Hedgerows and Farmscaping for California Agriculture

A Resource Guide for Farmers

2nd Edition

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Community Alliance with Family Farmers

Hedgerows and Farmscaping for California Agriculture

A Resource Guide for Farmers

by Sam Earnshaw

Community Alliance with Family Farmers
www.caff.org

COMMUNITY ALLIANCE WITH FAMILY FARMERS

CAFF builds sustainable food and farming systems through policy advocacy and on-the-ground programs that create more resilient family farms, communities and ecosystems.

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Introduction

Hedgerows, windbreaks, filter strips, grassed waterways, beetle banks and riparian plantings are increasingly being used in modern agricultural systems. Hedgerows have been planted in farming and rural landscapes for thousands of years. Fields were enclosed as early as the Bronze Age (3000 B.C.–1000 B.C.), and references to hedgerows exist back to 547 A.D. in Great Britain. Ancient hedgerows were used to confine livestock, define property lines, shelter farmland and dwellings from wind, provide food, medicine and fodder (game animals, fruit, nuts, herbs, acorns), and supply structural and fuel wood.

Jitze Couperus

Hedgerows surrounding fields on ALBA (Agricultural Land-Based Training Association) farm site in the Salinas Valley.

The reorganization and industrialization of farmland in Great Britain led to the removal of approximately 200,000 miles of hedgerows between 1947 and 1993, and their reduction continues into the present. However, research into the positive resource qualities of hedgerows for agriculture, wildlife and rural culture has brought attention to their value. The institution of Hedgerow Regulations in England and Wales in 1997 has slowed their removal and has led to efforts to preserve existing hedgerows and install new ones.

In the 1970s and 1980s the International Tree Crops Institute USA promoted multi-purpose hedgerows, and Bill Crepps and Robert L. Bugg researched hedgerows at the University of California Davis, developing lists of insectary plants. John Anderson began installing multi-species native hedgerows in 1978 at Hedgerow Farms in Winters, California, and Yolo County's Resource Conservation District's (RCD) *Bring Farm Edges Back to Life!* brought practices and information to farmers' attention. The USDA Natural Resources Conservation Service (NRCS), RCDs and organizations like CAFF and the Xerces Society have been active in conservation plantings, and approximately 200 miles of hedgerows have been planted on farms in California since the mid-90's.

Windbreaks have been encouraged and used for climate modification and other conservation objectives in the United States since the 1930s. Filter strips, grassed waterways, beetle banks and riparian plantings are effective at controlling runoff and non-point source pollution from entering waterways as well as providing wildlife habitat. This resource guide focuses primarily on hedgerows, although there is some overlap with other types of plantings, such as with the use of large shrubs or trees to provide windbreak effects, or with the use of grasses and understory plants in hedges to give additional soil cover and minimize runoff. Much research is being conducted in many countries into diverse aspects of the functioning of farmscape systems.

Native trees and shrubs bring diversity to agricultural landscapes.

Definitions

Hedgerows are defined as lines or groups of trees, shrubs, perennial and/or annual forbs and grasses that are planted along roadways, fences, field edges or other non-cropped areas. The word “hedge,” from the Old English word “hegg,” referred to an enclosure or boundary formed by closely growing bushes or by dead plant material.

Windbreaks are barriers usually consisting of trees or shrubs that are used to reduce and redirect wind, resulting in microclimate changes in the sheltered zone.

Filter Strips are planted areas that use vegetation to control soil erosion, slow water runoff from agricultural lands, and capture and prevent sediments and nutrients from entering waterways.

Grassed Waterways are plantings of native or non-native annual or perennial grasses or other suitable vegetation in water drainages, to hold the soil in place and to reduce scouring, channeling, and gully erosion.

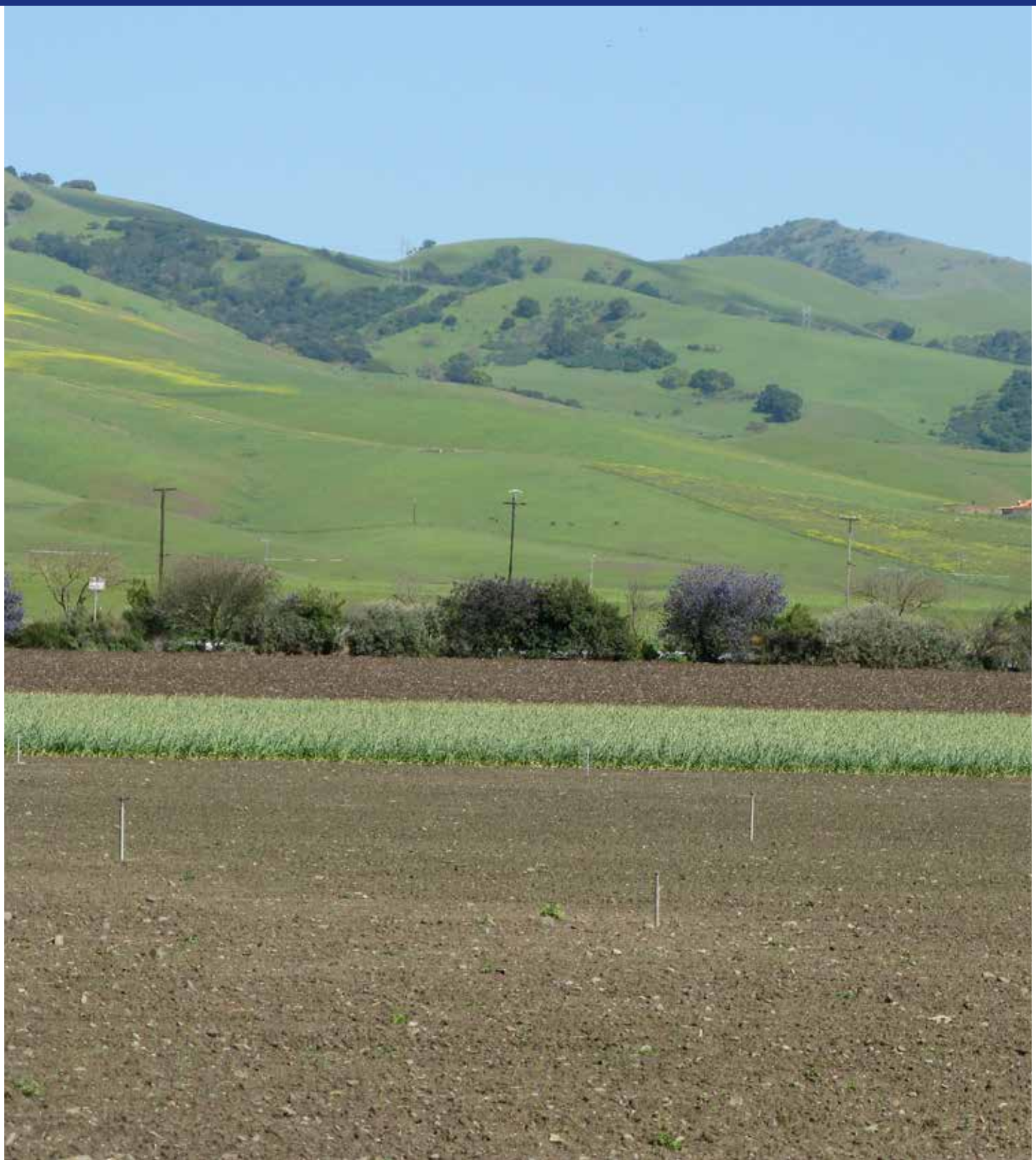
Gwendolyn Ellen

Beetle Banks are plantings of native or non-native perennial bunchgrasses within fields or on field edges that provide shelter and alternate prey for general crop pest predators.

Riparian Areas are plant habitats and communities along river margins, creeks and banks, characterized by water-loving plants.

Farmscaping is the management of vegetation on and around the farm, to include conservation plantings on roadways, field margins, waterways, natural areas and within cropped or in non-cropped areas. The term “farmscaping” can cover a wide range of practices, such as grassed waterways, buffers, filter strips, insectary strips, riparian plantings and cover crops, as well as hedgerows and windbreaks.

