarlet pimpernel
	Dodecatheon hendersonii		shooting star
RANUNCULACEAE - Buttercup Family (5 taxa)			
	Aquilegia formosa		columbine
	Delphinium californicum		larkspur
	D. decorum		larkspur
	Ranunculus aquatilis	var. *subrigidus*	buttercup
	R. californicus		California buttercup
RHAMNACEAE - Buckthorn Family (2 taxa)			
	Rhamnus californica		California coffeeberry
	R. crocea		redberry
ROSACEAE - Rose Family (22 taxa)			
	Acaena pinnatifida	var. *californica*	
	Aphanes occidentalis		
	*Cotoneaster franchetii**		cotoneaster
	*C. lacteus**		cotoneaster
	*C. pannosa**		feltleaf cotoneaster
	Cotoneaster sp.*		cotoneaster
	*Crataegus monogyna**		hawthorn
	Fragaria chiloensis		beach strawberry
	F. vesca		wood strawberry
	Heteromeles arbutifolia		toyon
	Holodiscus discolor		ocean spray
	Horkelia californica		horkelia

	Oemleria cerasiformis		oso berry
	Potentilla anserina	*pacifica*	silverweed; silver beach
	P. glandulosa	*glandulosa*	cinquefoil
	Prunus ilicifolia		hollyleaf cherry
	*Pyracantha angustifolia**		firethorn
	Rosa gymnocarpa		California wild rose
	*R. eglanteria**		sweet-brier
	*Rubus discolor**		Himalayan blackberry
	R. parviflorus		thimbleberry
	R. ursinus		California blackberry
RUBIACEAE - Madder Family (4 taxa)			
	Galium aparine		bedstraw; goosegrass
	G. californicum		bedstraw; cleavers
	G. porrigens		bedstraw
	*Sherardia arvensis**		field madder
SALICACEAE -Willow Family (2 taxa)			
	Salix lasiolepis		arroyo willow
	S. sitchensis		Sitka willow
SAXIFRAGACEAE -- Saxifrage Family (4 taxa)			
	Heuchera micrantha		alum root
	Lithophragma affine		woodland star
	Saxifraga californica		saxifrage
	Tellima grandiflora		fringe cups
SCROPHULARIACEAE - Figwort Family (12 taxa)			
	*Bellardia trixago**		bellardia
	Castilleja affinis		paintbrush
	C. exserta		purple owl's-clover
	C. latifolia		paintbrush
	C. wightii		paintbrush
	Collinsia multicolor		collinsia
	*Kickxia elatine**		fluellin
	Mimulus aurantiacus		sticky monkeyflower
	M. guttatus		seep monkeyflower
	*Parentucellia viscosa**		
	Scrophularia californica	*californica*	figwort; bee plant
	Triphysaria pusilla		dwarf owl's-clover
SOLANACEAE -- Nightshade Family (2 taxa)			
	Solanum douglasii		nightshade
	S. umbelliferum		nightshade
URTICACEAE - Nettle Family (1 taxon)			
	Urtica dioica	*holosericea*	stinging nettle
VALERIANACEAE - Valerian Family (1 taxon)			

	Plectritis brachystemon		plectritis
Class Monocotyledones			
ARACEAE -- Arum Family (2 taxa)			
	*Arum italicum**		Italian arum
	*Zantedeschia aethiopica**		calla lily
CYPERACEAE - Sedge Family (5+ taxa)			
	Carex dudleyi		sedge
	C. tumulicola		sedge
	Carex spp.		sedge
	Cyperus eragrostis		nut-sedge
	Eleocharis macrostachya		
	Scirpus californicus		bulrush
IRIDACEAE - Iris Family (3 taxa)			
	*Crocosmia crocosmiiflora**		montbretia
	Iris douglasiana		Douglas's iris
	Sisyrinchium bellum		blue-eyed grass
JUNCACEAE - Rush Family (6 taxa)			
	Juncus bolanderi		rush
	J. bufonius	var. *bufonius*	toad rush
	J. effusus		
	J. falcatus	var. *falcatus*	rush
	J. patens		
	Luzula comosa		wood rush
LILIACEAE - Lily Family (10 taxa)			
	Allium acuminatum		Hooker's onion
	*A. triquetrum**		
	*Amarylllis belladonna**		naked lady
	Calochortus albus		Mariposa tulip
	Chlorogalum pomeridianum		soap plant
	Dichelostemma capitatum	*capitatum*	blue dicks
	Fritillaria affinis		checker lily
	Smilacina stellata		false Solomon's-seal
	Trillium chloropetalum		giant trillium
	Triteleia laxa		Ithuriel's spear
ORCHIDACEAE - Orchid Family (2 taxa)			
	*Epipactis helleborine**		orchid
	Piperia elegans		piperia; rein orchid
POACEAE - Grass Family (47 taxa)			
[aka GRAMINAE]	*Agrostis capillaris**		colonial bentgrass
	A. pallens		bentgrass
	*Aira caryophyllea**		silver European hairgras
	*Avena barbata**		wild oats