Benefits of Hedgerows 2



Hedgerows can have multiple functions: they can serve as habitat for beneficial insects, pollinators and other wildlife; provide erosion protection and weed control; serve as windbreaks; stabilize waterways; reduce non-point source water pollution and groundwater pollution; increase surface water infiltration; buffer pesticide drift, noise, odors and dust; act as living fences and boundary lines; increase biodiversity; sequester carbon; and provide an aesthetic resource. A list of these and other functions of conservation plantings is shown in Figure 1.

Diversity in hedgerow species, especially when using native plants, assures a range of attributes, such as the attraction of multiple kinds of insects and wildlife, positive effects for soil and water resources, and success of individual plants under site-specific climatic and other environmental conditions. These plantings can also bring diversity and beauty to the farm, and most growers use plants that they personally like, reporting that they are pleased with the benefits farmscaping brings to their farms.

Organic operations that use the USDA National Organic Program (NOP) label are obligated to "conserve biodiversity, and maintain or improve natural resources, including soil, water, wetlands, woodlands and wildlife" on each certified parcel. Conservation plantings, such as hedgerows, grassed waterways, filter strips, windbreaks, beetle banks or riparian plantings can be a relatively easy way to satisfy this certification requirement.

Flowering plants like Yarrow and Buckwheat in between major shrubs provide nectar and pollen for pollinators.

Figure 1
Functions of Conservation Plantings

- Serve as habitat for natural enemies and pollinators
- Provide wildlife habitat and corridors

- Provide weed control
- Provide seeds and cuttings for native plant propagation
- Increase local and regional biodiversity

- Reduce non-point source water and groundwater pollution
- Increase surface water infiltration and groundwater recharge
- Stabilize waterways

- Provide erosion protection
- Improve soil health and quality
- Protect soil from action of raindrops

- Act as living fences, barriers and boundary lines
- Provide buffer from pesticide drift, noise, odors, pathogens and dust
- Sequester carbon
- Serve to moderate wind as windbreaks
- Improve air quality
- Protect from frost

- Provide economic returns
- Create shade for farmers and workers
- Provide an aesthetic resource

Insects: Predators, Parasitoids and Pests

Hedgerows have habitat value for beneficial insects by providing nectar and pollen, alternate hosts and prey, shelter during winter cold and summer heat, wind protection, and nesting sites. Among the natural enemies attracted to many commonly used hedgerow plants are bigeyed bugs, syrphid flies, lady beetles, minute pirate bugs, green and brown lacewings, parasitic and predatory wasps, tachinid flies and spiders. Some of the many insect pests that fall prey to the above-listed natural enemies are aphids, mealy bugs, leaf hoppers, scales, mites, whiteflies, lygus bugs, thrips, squash bugs, stink bugs, codling moths, corn earworms, leafrollers and other caterpillars.

Jack Kelly Clark

Green lacewing, a predator of pest insects

Research and field studies have shown that hedgerows and habitat plantings can enhance pest control and pollination in crops, and more work is being done to obtain information regarding specific crops and specific plant associations in various agricultural situations (http://calag.ucanr.edu/archive/?article=ca.2017a0020). Using flowering plants to lure natural enemies into crop production areas is a common practice, known as conservation biological control.

Sweet Alyssum as in-field insectary

Rachael Long

Zamora, CA flowering hedgerow adjacent to almonds, spring

Examples of these insectary plantings include the planting of Alfalfa or Sweet Alyssum strips within fields, and dispersing blocks of individual annual insectary plants such as Dill, Coriander and Toothpick Ammi among crops. Care should be taken to prevent plants such as Sweet Alyssum and Toothpick Ammi from becoming invasive and problematic as weeds in natural areas.

Many hedgerow plants have large flower heads with multiple flowers, to provide plentiful pollen and nectar as well as wide landing pads for the beneficials. California Buckwheat, Elderberry and Yarrow are examples of plants with this type of floral structure.

Alyssum interplanted in brassicas to control cabbage aphid

California Buckwheat has multiple flowering heads.

Rachael Long

Zamora, CA flowering hedgerow adjacent to almonds, summer

Figure 2
Flowering Periods for Commonly Used Hedgerow Plants

	Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec
Willow spp.												
Ceanothus spp.												
Yarrow												
Elderberry												
Coffeeberry												
Hollyleaf Cherry												
Toyon												
Buckwheat spp.												
Deergrass												
Milkweed												
Aster												
Goldenrod												
Saltbush, Quailbush												
Coyote Brush												

Planting a diversity of shrubs and forbs can provide a year-round flowering sequence. For example, Ceanothus blooms from February through August; Buckwheat, Toyon and Yarrow flower in the summer; and Coyote Brush blooms from August through January. With such an array of flowering plants, a 12-month supply of pollen and nectar is available and beneficial insects with different life cycles are more likely to stay onsite. Pest control with beneficial insects can be more effective when managers evaluate the flowering times of certain species as they relate to the insects using those flowers, and determine if adding additional plant species is needed for the natural enemies of interest.

Toyon

Besides being used as pollen and nectar sources, hedgerows can be visited by natural enemies to find insect hosts or prey, to secure cover, to feed on plant sap or to use vegetation as egg-laying sites for reproduction. Habitat plantings provide both nectar and pollen sources and natural enemy/plant associations. For example, beetle banks are planted to provide vegetative habitat for natural enemies, birds and other predatory fauna. They are specifically important refugia for predacious ground beetles that, often absent due to multiple sources of disturbances to the soil, prey upon multiple crop pests including caterpillars, slugs and snails.

Will Suckow

Hedgerow with flowering Toyon next to processing tomatoes

Beetle banks draw in and maintain a population of beneficial insects near crops.

Jack Kelly Clark

Predacious ground beetle

Pollinator Plants

Jessa Kay Cruz

Ceanothus blooms attract many pollinators and natural enemies.

Flowering plants attract and support many other kinds of beneficial insects including pollinators, which are economically important for farmers. Bees, butterflies, flies, beetles and others pollinate many food crops.

Including plants in hedgerows that provide habitat for pollinators has the potential to increase the effectiveness of pollination on nearby fields and can build up a reservoir of insects that work for the farm. Hedgerows serve as protection for sensitive insects from pesticide drift from neighboring agricultural fields and also provide potential nest sites for native bees. Wild and domesticated bees are the most significant pollinators and generally travel less than 500 meters from their nests. The creation of habitat can attract and keep bees near the crop. The undisturbed soil in between bunch grasses in a beetle bank provides excellent nesting sites for solitary, soil-nesting native bees. Additionally, some growers install constructed “nest blocks” for wild native bees that simulate natural nesting cavities, or leave dead tree snags for nesting bees.

Jack Kelly Clark

Syrphid fly, a pollinator and predatory insect

Flowering plants near berries bring in pollinators.

Birds as Biocontrol

Hedgerows, windbreaks, riparian areas, flowering plants and grasses provide habitat for many species of birds, which utilize these types of vegetation for roosting, perching, nesting, and acquiring food. Several studies report that birds can be effective on farms in controlling many pest insects, including caterpillars, moths, ants, aphids, leafhoppers and scale, and in eating significant amounts of weed seeds.

Charles Peck

Birds eat pest insects.

Many growers install Bluebird boxes to increase these insect-eating birds.

Eric Lodge

Great Blue Herons love gophers.

Common beneficial birds are Bluebirds, Chickadees, Woodpeckers, Swallows, Flycatchers, Warblers, Bushtits and Wrens. Bird boxes for Bluebirds and other songbirds help increase bird populations on farms. Some birds are only insectivores; others rely on insects during nesting season to feed their young and may turn into pests on certain crops once the young are out of the nest. There are different strategies to prevent bird damage and crop loss, including noise scare tactics, netting, alternative crop choices and locations, and use of falcons. Raptors such as owls, hawks, kites, and falcons help control gophers, ground squirrels, voles, mice, rabbits and other rodents. Many farms have installed owl boxes to create nesting habitat for barn owls, and piles of gopher bones in the owl pellets beneath the boxes are indicators of successful predations.

Susan Sorenson-Birds in the Yard

Hawks love rodents.

Gwen Huff

Steve Simmons with a resident of one of his barn owl boxes.

Wildlife Habitat

Using native plant species that occur in local ecosystems to extend wildlife habitat and connect to existing vegetation.

Creative farmscaping can provide opportunities for integrating wildlife needs with farming and ranching. Some farmers and landowners are increasingly interested in planting habitat that can attract wildlife. Besides creating natural places for birds and beneficial insects, vegetation plantings can provide valuable corridors for a wide variety of wildlife, including coyotes, foxes, bats and other mammals, snakes, lizards, frogs, other reptiles and amphibians. One farmer takes pictures of snakes found in his hedgerows to show his workers so they appreciate their presence and don't kill every snake they see.

Growers report seeing foxes in newly planted riparian vegetation, gopher snakes in North Coast, Central Coast and Central Valley hedgerows, a coyote den under the Coyote Brush, frogs, and even a mountain lion rambling along the edge of a planting. Increasing biodiversity on borders and unused areas of the farm, such as along roadways and fences, can link with adjoining natural and farmscaped areas and increase the biodiversity and ecological health of the entire farm.

Eric Lodge

Snakes eat gophers.

Jason Wade

Coyote in the hedge

Planting hedgerows and restoring natural areas such as wetlands or grasslands with native plants adds wildlife values to the farm and provides ecosystem services, such as habitat for natural enemies, pollinators, insect-eating birds, raptors and rodent predators, as well as erosion control, groundwater recharge and wind modification. Lady beetle clusters on trees and shrubs in wildlands and the large diversity of predatory wasps found in some riverine habitat are examples of ecosystem services provided by natural areas. On the landscape level, a wider variety of wildlife species may be accommodated by linking farms and ranches into wildway corridors, so that connectivity is created on local and regional levels. In general, the wider the linkage, the better for wildlife. Connecting hedgerows to riparian zones, ponds, ditches, forests, chaparral, grasslands and woodlots provides more habitat opportunities for wildlife.

Native trees and shrubs create a corridor linking with Central Valley riparian area.

Ponds, wetlands and developed vegetative plantings in natural areas of the farm can address the needs of various fish and wildlife species. These areas can be established with the assistance of qualified biologists and can broaden the scope of hedgerow plantings. Several large vineyards in California are working on these types of habitat creation.

Introducing or removing vegetation that may attract rare and endangered species without instituting certain measures could cause problems for landowners. For example, removal of Elderberry in some counties requires replanting of replacement plants in other locations and monitoring these new plants for the protected valley longhorn Elderberry beetle for 10 years.

This pond attracted a river otter.

A mixed native plant hedgerow connects with oak woodland, providing a wildlife corridor.

New habitat plantings that could attract rare and endangered species may also be a concern to growers, but planting a hedgerow will not create rare and endangered species habitat unless all of the ecological needs of the species are met. The Safe Harbor concept, developed by the U.S. Fish and Wildlife Service (USFWS), offers agreements that provide a way for farmers to restore and maintain habitat that could contain or attract threatened or endangered species without fear of incurring additional regulatory restrictions. In the Central Valley, planting and then having to remove Elderberry that may attract the threatened valley longhorn Elderberry beetle can be addressed by the farmer developing Safe Harbor Agreement. Contact USFWS for information on Safe Harbor agreements (https://www.fws.gov/endangered/landowners/safe-harbor-agreements.html).

To address the issue of fragmentation and habitat loss, NRCS has produced a Conservation Corridor Handbook (1999) that contains a wide range of practices to improve habitat and enhance landscape functions (https://www.nrcs.usda.gov/wps/PA_NRCSConsumption/download?cid=stelprdb1082007&ext=pdf).

Erosion Protection and Runoff Control

This erosion ditch is planted with perennial grasses and Yarrow.

Erosion ditch, before revegetation

Native perennial grasses stabilize eroding banks.

Hedgerows and other farmscape plantings such as filter strips, riparian plantings and grassed waterways can help control erosion and water runoff from agricultural fields and can reduce the amount of nutrients, pesticides and sediments that are flowing from agricultural land to waterways. Plantings of shrubs and grasses can slow runoff, increase surface water infiltration by improving soil structure around the root zone, reduce sediment movement, assist with infiltration and assimilation of plant nutrients, and cool water on small watercourses by shading.

To address water quality impairment caused by discharges from agricultural lands, the State Water Resources Control Board developed the statewide Irrigated Lands Regulatory Program (ILRP). Under the ILRP, Regional Water Quality Control Boards in California have adopted, or are in the process of adopting, Waste Discharge Requirements (WDRs) or Conditional Waivers of WDRs (Orders). These Orders are issued to either grower coalition groups or individual growers and require farmers to meet certain water quality conditions, some of which can be met by implementing approved management plans and practices to reduce water runoff, nutrients, sediments, pesticides and other agrochemicals. Planting hedgerows may be part of a grower's plan to comply with WDR's. More information on ILRP requirements and enrollment process can be found on local Regional Water Quality Control Board Web sites, which can be located on the State Water Resources Control Board website: www.waterboards.ca.gov.

Weed Replacement

Hedgerows and other vegetative plantings can effectively shade out and replace invasive annual weeds in non-cropped areas. Over time, as the plantings develop in size and root structure, perennials outcompete annual weeds for light, water, air and soil. Any planting requires management of unwanted weedy growth, and attention to weed control in farmscape plantings is required, particularly during establishment. Some situations require weed management six to nine months prior to planting. Controlling weeds between rows in multi-row hedgerows can be challenging and should be a consideration in the hedgerow design. Placing a thick layer of mulch or utilizing weed fabric or a plastic mulch at planting can be effective in reducing weedy growth as well as preserving soil moisture. In certain cases, layers of undyed cardboard can be placed before the mulch is applied for increased weed suppression. The replacement of unsightly and costly weedy areas with multi-functional perennial vegetation can help achieve the farm management goal of reducing the weed seed bank. Research has shown that weedy borders contain a significantly higher ratio of pest insects to natural enemies than do native plant hedgerow plantings.

Hedgerow shrubs can smother and outcompete weeds.

A six-inch layer of mulch suppresses weeds and retains moisture.

Installing shrubs on this bank will replace annual weeds and provide beneficial insect habitat.

Short-growing species of Ceanothus, Coffeeberry, Sage and Yarrow replace weeds on this berm.

Windbreaks

Coast Redwood, Incense Cedar, Soapbark Tree, and Giant Sequoia as windbreak in San Juan Bautista

Hedgerows can modify winds with plants of various heights. Windbreaks help control wind erosion, reduce the drying effects of wind on soil and plants, help protect young seedlings and crops, provide increased yields, shelter buildings and living areas, moderate the spread of pheromones in orchards, and store carbon. Windbreaks also offer valuable cover and nesting sites for birds and other wildlife. Tall, medium-tall, dense, and low-growing evergreen trees can be used singly, together, or in combination with shrubs. Some windbreaks use native trees such as Coast Redwood, Incense Cedar and Giant Sequoia, as well as other native evergreen trees such as Wax Myrtle, Hollyleaf Cherry, Catalina Cherry, Monterey Cypress, and several species of oaks. Large vigorous species of native shrubs such as Ceanothus, Quailbush, Sugarbush, Flannel Bush and Coffeeberry can also serve in a windbreak.

Non-native evergreen trees such as Pepper Tree, Strawberry Tree, and Soapbark Tree also can make effective components of windbreaks, although there is higher insect and bird biodiversity associated with native species. The non-native hybrid Willow sold under the name Austree (*Salix hybrid*), while not evergreen, is fast growing and is commonly used.