	*Brachypodium distachyon**		
	*Briza maxima**		rattlesnake grass
	*B. minor**		quaking grass
	Bromus carinatus	var. *carinatus*	California brome
	B. carinatus	var. *maritimus*	California brome
	*B. diandrus**		ripgut brome
	*B. hordeaceus**		soft chess
	*B. madritensis**	*rubens*	red brome
	*B. madritensis**	*madritensis*	foxtail chess
	Calamagrostis stricta	*inexpansa*	reedgrass
	*Cortaderia jubata**		Andean plumegrass
	*C. selloana**		pampas grass
	*Dactylis glomerata**		orchard grass
	Danthonia californica	var. *californica*	California oatgrass
	D. californica	var. *americana*	Calif. Oatgrass
	Elymus glaucus	*glaucus*	blue wildrye
	*Festuca arundinacea**		tall fescue
	F. californica		California fescue
	F. rubra		red fescue
	*Gastridium ventricosum**		nit grass
	*Holcus lanatus**		purple velvet grass
	Hordeum brachyantherum		barley
	*H. marinum**	*gussoneanum*	Mediterranean barley
	*H. murinum**	*leporinum*	foxtail barley
	Koeleria macrantha		junegrass
	Leymus triticoides		
	*Lolium multiflorum**		Italian ryegrass
	*L. perenne**		perennial ryegrass
	Melica californica		California melic
	M. imperfecta		melic
	M. torreyana		melic
	Nassella lepida		needlegrass
	N. pulchra		purple needlegrass
	*Paspalum dilatatum**		dallis grass
	*Phalaris aquatica**		Harding grass
	*Poa annua**		annual bluegrass
	P. secunda	*secunda*	one-sided bluegrass
	P. unilateralis		ocean bluff bluegrass
	*Polypogon australis**		Chilean beard grass
	*P. maritimus**		Mediterranean beard gra
	*Triticum aestivum**		wheat
	*Vulpia bromoides**		
	*V. myuros**		rattail fescue
TYPHACEAE -- Cattail Family (1 taxon)			
	Typha angustifolia		cattail

8.2 MILAGRA RIDGE BUTTERFLY LIST

observed by Robert Langston 1985-1991, 1993-1994

Hesperlidae: True Skippers

Polites sabuleti, Sandhill skipper
Hylephila phyleus, Fiery skipper
Pyrgus communis, Common checkered skipper
Poanes melane, Umber skipper
Ochlodes sylvanoides, Woodland skipper

Papilionidae: Swallowtails

Papilio eurymedon, Pale swallowtail
Papilio rutulus, Western tiger swallowtail
Papilio zelicaon, Anise swallowtail

Pieridae: Whites and Sulfers

Euchloe ausonides, Large marble
Colias eurytheme, Orange sulfur
Phoebis agarithe, Large orange sulfur
Pontia protodice, Checkered white
Anthocharis sara, Sara orange-tip
Pieris rapae, Cabbage white

Satyridae: Satyrs and Wood Nymphs
Coenonympha tullia, Common ringlet

Danaidae: Milkweed Butterflies
Danaus plexippus, Monarch

Lycaenidae: Gossamer-winged Butterflies

Callophrys dumetorum, Green hairstreak
Celastrina ladon echo, Echo blue (spring azure)
Icaricia acmon, Acmon blue
Icaricia icarioides missionensis, Mission blue
Strymon melinus pudicus, Common hairstreak
Lycaena xanthoides, Great copper
Callophrys mossii bayensis, San Bruno elfin

Nymphalidae: Brushfooted Butterflies

Phyciodes pratensis, Field crescent
Phyciodes mylitta, Mylitta crescent
Junonia coenia, Buckeye
Vanessa annabella, West coast lady
Vanessa atalanta rubria, Red admiral
Vanessa cardui, Painted Lady
Vanessa virginiensis, American painted lady
Nymphalis californica, California tortoise shell

8.3 ENDANGERED SPECIES OFMILAGRA RIDGE

Mission Blue Butterfly (*Icaricia icarioides missionensis*)

Status
Endangered

Description
On the upperside of the wings, the adult female is brown with some blue, and the male is light blue. Both have blackish wing edges. The underside of the wings is off-white with two rows of irregularly shaped black spots. The larva (caterpillar) is light green with diagonal white bars on each segment.

Size
Adults are about the size of a quarter (21 to 33 mm). Larvae are very small and rarely seen.

Habitat
The Mission blue requires a host plant and

appropriate nectar plants in a coastal grassland habitat. The host plants utilized by the Mission blue are silver lupine (*Lupinus albifrons*), summer lupine (*Lupinus formosus*), and varicolor lupine (*Lupinus variicolor*). Nectar plants include various composites (Asteraceae) that grow in association with the lupines.

Range

Remaining populations of Mission blue butterfly are found in only a few locations around the San Francisco Bay area in California: the Marin Headlands (Marin County), the Skyline Ridges (San Mateo County), San Bruno Mountain (San Mateo County), and possibly at Twin Peaks (San Francisco County). The historical distribution of the species probably encompassed much of the coastal scrub/grassland habitat of the northern San Francisco peninsula and Marin County.

Life Cycle

The eggs are usually laid singly on the dorsal side of new lupine leaves, but may also be laid on stems, flowers, and seed pods of the lupine. Eggs hatch within six to ten days, and the first and second instar larvae feed on the mesophyll of the host plant. Approximately three weeks after eclosion, the second instar larvae begin diapause, usually in the litter at the base of the host plant. **Diapause** begins at about the same time that the host lupine shifts its energy from leaf maintenance to flower and seed production. Larvae remain in diapause for the rest of the summer and through the winter, and emerge to continue feeding in the spring. **Pupation**, which lasts about a week, occurs in the duff at the base of the host plant or other plants. The adult flight period lasts from March to June. Adults live for approximately one week, and females lay eggs on the host plant. The complete life cycle of the Mission blue lasts one year.