Vigorous trees such as pines are fast growing, but are relatively short-lived, shed branches and can fall over. Windbreaks of Blue Gum (*Eucalyptus globulus*) were used in the Salinas Valley since the late 1880s, as documented by John Steinbeck in East of Eden, but many have been taken out. Blue Gum can be extremely aggressive and invasive, displacing the diversity of native habitat and having negative characteristics for California wildlife, such as diminishing breeding sites for ground- and shrub-nesting songbirds. The effects of windbreaks shading adjacent crops should be considered. More information on windbreak designs can be found at local NRCS offices and on the USDA's National Agroforestry Center's website: https://www.fs.usda.gov/nac.

An Egret investigates new windbreak planting.

Carbon Storage - Mitigation of Climate Change

Farmscaping with trees, shrubs and grasses can help mitigate the effects of a changing climate, which include drought, increased precipitation, higher pest insect pressure and altered wildlife habitat. There are many research studies and resources available that document the role that vegetation plays in capturing and storing carbon in plant material and in the soil. Tools such as COMET planner from NRCS (http://comet-planner.com/) are available to evaluate potential carbon sequestration and greenhouse gas reductions with specific conservation practices. The state of California is promoting programs through legislation to support practices that increase soil organic matter which can reduce greenhouse gas emissions and sequester carbon. The Healthy Soils Program is a collaboration of state agencies and departments led by the California Department of Food and Agriculture (CDFA) that encourages a combination of innovative farm and land management practices such as windbreaks, hedgerows, filter strips, grassed waterways and riparian areas (https://www.cdfa.ca.gov/oefi/healthysoils/docs/HealthySoilsFactSheet.pdf).

Increasing biodiversity with these plantings will support ecosystem stability and provide resilience to dramatic changes and events. With its large land base and wide diversity of activities, California agriculture can play an important role in mitigating the effects of a warming climate.

Woody plants capture and store carbon, and provide resilience to climatic changes.

Amy Kaplan

Large shrubs and trees sequester carbon and act as windbreaks.

Economic Returns

A pomegranate hedge, with Sweet Alyssum in-field insectary in the foreground.

The inclusion of plants in hedgerows and windbreaks that bring income to the farm can broaden the scope and appeal of farmscaping. Citrus, Persimmon, Mulberry, Pineapple Guava, Pomegranate, nut trees, berries, Rosemary, Oregano, Lavender, Sage, Thyme, Lemon Verbena, and a wide variety of other medicinal and culinary herbs are a few of the potential crop species that can be considered. Ornamental plants for cut flowers and foliage, and trees for structural and fuel wood, are additional options.

When hedgerows, grassed waterways or other plantings reach a point of growth where they are smothering weeds, some savings may be realized by the elimination of weeding or herbicide costs. The increase in hedgerows of resident beneficial insects, including natural enemies and bee pollinators, has the potential to lead to a reduction in pest management costs by lowering the need to purchase beneficial insects or pest control materials. When factoring in the potential economic benefits associated with lower pest management costs and assistance with crop pollination, hedgerows can provide a return on investment in 7 to16 years. Hedgerow costs may be further reduced by using incentive programs from the Natural Resources

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Eco-labels promote a farm's stewardship and biodiversity values.

Conservation Service (NRCS), the California Department of Food and Agriculture (CDFA) or other sources. Farmers have had beehive fees lowered when the flowering resources of hedgerows have enabled the beekeeper to leave hives on the farm for a longer period of time.

Plantings that minimize or stop soil erosion save farmers money spent in disposing of or hauling back onto the farm soil that has moved after storm events. Soil fertility that is maintained by the prevention of soil loss is also an economic benefit of conservation plantings. Regulatory actions and associated fees, as well as the possibility of conflicts with neighbors, may also be reduced or eliminated by the control of soil erosion.

Habitat plantings help farmers comply with marketing programs utilizing eco-labels such as the National Organic Program, which requires maintaining and increasing on-farm biodiversity. Programs such as Bee Better Certified and Salmon-Safe encourage consumers to purchase products associated with farms that protect habitat and water resources. Habitat plantings that are wider and larger than single rows can encourage more diversity of birds and other wildlife, and can be developed as an income-generating attraction for regional agritourism activities. Farms that have Community Supported Agriculture (CSA) programs, U-Pick operations or that host on-farm activities such as community events and farm-to-table dinners can highlight their stewardship and wildlife-friendly practices.

With hedgerows providing flowering resources for bees, beekeeping fees were reduced.

Barriers and Buffers

Hedgerows can reduce impacts from potential pesticide drift, dust and noise arising from farm operations, and can act as a boundary or separation from adjoining properties. Plantings that are used as a pesticide buffer cannot legitimately serve as wildlife/insectary habitat. Vegetation as a barrier is more permeable to wildlife than solid or wire fencing. Organic farms must have a distinct buffer zone between certified ground and neighboring conventionally farmed ground. A good resource is Conservation Buffers in Organic Systems: http://bit.ly/1tZkd5j.

Hedgerow plantings may act as a barrier and intercept pathogens at the farm's border, and are an ideal way to provide a buffer zone that is more effective to block drift than a non-cropped or bare area.

This hedgerow will create a buffer between a conventional and organic farm.

Air Quality

Windblown dust particles, as well as contaminants on these particles, can contribute to air quality problems. Hedgerows and windbreaks can modify wind patterns to trap and reduce the mobilization of dust, pathogens and pesticide drift. On farms and in areas where wind can create air pollution problems, vegetation of varying heights can be planted to help reduce wind speeds and thereby decrease the amount of windblown dust that comes from unpaved roads, equipment yards and farm fields. Vegetation planted around confined animal facilities can reduce wind velocity, provide a visual barrier, lessen windblown objects such as feathers, reduce odors and trap pathogens or contaminants.

The San Joaquin Valley Air Pollution Control District has a regional program, called the Conservation Management Practice Program, to reduce air pollutant emissions from agricultural sources with farming techniques referred to as Conservation Management Practices (CMPs). Information about this program can be found on the website www.valleyair.org.

Well-established planting will protect crops from dust.

Perennial grasses along a roadway in Salinas Valley

Native Grasses, Sedges and Rushes

Native perennial grasses, sedges and rushes can be used to vegetate waterways, ditches, filter strips, riparian areas and pond edges. These plants are drought tolerant, can help stabilize the soil, keep out annual weeds, provide habitat for beneficial insects and other wildlife, reduce erosion, improve water infiltration, and filter out sediments, nutrients and pathogens. Temporary upstream sediment traps may be necessary to prevent ditches from silting up. Native grasses can be effective in hedgerow plantings as understory plants either by themselves or with other low-growing forbs.

The types of plants selected will depend on location, soil type and moisture conditions expected throughout the year. Sedges and rushes generally grow best in moist areas, although there are some exceptions. Some native grasses spread through rhizomes, while others grow as tufted bunchgrasses. Creeping Wildrye and Red Fescue which grow throughout California form dense, solid stands of vibrant grass and are very effective in stabilizing waterways, trapping sediments and other pollutants, and outcompeting annual weeds.

Eroding ditch in the Salinas Valley

Native grasses were seeded; temporary upstream sediment trap was installed in winter to prevent siltation.

Rushes stabilize the bank edges.

Native grasses grown for seed on Hedgerow Farms.

Problems with Hedgerows and Other Plantings 3

As with any farming operation, problems can occur. Solutions exist that are site-specific and involve thorough planning and analysis, fine-tuning the selection and location of plant materials, and implementing sound management practices. Issues with hedgerow plantings include:

- Costs of planting a hedgerow
- Limiting equipment movement
- The time involved with management of weeds, irrigation and/or vigorous growth of branches
- The potential for wildlife (especially cottontail rabbits and birds) to damage adjacent young crops
- The risk of bringing in plants, mulch or soils that spread plant diseases
- Misconceptions by auditors and buyers about food safety requirements
- Plant mortality over time, and the need to replant
- Inadequate plant density leading to a sparse hedge with gaps
- Occasional spread of cultivated plants into adjacent crops
- The problems associated with pest insects, rodents or other mammals

Specific Problems and Solutions

Weeds

Controlling weeds is an expensive and time-consuming task for growers, and needs to be handled in the early stages of a conservation planting. Proper site preparation can include managing the weeds at the site six months to a year before the hedgerow is planted. Various methods of weed control include pre-irrigation and cultivation, pre-plant flaming, solarizing beds in appropriate climates, mulching, weed fabric, herbicides, hand cultivation, and weed-eating. Planting into a heavy mulch has proven successful in many situations. A six-inch layer of mulch can effectively control weeds. A dedicated effort to control weeds in the first one to two years will save a lot of time weeding later, while increasing the likelihood of successful hedgerow establishment. As hedgerows grow larger over time, fewer weeds grow underneath them, with some older and more established hedgerows being practically weed-free, resulting in less weed control needs than conventionally managed field edges.