Food Source

Mission blue larvae will feed only on the leaves of the three host lupines: *L. albifrons*, *L. formosus*, and *L. variicolor*. Adults may drink the nectar of composite flowers (sunflower family) using a long tube called a proboscis that extends from the underside of the head.

Population

The San Bruno Mountain population is estimated at 18,000 adults. The Skyline Ridges support approximately 2,000 adults, and there may be as many as 500 at Twin Peaks. The Marin Headlands population has not been estimated, but is significant.

Behavior

Mission blue larvae spend most of their time feeding on lupine leaves in a variety of weather conditions. Adults spend their short lives mating, laying eggs, and nectaring. To locate a mate, adults patrol in patches of host plant, rarely straying far from the lupine habitat. On rainy, cool, windy, or foggy days, adults hide out underneath vegetation.

Survival Threats

The main threat to the Mission blue is habitat loss due to agricultural and urban expansion. Various parasites and predators threaten the Mission blue during its life cycle. Eggs and larvae are parasitized by other insects, such as wasps and flies. Rodents prey upon both larvae and pupae, and many pupae die due to desiccation. Invasive exotic plant species, such as ice plant, pampas grass, broom, gorse, and eucalyptus, also threaten habitat. Trampling of host plants, larvae, and pupae by humans and dogs is also a problem in some areas.

Legal Protection

The Mission blue was added to the Federal Endangered Species List in 1976, and is protected under the **Endangered Species Act**.

References
Arnold, Richard A. 1983. Ecological Studies of Six Endangered Butterflies (*Lepidoptera, Lycaenidae*): Island biogeography, patch dynamics, and the design of habitat preserves. UC Publications in Entomology, Volume 99. UC Press.

Cushman, J. Hall 1993. The Mission Blue, Plebejus icarioides missionensis Hovanitz. In *Conservation Biology of Lycaenidae (Butterflies)*, ed. T.R. New. International Union for Conservation of Nature and Natural Resources, Gland, Switzerland.

San Bruno Elfin Butterfly (*Callophrys mossii bayensis*)

Status
Endangered

Description
The San Bruno elfin is brown on the upperside, and reddish brown on the underside with a whitish, irregular median line (both sexes). The larvae (caterpillars) are bright red or bright yellow.

Size
Adults are 20 to 24 mm (a bit smaller than the Mission blue). Larvae are very small, but easily spotted due to their bright coloring.

Habitat
The elfin occurs only on north-facing slopes within the fogbelt where its host plant, stonecrop (*Sedum spathulifolium*) grows. Stonecrop grows in coastal grassland and low scrub on thin, rocky soils.

Range
Remaining populations of San Bruno elfin butterfly are found in only three locations around the San Francisco Bay area in California: Milagra Ridge (San Mateo County), San Bruno Mountain (San Mateo County), and Montara Mountain (San Mateo County). Though the elfin has always been a sparse population due to the limited range of its host plant, the historical distribution of the species probably included Twin Peaks and Mount Davidson (San Francisco County).

Life Cycle
Females oviposit on the ventral surface of stonecrop from February to early April. The red or yellow larvae hatch in five to seven days and feed on Sedum leaves in the first and second instar. Third instar larvae begin to feed on the flower heads of the Sedum in May, and continue to do so in the fourth instar. The fourth instar pupates at the base of the hostplant, and the pupa enters a diapause, which lasts through the summer, fall, and early winter. Adults emerge February to early April and live for about a week, mating and laying eggs on the host plant.

Food Source
Elfin larvae will feed only on the leaves of the host plant, *Sedum spathulifolium*. Adults may drink the nectar of early-blooming coastal flowers, especially hog fennel (*Lomatium utriculatum*), using a long tube called a proboscis that extends from the underside of the head.

Population
The San Bruno Mountain population is estimated at 1,000 or more adults within 15 subpopulations. Montara Mountain supports about 10 subpopulations, and Milagra Ridge supports about four.

Behavior
First and second instar larvae spend most of their time feeding on stonecrop leave, while the third and fourth instars feed on stonecrop flowers. Larvae are active in all weather conditions. Adults spend their short lives mating, laying eggs, and nectaring. To locate a mate, adult males perch in the vicinity of the host plant, fly-

ing out to investigate passing insects. Females spend even less time in flight than males. Adults rarely stray far from the Sedum habitat. On rainy, cool, windy, or foggy days, adults hide out underneath vegetation.

Survival Threats
The habitat of the San Bruno elfin has been reduced due to urbanization in some areas, though the remainder of the habitat is protected as County, State, and National Parks. Other land uses, such as quarrying on San Bruno Mountain and possible road construction on Montara Mountain, may destroy or disturb habitat. The invasive exotic plant species, such as ice plant, pampas grass, broom, gorse, and eucalyptus, also threaten habitat. Parasitization of larvae by a Tachinid fly occurs at a rate of 50 to 80 percent, and rodents may eat both larvae and pupae.

Legal Protection
The San Bruno elfin was added to the Federal Endangered Species List in 1976, and is protected under the Endangered Species Act.

Reference
Weiss, Stuart B. 1993. The San Bruno Elfin, *Incisalia mossii bayensis* (Brown). In *Conservation Biology of Lycaenidae (Butterflies)*, ed. T.R. New. International Union for Conservation of Nature and Natural Resources, Gland, Switzerland.

California Red-legged Frog (*Rana aurora draytonii*)

Status
Threatened.

Description
The abdomen and hind legs of adults are red; the backs are characterized by small black flecks and larger irregular dark blotches with indistinct outlines on a brown, gray, olive, or reddish background color. Dorsal spots usually have light centers. Skin folds across the back are common. In their tadpole stage, the frogs are dark brown and yellow with darker spots.