Weed-eaters are effective tools for managing unwanted vegetative growth in habitat plantings.

Tree-trimming services and landfills can supply clean, disease-free mulches.

Certain rhizomatous native grasses, such as Creeping Wildrye and Red Fescue, and some spreading forbs such as Aster and Yarrow, can suppress annual weeds. Sweet Alyssum, also a good plant for attracting beneficial insects, can smother weeds, but can become invasive into adjacent natural areas.

The spread of seeds from a hedgerow into adjacent fields is normally not a problem when fields are cultivated, but in some cases, plants such as Coyote Brush can invade adjacent non-tilled fields. Male Coyote Brush, while difficult to source from the nurseries, can be an acceptable choice when the grower is concerned about its spread. Mulches, which should be certified pathogen-free, suppress weeds, with a secondary benefit of helping to regulate moisture. Mulches, while having a labor and material cost, can be replenished periodically until the hedgerow plants cover the ground.

Native perennial grasses can form thick sod and suppress weeds.

Growers have seeded Alyssum into newly planted hedgerows to outcompete weeds.

Pest Insects

It is important to be knowledgeable about the introduction of plants that harbor a known pest to a susceptible crop. Some pest insects are normally attracted to hedgerow plants, and these pests provide food for predators and parasites. To maintain natural enemies in the agroecosystem, it is necessary to have an appropriate number of the host pests.

In North Coast vineyards, common Periwinkle (*Vinca minor*) and Himalayan Blackberry are the primary hosts and disease reservoirs for the Blue-green Sharpshooter and Pierce's disease. Elderberry and California Blackberry can be a host for the Blue-green Sharpshooter, but not important in transmitting the disease. Glassy Wing Sharpshooter, also a vector of Pierce's

Jack Kelly Clark

Lady beetle larvae are voracious aphid eaters.

Jack Kelly Clark

Tiny wasps lay their eggs in aphids.

disease, has a large number of host plants, but is currently limited in its distribution. Any riparian management that removes vegetation to control pests must be done in accordance with current regulations. Parasitic wasps as well as predatory lacewings, ladybug larvae, spiders and ants and some pathogens are known biological control agents of sharpshooters, and conservation plantings provide habitat for these natural enemies.

Grape whitefly and stinkbugs have been observed on Coffeeberry. Quailbush (Saltbush) can be a host for the beet leafhopper, which can transmit curly top virus to certain vegetable crops. Light brown apple moth has over 200 host plants in California, and research is being done to develop classical biocontrol for the pest, which is subject to predation and parasitism by natural enemies. Spotted winged drosophila has many host plants, and while there is some predation, current local natural enemy populations are not providing stable or significant control.

It may not be necessary to eliminate certain native plant species entirely from a planned hedgerow. Some plant-pest association reports are anecdotal and vary from region to region, and even from site to site within the same area, and by crop. The best strategy is to monitor the hedgerow plants, and to remove and replace those that are showing evidence of problem pests or diseases. Using many species of native plants, as opposed to plantings with single or few species, minimizes the proliferation of pest insects and expands suitable environments for natural enemies.

Jack Kelly Clark

Aphid mummies parasitized by wasps.

Jack Kelly Clark

Mature lady beetles also like aphids.

Rodents and Other Mammals

Rodents can cause major problems and need to be managed, regardless of field edge habitat. Studies have shown rodents to be equally dispersed throughout farm fields and adjacent landscapes, and not confined or necessarily attracted to hedgerows (http://bit.ly/2C9KJs6). Cottontail rabbits in particular like hedgerows and can damage seedling crops and young orchards and need to be managed with crop selection, buffers or row covers if damage is observed. While ground squirrels don't necessarily eat hedgerow plants, they can damage the bark and make burrows in the beds. These pests like to be able to see, so blocking their view with screening or even weedy growth can discourage their infestation of a planting.

Different kinds of plants and plant management have different characteristics that affect rodent activity. For example, the perennial grass creeping wildrye does not produce large amounts of seed, and as a result, mice are less common in these grass plantings than in areas colonized by seed-producing weeds. Many growers use owl boxes and perches to attract rodent-eating barn owls and raptors.

Besides being crop pests, rodents and other mammals can damage or destroy new conservation plantings. Below-ground and/or above-ground wire cages, as well as various types of fencing, can be used for gophers, ground squirrels, rabbits, deer, and wild pigs.

Since ground squirrels like to be able to see, screening with silt fabric can discourage infestation.

Drip tape was elevated on stakes to prevent damage.

Owls can help control rodents.

A simple perch provides site for raptors.

Rabbits chewed holes in this drip tape.

Wire cages can be used when gopher pressure is high.

Sfcitizen

Hawks and other raptors can help manage rodent populations.

Pathogens and Diseases

While some plant pathogens can be hosted by California native plants as well as by widespread ornamental landscape plants, care needs to be taken to prevent the spread of pathogens from hedgerow plantings. Toyon, a member of the rose family and a widely used hedgerow plant, is susceptible to fire blight, and the causative pathogen may be transmitted via pollinating insects to nearby apple and pear orchards. The fungus *Eutypa* that can cause a disease in grapes has been associated with *Ceanothus* and the timing of vineyard pruning. Sudden Oak Death Syndrome and certain *Phytophthora* can be hosted by some of the plants recommended for hedgerows and in contaminated wood-chip mulches.

Site specific species selection that supports biodiversity minimizes potential for unwanted pathogens or diseases.

These problems can be reduced or eradicated by specific management practices, including but not restricted to eliminating or limiting certain species from a site-specific plant list, purchasing certified disease-free plant materials or pruning affected branches. A diversity of plant species in the hedgerow reduces the potential for any one species to become a problem and allows farmers to use these native plants for their benefits.

Birds

In general, shrubs, particularly taller shrubs, attract birds. Many species of birds eat agricultural pest insects, and farmers have found that having birds in the hedgerows can be beneficial. Almost all songbirds are insectivores during the spring when they are raising their young. However, once the nesting season is over, certain species of birds, such as starlings, become fruit or berry eaters and can create problems for some agricultural crops and need to be managed with the use of bird-control devices or netting. Hummingbirds are known to be very aggressive against other birds, and growers have attracted them to vineyards and other crops with the placement of hummingbird feeders. A road or buffer five to ten feet wide between the crop and the hedge or alternative crop choices can help reduce the effects of certain birds feeding on seedlings.

Jo Ann Baumgartner

Netting is a strategy for keeping birds off of crops.

Farmers need to be knowledgeable about plant diseases and issues and can get information from local university cooperative extension agents and pest control advisors. Key questions to be asked are:

- How good of a host for a disease is a certain plant?
- Is that plant commonly infected?
- How readily can an insect vector pick up a pathogen from the plant?
- Is the plant being installed in an area where a natural reservoir of the disease occurs?
- Has the nursery providing the native plants been inspected for a disease or pathogen?

Food safety

Potential contamination of certain crops by various pathogens is an important concern for farmers, and there are many resources available for this issue. Whereas in the mid-2000's attention was put on the potential of habitat to harbor vectors for pathogens, more recent research has identified biodiversity and healthy habitat as being positive factors in preventing movement and proliferation of pathogens. **Every farm should have a food safety plan, regardless of field edge habitat.** The US Food and Drug Administration (FDA) **Food Safety Modernization Act (FSMA) of 2011 does not require farms to destroy animal habitat** or otherwise clear farm borders around outdoor growing areas or drainages. **Farmers need to monitor the crop and not the habitat planting for animal feces or presence.**

The factors to be considered before deciding whether animals are a food safety concern are:

- number of animals
- type of animals
- type of crop
- harvest procedure
- neighboring influences
- pathogen of concern
- additional processing required

Rodent feces and parts in mechanically harvested crops have emerged as an issue, with some grower-shipper certification groups requiring clean field borders in certain cases. Since FDA does not require clean buffers, buyers and auditors need to be educated about the benefits of habitat.