Size
At up to five inches long, the California red-legged frog is one of the West's largest native frogs. Females grow larger than males. The larvae range from 0.6 to 3.1 inches.

Habitat
Adult frogs require dense, shrubby or emergent riparian vegetation closely associated with deep still- or slow-moving waters. During winter, well-vegetated areas along these river corridors are needed for shelter.

Range
Remaining populations of the red-legged frog are found mostly in three California counties: Monterey, Santa Barbara, and San Luis Obispo. The frog's historical range extended from the vicinity of Point Reyes National Seashore, Marin County, California, coastally, and from the vicinity of Redding, Shasta County, California, inland south to northwestern Baja California, Mexico.

Life Cycle
Eggs are laid, which hatch in six to fourteen days. Larvae (tadpoles) undergo metamorphosis in three and one-half to seven months. Sexual maturity is attained at around three to four years of age. California red-legged frogs may live eight to ten years.

Food Source
The diet of California red-legged frogs is extremely variable. Invertebrates, small tree frogs and mammals are eaten by adults, while larvae are thought to feed on algae.

Population
In the past, over 80,000 red-legged frogs were harvested annually for their legs. Currently, while exact numbers are unknown, only three localities are known to support substantial (over 350) populations of adult frogs.

Voice
California red-legged frogs have paired vocal sacks, and usually call into the air.

Behavior
In general, adult frogs are quite wary. Highly nocturnal, they come under attack from wading birds. Adult frogs seem to use vibrations transmitted along the vegetation on which they are sitting to detect the approach of certain other predators, such as raccoons. They also sometimes fall prey to San Francisco garter snakes and two-striped garter snakes, with whom they share certain habitat. During periods of flooding, California red-legged frogs have been observed concealed in small pockets or mammal burrows along river banks, stabilized by shrubby riparian growth.

Reproduction
California red-legged frogs breed early in the year, from late November to late April. Males appear at breeding sites typically two to four weeks ahead of females, and call in small mobile groups of between three and seven to attract females. Egg masses containing between 2,000 and 5,000 small (0.1 inch in diameter), dark, reddish-brown eggs are attached to vegetation in or near the water, such as bulrushes or cattails.

Survival Threats
Bullfrogs, introduced to supply frog legs for restaurants in the face of declining numbers of the California red-legged frog, eat their eggs, and replace them in their habitat. Clearing of creek-bed vegetation and the creation of concrete banks threatens the frog's breeding habitats, as well as other forms of water-diversion associated with development.

Legal Protection
Endangered Species Act; Species of special concern in the state of California.

San Francisco Garter Snake (*Thamnophis sirtalis tetrataenia*)

Status
Endangered.

Description
One of the most beautiful serpents in North America. Wide dorsal stripe of greenish-yellow, edged with black, bordered on each side by a broad red stripe bordered by a black one. Belly is greenish-blue, and the top of the head is red. Relatively large eyes.

Size
Adults range from one and one-half to three feet long, and are slender.

Habitat
Ponds, marshes, roadside ditches, streams, meadows, city lots. Tends to stay near water.

Range
Western portion of the San Francisco peninsula, from around the San Francisco County line south along crest of hills at least to Crystal Lake, and along coast to point Ano Nuevo, San Mateo County, California.

Food Source
Food consists of fish, toads, frogs, tadpoles, salamanders, birds, small mammals, earthworms, slugs, and leeches.

Behavior
Tends to stay near water, entering it when frightened. A spirited snake, it defends itself energetically when captured. When

caught, it often bites and smears its captor with excrement and odorous contents of its anal scent glands. The young are born live, in broods that average around one or two dozen.

Survival Threats
Encroaching development in their habitat, and underwater channeling of water sources, threaten the San Francisco garter snake.

Legal Protection
Endangered Species Act.

Reference
Defenders of Wildlife at www.defendersofwildlife.org

Books & Resources

GROWING INDIGENOUS PLANTS

Complete Garden Guide to the Native Perennials of California, Glenn Keator, Chronicle Books, San Francisco.
Great guide, nice drawings, has everything about garden-worthy perennials.

Complete Garden Guide to the Native Shrubs of California, Glenn Keator, Chronicle Books, San Francisco.
Same for shrubs.

Creative Propagation, a Grower's Guide, Peter Thompson, Timber Press, Portland Oregon.
Good instructions for do-it-yourself propagation at home.

Growing California Native Plants, Marjorie G. Schmidt, University of California Press, Berkeley.
Good on all phases of growing, including plant lists for different garden situations.

Native Plants for Use in the California Landscape, Emile L. Labadie, Sierra City Press. Out of print.
If you see it at a used bookstore, pick it up. Nice drawings and one-page instruction sheets on many species.

Seed Propagation of Native California Plants, Dara E. Emery, Santa Barbara Botanic Garden.
Available from the botanic garden or from California Native Plant Society (CNPS). If you want to try growing from seed, this is a good book to have.

PLANT IDENTIFICATION

Flora of San Bruno Mountain, Elizabeth McClintock, Paul Reeberg, and Walter Knight, CNPS.
Description of the natives of this particular area of San Francisco.

Flowers of Point Reyes National Seashore, Roxana S. Ferris, University of California Press, Berkeley.

Grasses of California, Beecher Crampton, University of California Press, Berkeley. Best book for grass identification.

Jepson Manual, University of California Press, Berkeley.
The bible of plant identification for all 8,000 natives.