Research has shown that the presence of hedgerows increases wildlife diversity, but does not increase wildlife intrusion into adjacent crops, and more importantly, does not increase the prevalence of animals carrying foodborne pathogens (http://bit.ly/2C9KJs6). In fact, studies have shown an increase in food pathogens when habitat was reduced on farms (http://www.pnas.org/content/112/35/11126.full). Thus, clearing field edge vegetation on farms does not decrease wildlife or food borne pathogen prevalence in nearby fields. This is particularly important to know, given that the Food Safety Modernization Act (FSMA) is calling for farmers to implement co-management of wildlife and agriculture, instead of clear cutting wild habitat around their crops. That said, following mandated FSMA requirements including scouting crews and 'silt fences' where needed to exclude the potential intrusion of deer and wild pigs can help buyers and food safety auditors better integrate habitat on farms. More information on Food Safety and crop production issues can be found on the CAFF (www.caff.org), Wild Farm Alliance (www.wildfarmalliance.org) and National Sustainable Agriculture Coalition (NSAC) (http://sustainableagriculture.net/) websites.

This spinach crop was disked in for misguided food safety concerns.

Silt fence barriers can satisfy food safety auditors' and buyers' concerns.

Plastic sheeting food safety barriers are frequently torn apart by winds.

This hedgerow was planted to provide a buffer between the farm and a grazed pasture.

Causes of Failure

Irrigation - too little water or too much - has been the number one cause of failure in plantings. Other causes for the loss of hedgerow plantings are: too many weeds; deer and rodent damage; water-sensitive plants not planted on raised beds or ridges; too much fertilizer; improper location or spacing of the planting; plant material too small, unhealthy or young to be planted, especially in the winter when freezes may occur; and lack of availability of desired plants leading to improper substitution of other plants not suited for the site. Just because a plant is a “native” does not mean it is automatically appropriate or likely to succeed at the site. It is best to choose natives that naturally grow in the general area where they are planted. Unintended destruction of hedgerows by tractors or work crews can be prevented with good signage and education of workers and their supervisors.

Signs will help in the survival of habitat plantings.


Without signs, herbicides were applied and killed many planted shrubs.

Planning and Planting a Hedgerow

4

Whole Farm Planning

Farm planning is essential for the production of commercial crops and can help with the efficient implementation of hedgerows and other conservation practices. A whole farm plan, including a conservation plan, can begin with a Site Inventory Checklist, that describes with maps and aerial photos the following components: regional setting; land use; topography; hydrology and drainage; soils; vegetation; wildlife; climate and microclimate; existing and planned buildings and structures; sources of water for irrigation; crop production areas; non-cropped areas; views; spaces and senses; activities and circulation; utilities; historical and archaeological resources; legal regulations; off-site factors; and neighbors. Your local NRCS office can assist you with a conservation plan, including the creation of maps mentioned above. Hedgerows or other farmscaping projects can be planned by analyzing and coordinating a proposed project with the above-listed components of a Site Inventory Checklist (See Page 53: Planning and Planting a Hedgerow – Summary Pull-out Chart).

Farmscaping with native plants provides a way to help accomplish whole farm goals, such as pest and weed control, soil erosion reduction, climate modification, dust and chemical buffers, wildlife habitat enhancement, and increase in biodiversity. **A farmscape planting**, whether a hedgerow, windbreak, filter strip, grassed waterway, beetle bank or riparian area, **is a distinct farming operation** that should be integrated within the farm production plan and **managed as a separate crop** from planning through establishment and maintenance. Well-timed **maintenance and watering** are keys to **successful establishment.**

Seeding native grasses is only the first step in establishing a conservation planting.

Google Earth

Aerial photos are an excellent way to study the many components of a farm site.

Site Selection and Evaluation

Many factors can determine the selection and evaluation of a site for a hedgerow or other conservation planting. Frequently, growers have one or more areas where they would like to put plants, replace weeds, create habitat, attract beneficial insects, protect crops from wind and dust, filter and control runoff, or beautify a site. The first step is to identify non-cropped areas of the farm that would be suitable for the planting of vegetation. The most common sites are along roads and fences, areas that usually have some existing vegetation such as annual weeds that need to be managed. Filter strips are often located near water bodies to filter runoff before contaminants cause pollution, or in areas to slow and spread out water flow. Grassed waterways are most often used wherever ditches and drainages exist. Areas that regularly flood may be suitable for durable riparian species, such as Willows, rushes or sedges. Creek banks can be made more valuable by replacing invasive species with riparian habitat, or those banks may need bolstering with trees to withstand sloughing off into the creek during high flows.

A fence line is an ideal location for a hedgerow.

Hedgerows and native plantings often work well in areas of farms that are not suitable for crop production and need to be constantly weeded. Some areas will automatically be eliminated from consideration because they lack access to water or equipment, have severe weed infestations, or may conflict with crop production areas. Other major factors limiting site selection could be topographical (steep slope), hydrological (drainage problems), or cultural (adjacent land uses). Protection from pesticides is critical for any wildlife/insectary planting.

Short plants being installed on a berm.

Site Analysis

Once a site has been selected, several parameters need to be thoroughly evaluated. The analysis of the proposed planting site describes the location, such as along a fence, a road, near buildings or driveways, next to a river or stream, or proximity to cropland, and the types of crops grown. If the site is on the edge of the property, the boundary or property line may require surveying. The site can be on the edge of but not be too close to the production area of the cropped field or to neighboring property.

The length and width of the area should be measured. Normally, a minimum planting space from 10-to-15 feet in width is optimal for shrubs and trees, although grasses and smaller plants can be installed in narrower sites. Depending on the location and the plant species, periodic pruning may be necessary. Some plants may extend up to 20 feet in width. Make sure to plan for the hedgerow's potential maximum size.

Determining the characteristics of the soils of the site, whether they are heavy, medium or light, is necessary for establishing and maintaining a successful planting. Understanding the hydrology of the area is essential, so that potential flooding, low and high spots, and overall drainage and runoff patterns are considered.

Deer and rodents can destroy a planting or cause problems for adjacent crops. Plant selection and plant protection can be evaluated on sites where animal pressure could be a problem. As plants mature, fences or cages that restrict growth can be removed or refitted to meet evolving conditions. Other site considerations would be access for equipment, off-site factors such as runoff from adjacent areas, and location of trees, fences, roadways, overhead power lines or other existing features that could influence the design of the hedgerow.

Russ Hill

When mature, this hedge will protect the orchard and attract beneficials.

Mature hedgerow by orchard

Plant guards may be needed to protect young shrubs and trees where rodent pressure is high.

This hedgerow requires periodic pruning, to keep branches from impacting the road.

Irrigation

Critical pre-irrigation with drip system

An irrigation system that will function for two or three years is critical for the establishment and survival of a planting, if native plants are used. Whether the system is drip or tubing with emitters, sprinkler, flood or furrow, water truck or garden hose, some water is vital to get the plants through their first two or three hot, dry California summers. Drip irrigation is the most efficient and works well for the majority of hedgerow installations. Weed management issues are significantly higher when using flood or sprinkler irrigation as compared to drip. Plants that look fine in April may be dried up and dead by September without water. **It is also important to make sure that the irrigation system is in place before the hedgerow is planted.** Not only can the system be used for the essential pre-irrigation of the site, it can also provide the critical watering that newly planted plants require immediately.