Marin Flora, John T Howell, University of California Press, Berkeley.
Has keys to the natives of Marin.

Plants of the Coast Redwood Region, by Kathleen Lyons and Beth Cooney-Lazaneo, Looking Press, Boulder Creek.
Beautiful color photos.

Plants of the San Francisco Bay Region, Eugene N. Kozloff and Linda H. Beidleman, Sagen Press, Pacific Grove, CA.
Available in many bookstores or from CNPS. Great color pictures for identifying plants.

Shore Wildflowers of California, Oregon and Washington, Philip A. Munz, University of California Press, Berkeley.
Some color pictures and many drawings of most of our seaside plants.

Spring Wildflowers of the San Francisco Bay Region, Helen K. Sharsmith, University of California Press, Berkeley.
The standard beginner's guide to identifying wildflowers.

OTHER PLANT-RELATED BOOKS

California's Changing Landscapes; Diversity and Conservation of California Vegetation, Michael Barbour, Bruce Pavlik, Frank Drysdale, Susan Lindstron, CNPS.
How human practices have changed California plant communities.

Common Butterflies of California, Bob Stewart, West Coast Lady Press.
Ecology and Restoration of Northern California Coastal Dunes, Andrea J. Pickart, John Sawyer, CNPS.
All you want to know on this subject.

Kashaya Pomo Plants, Jennie Goodrich, Claudia Lawson, Vana Parrish Lawson. Native American plant uses.

A Wildflower by Any Other Name, Karen B. Nilsson, Yosemite Association. A great book of stories of the early California plant explorers, Echscholtz, Chamisso, Florence Bailey, Nuttall, Kellogg, Coulter, and Fremont.

LOCAL SOURCES OF INDIGENOUS PLANTS

CalFlora, Sommers Lane, Fulton, just north of Santa Rosa. (707) 528-8813. Sherrie Althouse or Phil Van Solen

Go Native Nursery, 330 Cypress Avenue, Moss Beach. (650) 758-2286 & www.gonative nursery.com

Larner Seeds, 235 Grove Road, Bolinas, West Marin. (415) 868-9407. www.larnerseeds.com. Judith Lowery

Mostly Natives, 27235 Highway 1, Tomales, northwest Marin. (707) 878-2009. www.mostlynatives.com. Walter Earle

North Coast Natives, Petaluma/Two Rock, (707) 769-1213. Dan Segal

Yerba Buena Nursery, 19500 Skyline Boulevard, Woodside. (415) 851-1668

Green Gardens Glossary

A

Achene: a small, dry fruit with one seed inside.

Adventitious: arising from an unusual place, such as buds emerging from places other than leaf axils, roots growing from stems or leaves. Also, roots developed by cuttings to aid in water and nutrient uptake.

Allelopathic: the inhibition of growth of one plant species by another due to the release of chemical substances.

Alternate leaves: not directly across from each other along the stem.

Angiosperm: plants whose seeds are borne within a mature ovary or fruit.

Annual: completes its life cycle in one growing season and dies back each year (compare to perennial).

Apical meristem: undifferentiated tissue at the tip of the plant, from which the plant continues to grow.

Asexual propagation: plant propagation by cuttings, layering, division, or grafting.

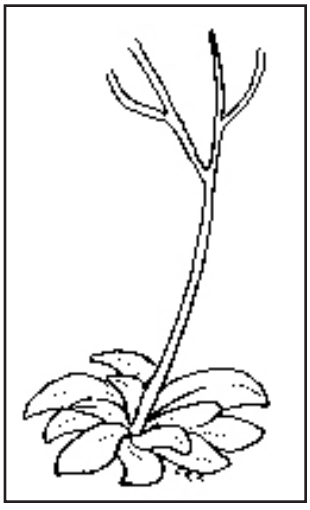
Astringent: having a quality that contracts body tissues and slows down secretions such as bleeding.

Axil: the angled space between a plant part, like a leaf and where it attaches to the plant's axis or main supporting structure, such as a branch or stem.

B

Basal leaves: growing from the base of a stem. [Fig. 1]

Biennial plant: germinates and develops one year, flowers and sets seeds the next year, and dies.



[Fig. 1] Basal leaves grow from the base of a stem.

Biological diversity: the variety of life in a given ecosystem.

Blade: the leaf itself; the flattened part of a leaf not including the petiole.

Bract: a modified leaf often near the flower or inflorescence of a plant; sometimes looking like a petal when brightly colored.

Browser: an animal, such as a deer or rabbit, that nibbles on leaves, twigs, and the buds or shoots of young plants.

C

Cambium: meristematic tissue in woody plants that lies between the bark and wood; usually only one or two cells thick; divides into the cells that gives a woody plant thickness (or caliper).

Carpel: structure within the ovary bearing ovules in the flower or seeds in the fruit.

Cation exchange capacity: relative number of sites on a particle that are negatively charged, as with clay or organic matter; attracts positively charged ions (like nutrients) and holds them until the plant needs to absorb them.

Chlorosis: yellowing of the plant tissue, due to the failure of chlorophyll to develop, usually because of nutrient deficiency (N or Fe) or infection.

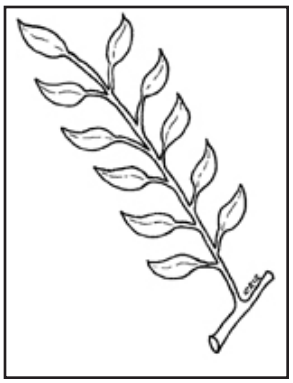
Chromosome: a linear body within the nucleus of a cell; contains individual genes.

Clone: an exact genetic copy, asexually reproduced from a plant part rather than the union of pollen and ovule (gametes).

Co-exist: to exist together without harming one another.

Compound: when a leaf is made up of completely separate segments called leaflets (compare to simple leaves). (A compound leaf is made up of completely separate segments called leaflets.) [Fig. 2]

Corolla: a term used when referring to all the petals of a flower



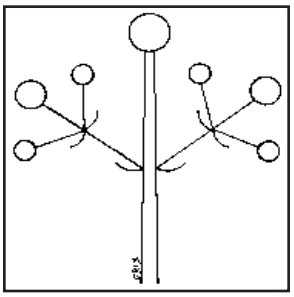
[Fig. 2] A compound leaf is made up of completely separate segments called leaflets.

Cotyledon: seed leaf; a modified leaf present in the seed, often functioning for food storage.

Crown: the base of the plant from which leaves and runners originate.

Cuticle: waxy external covering of a plant or insect; the epidermis.

Cyme: a flower cluster in which the central or terminal flower blooms earliest. [Fig. 3]



[Fig. 3] A cyme is a flower cluster in which the central or terminal flower blooms earliest.

D

Deciduous: loses its leaves in response to the cold season; opposite of evergreen.

Decoction: an extract of essence or flavor produced by boiling down.

Dehisce: opens spontaneously (without assistance) when ripe along a regular line in the seed pod.

Dentate: a term used when the teeth on the margins of a leaf are rather large.

Diapause: period of suspended growth or development and reduced metabolism in the life cycle of many insects, in which the organism is more resistant to unfavorable environmental conditions that in other periods.

Dichotomous key: a tool used to determine the identity of plants.

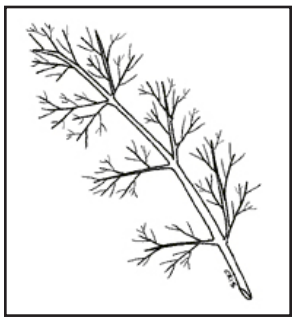
Dioecious: has separate male and female flowers that are found on separate plants.

Dicotyledons: or dicots have two cotyledons or seed leaves. Dicots consist of broadleaf plants, lupines and most of the herbaceous and woody shrubs in Golden Gate National Recreation Area.

Direct seeding: a method of revegetation in which seeds are sown directly on a restoration site.

Dissected leaves: separated into many narrow segments; often feathery looking. [Fig. 4]

Drainage: an area through which run-off water drains; usually lower than surrounding areas.



[Fig. 4] Dissected leaves are separated into many narrow segments; often feathery looking.

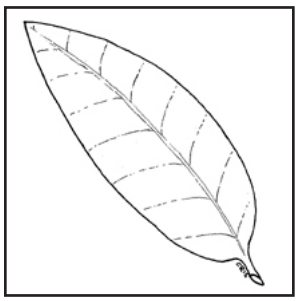
Dune scrub: shrub vegetation that occurs inland from the foredune community.

Dunescape: a landscape covered in dunes.

E

Ecosystem: all populations living together and the physical factors with which they interact.

Elliptic leaves: shaped like an ellipse, with the center part of the leaf blade is widest and the two ends of the blade the same size. (Elliptic leaves are shaped like an ellipse, with the center part of the leaf blade is widest and the two ends of the blade the same size) [Fig. 5]



[Fig. 5] Elliptic leaves are shaped like an ellipse, with the center part of the leaf blade is widest and the two ends of the blade the same size.

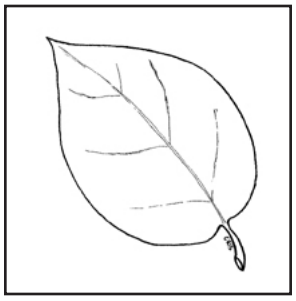
Embryo: a new plant formed from the union of a male and female gamete during fertilization; it consists of an embryo axis which has a growing point at both ends -- one develops into the shoot and one develops into the root -- and one or more seed leaves (cotyledons) attached to the embryo axis.

Endangered: survival is in immediate danger.

Endangered Species Act: legislation to protect biological resources in the United States.

Endosperm: nutritive tissue formed within the seed to feed the developing embryo.

Entire leaf: the margins, or edges, of the leaf are smooth and without teeth or lobes. [Fig. 6]



[Fig. 6] The margins, or edges, of an entire leaf are smooth and without teeth or lobes.

Enzyme: in living cells, a complex protein that starts or speeds up chemical reactions; is not consumed in the reaction. (The margins, or edges, of an entire leaf are smooth and without teeth or lobes)

Epidermis: superficial cell layer covering all parts of the plant except the root tip and apical meristem.

Exotic plant species: plant species that did not evolve in its present environment, but was introduced, deliberately or accidentally, by humans.

Exude: to ooze or seep out.

F

Foliage: the leaves of a plant or tree.

Food storage tissue: complex storage products (carbohydrates, fats, oils, and proteins) laid down in the seed by the mother plant.

G

Genetic diversity: the variability in genetic or hereditary make-up among individuals within a single species.

Genotype: genetic make-up of a plant.

Germinate: to sprout.

Gymnosperms: plants whose seeds are not enclosed in an ovary; conifers are gymnosperms.

H

Habitat Restoration: to restore or bring back ecological integrity by actively removing invasive exotic plants, propagating indigenous plants, and monitoring the resulting changes.