A common irrigation system utilizes tubing with emitters, where two emitters are used for each plant, placed 6” to either side of the plant stem, to accommodate movement of the tubing due to temperature variation. Shrubs and forbs get ½ gallon per hour (GPH) emitters, and trees get 1 GPH emitters. A filter and a pressure regulator can be used if necessary. The irrigation supply company can calculate friction loss in drip tubing for a site. The distribution uniformity (DU), or how accurately and evenly water gets distributed from the drip emitters along the line, depends on the incoming flow, the length of the line, the diameter of the tubing, and the number and flow rate of drip emitters used per line. On sites with slopes or uneven terrain, pressure-compensating emitters would be used. Typically, a system can run for 3 to 5 hours a week during the dry season, depending on the soils and climate.

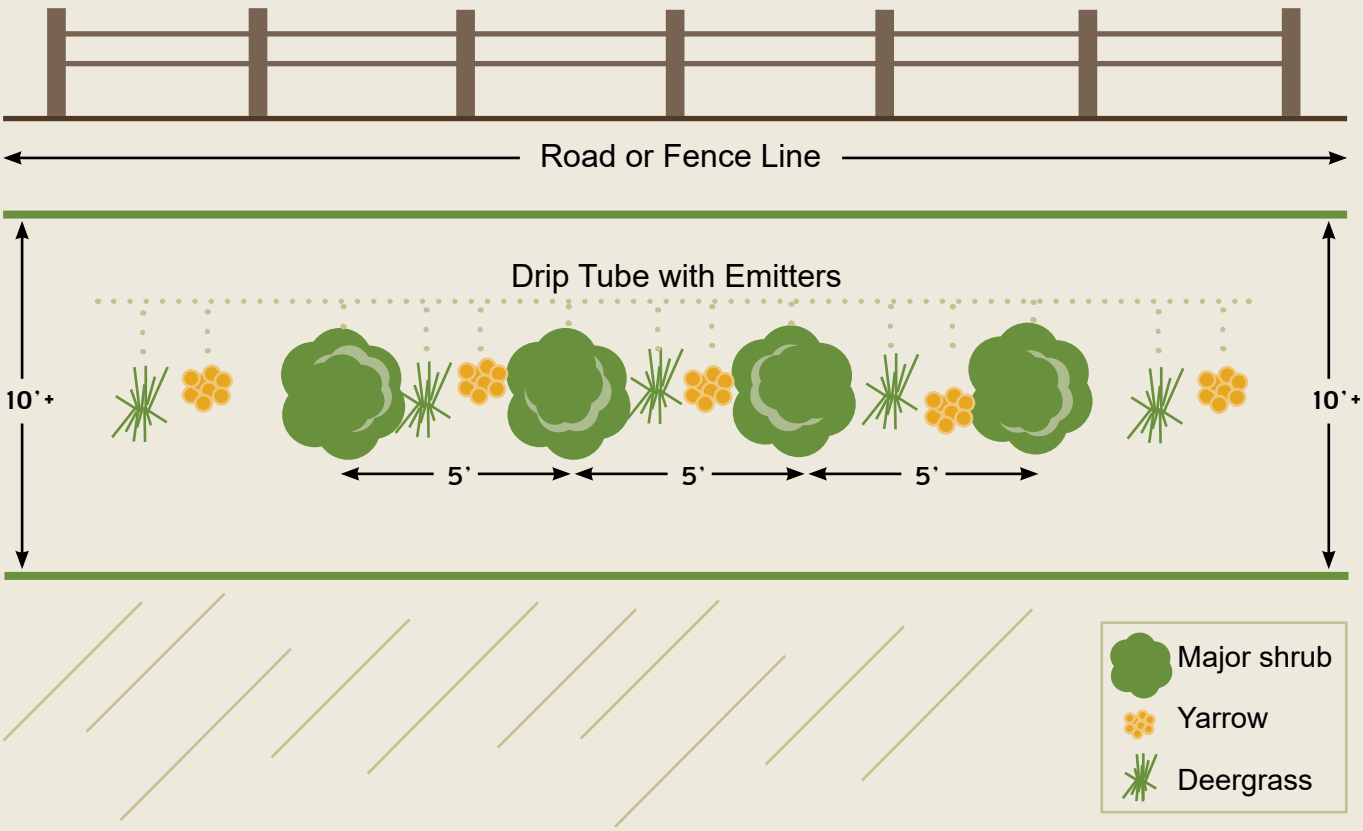
Ongoing irrigation needs to be monitored, to ensure the plants are getting enough moisture but not too much. In general, hedgerows in California will only need irrigation for three years, but in certain areas of extreme heat and very deep aquifers, water will need to be provided indefinitely.

Planning and Design

With the site analysis completed, planning and design of the hedgerow can take place. Design can be complex or simple, with elaborate landscape-type drawings or basic sketches of the planned planting. Hedgerow design involves placing major shrubs or trees at a certain spacing with smaller shrubs, forbs or grasses in between. Plans for the irrigation system should be included in the design layout.

Given the "normal" California Mediterranean climate, with cool wet winters and hot dry summers, conservation plantings can be installed in all twelve months of the year, provided irrigation is available, unless it is an extremely wet winter or extremely hot summer. Fall plantings are ideal, but farm scheduling, labor availability and plant availability are factors that can influence timing of the planting. New plantings are rarely successful when installed in cold, overly wet winters or in times of excessive heat.

Figure 3
Sample Layout for Hedgerow with Drip-emitter System



Plant Selection

Developing the plant list is an important step, as decisions on the size of the plants and their suitability to the environment, whether riparian, woodland, chaparral or irrigated cropland, need to be made. Numerous plant books and materials as well as local agricultural consultants and biologists are available that can provide specific information about the basic components of local plant communities. Organizations such as NRCS, RCD, Xerces Society, California Native Plant Society, Audubon Society and California Native Grass Association can provide specific recommendations and also help locate local nurseries that offer native plants. Botanical gardens and native plant nurseries are excellent sources of information and inspiration for selection of suitable plant species for specific areas. NRCS has an excellent on-line process for finding appropriate plants for your site, which you can access by following the steps in the adjacent box. Audubon Society also has a searchable online plant list (https://www.audubon.org/native-plants).

Steps to See Plant Lists for a Specific Locality

1. Visit www.calflora.org
(You may have to register and log in with an email address and a password that you can create.)

2. Scroll down on left to NRCS eVegGuide

3. Click on the map to select a location

4. Go to Search Criteria

5. Under Practice, choose a value
(i.e. 422 - Hedgerow Planting)

6. Under Plant Type, select Shrub
(and/or Forb, Tree, Grass)

7. Under Native?, Click on the box

8. Click on SEARCH, and a list of plants will come up.

Elderberry, a very adaptable large shrub or small tree

Figure 4
Sample Hedgerow Plant List

Plant Name	Scientific Name	Type or Location
Buckwheat spp.	*Eriogonum spp.*	Medium shrub
Ceanothus spp.	*Ceanothus spp.*	Major shrub
Coffeeberry	*Frangula californica (Rhamnus)*	Major shrub
Coyote Brush	*Baccharis pilularis*	Major shrub
Deergrass	*Muhlenbergia rigens*	In between shrubs
Elderberry	*Sambucus Mexicana*	Major shrub
Flannel Bush	*Fremontodendron californicum*	Major shrub
Manzanita spp.	*Manzanita spp.*	Major shrub
Quailbush/Saltbush	*Atriplex lentiformis*	Major shrub
Redbud	*Cercis occidentalis*	Medium tree
Sage spp.	*Salvia spp.*	Major shrub
Toyon	*Heteromeles arbutifolia*	Major shrub
Yarrow	*Achillea millefolium*	In between shrubs