Hardening off: the process by which a young plant adjusts to high sun intensity.

Herbaceous plants: plants that do not develop woody tissue; may be annual, biennial, or perennial.

Hottentots: nomadic, pastoral people of Africa.

Hypha: vegetative growing organs of a fungus; white threads or filaments of a fungus that invade a plant.

I

Imbibe: to take in, as to take in water; the root imbibes water through ultra microscopic pores in the root tissue.

Indehiscent: seed pod that does not open along regular lines or valves.

Indigenous: native to or occurring naturally in a particular area.

Inflorescence: the flowering part of a plant; almost always used when referring to a flower cluster.

Infusion: a liquid extract produced by steeping or soaking (like tea, etc.) to extract flavors or other qualities.

Instars: growth phase in insects (larva at different sizes).

Interdependent: mutually dependent; elements in an ecosystem depend on one another for survival.

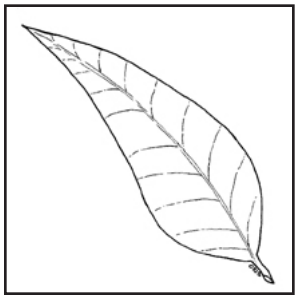
Invasive plants: plant species, usually exotic, that have copetitive survival and reproductive characteristics, and can therefore outcompete non-invasive, indigenous plant species.

J

J-root: root with a j- or u-shaped kink, usually from bending during transplanting.

L

Lanceolate leaf: lance-shaped; several times longer than wide with the widest part at the base and tapering to a point at the apex. (Lanceolate leaves are lance-shaped; several times longer than wide with the widest part at the base and tapering to a point at the apex.) [Fig. 7]



[Fig. 7] Lanceolate leaves are lance-shaped; several times longer than wide with the widest part at the base and tapering to a point at the apex.

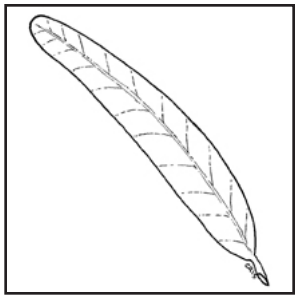
Latent root initials: cells that have differentiated into root but have not expanded by cell division and are dormant; in strawberries they are the little nubs on the bottom of each plantlet on a runner.

Lateral bud: bud on the side of a stem.

Leaflets: one of the segments (looks like a small leaf) in a compound leaf.

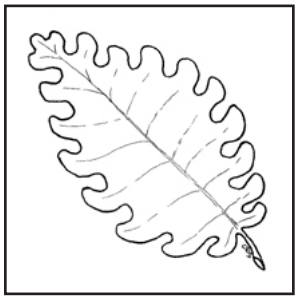
Legume: a plant belonging to a large family of plants that include peas, beans, clovers, etc.; the fruit is usually a pod; most legumes have special nodules on their roots with nitrogen-fixing bacteria that can take nitrogen out of the air and "fix" it into the soil thus increasing the richness of the soil for all plants.

Linear leaves: narrow and flat with sides parallel (such as a grass leaf blade). [Fig. 8]



[Fig. 8] Linear leaves are narrow and flat with sides parallel (such as a grass leaf blade).

Lobed leaves: rounded, curvy, or wavy in shape. [Fig. 9]



[Fig. 9] Lobed leaves are rounded, curvy, or wavy in shape.

Luke: nickname of a planting tube used the most at Golden Gate National Recreation area; black plastic, one and one-half inches in diameter, eight inches long. The larger tube is called "vader."

M

Monecious: when a plant has separate male and female flowers (i.e., the stamens are found in one flower and the pistils are found in a separate flower) but the flowers are found on the same plant.

N

Naturalized: when a plant has taken over the natural range of native plants and acts like it's always been a part of the original landscape.

Nectar: the sweetish liquid in many flowers used by bees in the making of honey.

O

Oblanceolate leaves: inversely lanceolate; the tapered end attaches to the petiole (or stalk) and the widest end is at the apex of the leaf blade. [Fig. 10]

Oblong leaves: two to four times longer than wide with the sides being nearly parallel. [Fig. 11]

Opposite leaves: directly across from each other along the stem. [Fig. 12]

Ovate leaves: vaguely egg-shaped and connected at the broader end to a stem or branch. [Fig. 13]

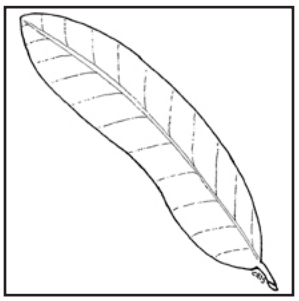
P

Palmate leaves: vaguely hand-shaped, either because it is palmately lobed like a simple leaf or because, in a compound leaf, all leaflets radiate out from a central point. [Fig. 14]

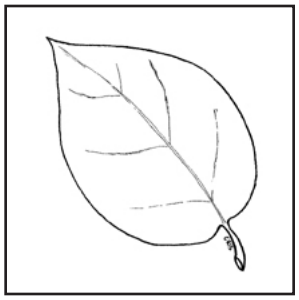
Palmate veins: when the veins of a leaf radiate from a central point so that the pattern is vaguely hand-shaped. [Fig. 15]

Panicle: a compound inflorescence with the youngest flowers being at the apex. [Fig. 16]

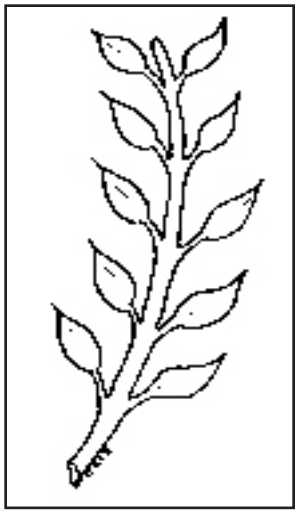
[Fig. 10] Oblanceolate leaves are inversely lanceolate; the tapered end attaches to the petiole (or stalk) and the widest end is at the apex of the leaf blade.



[Fig. 11] Oblong leaves are two to four times longer than wide with the sides being nearly parallel.



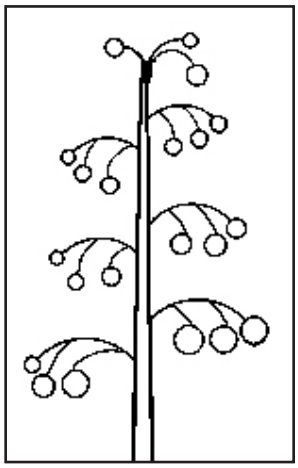
[Fig. 13] Ovate leaves are vaguely egg-shaped and connected at the broader end to a stem or branch.



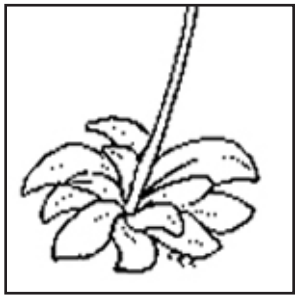
[Fig. 12] Opposite leaves are directly across from each other along the stem.

[Fig. 14] Palmate leaves are vaguely hand-shaped, either because the leaf is palmately lobed like a simple leaf or because, in a compound leaf, all leaflets radiate out from a central point.

[Fig. 15] Palmate veins of a leaf radiate from a central point so that the pattern is vaguely hand-shaped.



[Fig. 16] A panicle is a compound inflorescence with the youngest flowers being at the apex.



[Fig. 20] A rosette is a basal cluster of leaves arranged in a circular fashion (such as the leaves of the common dandelion).

Pappus: a tuft of hair on the seed of a plant that helps disperse the seed.

Parallel veins: when the veins on a leaf run parallel from tip to tip along the leaf; typical of grasses and grass-like leaves. [Fig. 17]

Pedicel: the stalk of a single flower in an inflorescence or cluster of flowers.

Perennial: a plant whose life cycle lasts for several years; a plant that comes back year after year without having to be replanted each year.

Petiole: the stalk of a leaf blade that attaches it to a branch of a plant.

Pinnately compound leaves: compound leaflets on opposite sides of a long axis. [Fig. 18]

Pistil: the seed producing part of a flower; often referred to as the female part of a flower.

Pollination: when pollen is transferred to the stigma of flower's pistil leading to fertilization and seed production.

Poultice: a warm cloth or medicinal mixture applied to a sore or inflamed part of the body.

Prostrate: lying flat or trailing along the ground.

Purgative: something that purges or gets rid of something from within the body.

Q

Quadrat: a plot (usually rectangular) used for ecological or population studies.

R

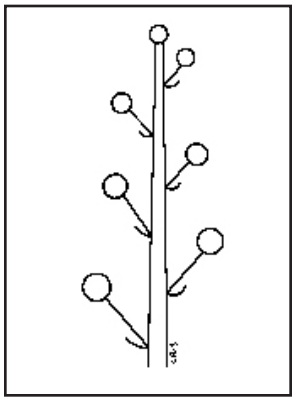
Raceme: an inflorescence with pedicelled flowers (the flowers having little stalks) on a long axis (stem or branch) with the youngest flowers at the apex (top). [Fig. 19]

Rhizome: a thickened stem that looks like a root and grows horizontally along the ground just at or beneath the surface.

Rosette: a basal cluster of leaves arranged in a circular fashion (such as the leaves of the common dandelion). [Fig. 20]

[Fig. 17] Parallel veins on a leaf run parallel from tip to tip along the leaf; typical of grasses and grass-like leaves.

[Fig. 18] Pinnately compound leaves are compound leaflets on opposite sides of a long axis.



[Fig. 19] A raceme is an inflorescence with pedicelled flowers (the flowers having little stalks) on a long axis (stem or branch) with the youngest flowers at the apex (top).

S

Serrated leaves: toothed; jagged "teeth" directed forward towards the tip of the leaf.

Sessile: having no stalk of any kind.

Simple leaves: singular; only one segment between the stem of the leaf and the tip of the leaf blade (compare to compound leaves).

Spike: an inflorescence with sessile flowers (the flowers having no stalk of any kind) on a long axis (stem or branch) with the youngest flowers at the apex (top).

Stamens: the pollen bearing organs of a flower; often referred to as the male part of a flower.

T

Toothed leaves: jagged-edged. (Toothed leaves have jagged edges.)

Transpiration: the loss of water from a plant through small openings in the plant's leaves.

U

Umbel: a convex or flat-topped inflorescence, where all the flowers arise from one central point. (An umbel is a convex or flat-topped inflorescence, where all the flowers arise from one central point.)

V

Vader: nickname of a planting tube used at Golden Gate National Recreation Area; black plastic, two inches in diameter, ten inches long. The smaller planting tube is called a luke.

W

Woody plants : plants that produce hardened xylem cells containing lignens and cellulose (wood); live for many years.

X

Xylem: hollow plant cells that move water from the roots; in woody plants the xylem gradually dies and more is formed—dead xylem tissue becomes the wood in a woody plant.