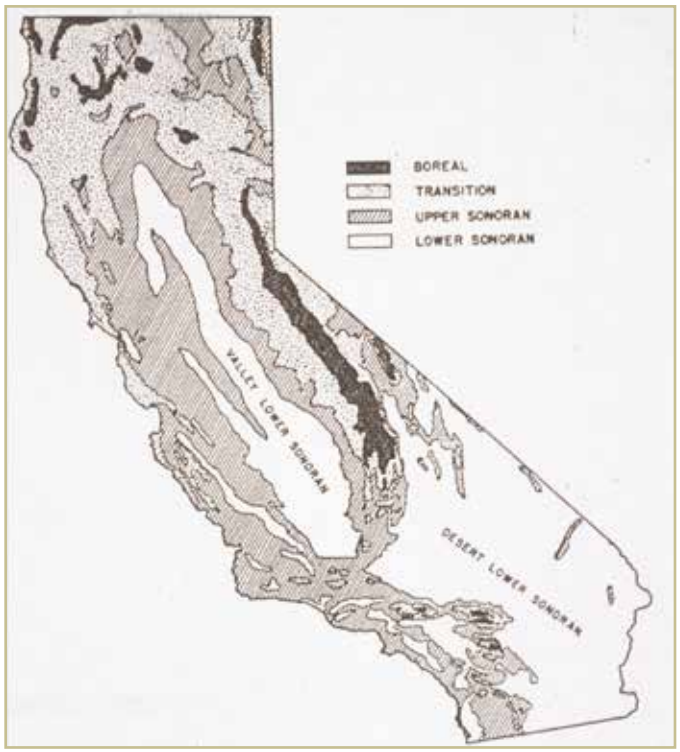
California contains a wide array of genetically distinct populations of native plant species. Growers are encouraged to use native plants in hedgerows and other conservation plantings that naturally occur in local ecosystems. Many areas have nurseries that carry local plant stock, which some people believe is important because of the possibility of non-local natives hybridizing with resident native vegetation and reducing the purity of local genetic material. Others believe that at this point in history, much of the landscape has been degraded and any increase in biodiversity with the use of native plants can be beneficial. Native plants have evolved with a complex of insects that support birds and predatory and parasitic insects and thus provide a more developed biodiversity for natural enemies than introduced vegetation. Local agricultural consultants and biologists can be consulted regarding the selection of appropriate non-native, non-invasive species to avoid impacting indigenous resources. Some situations exist where non-native plants are desirable for hedgerows because of their beneficial insect-attracting potential or their possible economic return to the farm. Examples of these include Olive, Citrus, Pomegranate, Soapbark Tree, Rosemary, Lavender and other herbs or flowers.

Many different native plants can be used in hedgerows.

The geography and climate of California are such that many plants used in hedgerows grow over a wide range of situations, which will be important as the climate changes. Identifying the local and regional ecosystem in which the farm exists helps to determine which plants are suitable, will grow well, and can support the greatest variety of wildlife. Shrubs such as Coyote Brush, Toyon, Coffeeberry, Saltbush and Ceanothus can be grown from Northern to Southern California, from the coast to the foothills of the Sierras. The many species of oaks, endemic to different regions of the state, support a vast array of insects that attract insect-eating birds.

Oak trees attract a vast array of life: plant it, and they will come.

Furthermore, certain plants are able to thrive outside their naturally occurring distributions. For example, the fog-loving coast redwood prospers in Bakersfield, Hollister and other hot inland areas, as long as there is sufficient



C.Hart Merriam

Life zones of California

Figure 5

The Gold-cup Oak and Various Associated Consumers

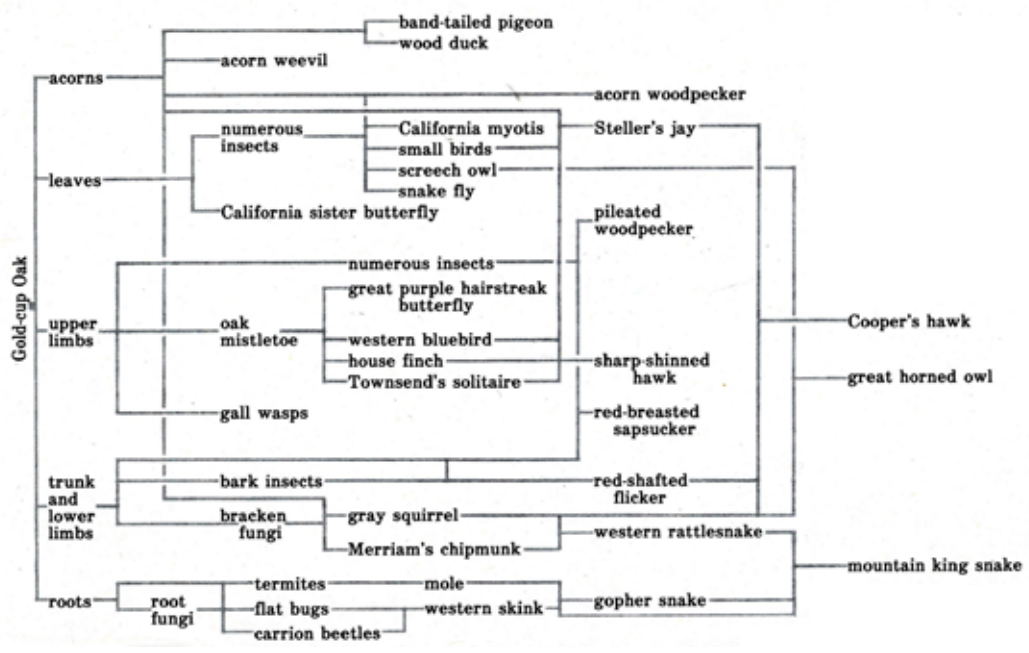


Chart courtesy of "Yosemite National Park," page 253, by Jeffrey P. Schaffer, 1983

irrigation. However, keeping with native plants that evolved with the regional climate is a better strategy than planting coastal plants in the inland desert areas. Driving or walking around the region for a planned hedgerow and observing what is growing well can help determine which plants to choose for the project.

Many native grasses, such as creeping wildrye and red fescue, can be grown throughout the state. The overall climate of the area, specifically the timing and amount of precipitation and the range of seasonal temperatures, is important information for predicting the requirements of the proposed planting. Plant selection should be made with consideration to the local climate that is predicted to be warmer than the historical average, choosing plants adaptable to hotter temperatures and different hydrological conditions. The CDFA and California Climate and Agriculture Network (CalCan) websites (http://bit.ly/2njEh7P) and (http://bit.ly/2BzbzoB) provide information on anticipated changes in plant survival in view of the warming climate.

The height of the proposed hedgerow depends on its purpose and location. Commonly planted hedgerow shrubs, such as Ceanothus, Coyote Brush, Coffeeberry, Sage and Buckwheat, are available in short, medium and tall forms, so a planting can be adapted to diverse situations. Smaller shrubs, forbs and grasses can be interplanted between the major plants. A tall planting that could include trees would be called for where protection from wind was desired. Where shade, overhead wires, neighboring land uses or traffic visibility could be a problem, shorter plants would be appropriate. The full growth of the plants should be accounted for, so they won't interfere with field roads, tractor turnarounds, or crop areas. Berms or slopes in the middle of cropped areas are common, and these sites are well suited for prostrate and spreading shrubs, forbs and grasses.

Prostrate Coyote Brush

Short varieties planted on berms can smother weeds, stabilize soil and provide habitat for beneficial insects.

Quailbush/Saltbush, shown here in the southern San Joaquin Valley, can be planted in hedgerows throughout the state.

Plants should be selected to match soil and hydrologic characteristics of the site. Water and soil conditions have been major issues on how well a hedgerow survives and thrives. Plant tolerances, potential future irrigation, possible flooding and crop changes need to be considered.

Flowering hedgerows provide nectar and pollen as well as cover and habitat for insects.

Flammability, height and shading issues, and potential to become invasive on adjoining lands are other considerations. Hardy, long-lived species such as oaks are suitable for various situations.

Desired density and spacing will determine the number and sizes of plants to be chosen. Major shrubs can be spaced at four-to-five feet apart for dense hedges, and from six-to-eight feet apart for less density. In all hedges, one or two smaller plants can be planted between larger ones. Grasses and forbs can be added as the lower stratum in the hedgerow and can cover the soil, reduce weeds, and provide overwintering habitat for beneficial insects. The use of plants that spread, such as Hummingbird Sage, Aster, Clematis, Yarrow, Hedge Nettle, Creeping Wildrye and others, may allow for wider spacing of larger shrubs. Trees can be spaced at 10 feet apart or more. Native grasses can be planted as either plugs or established from seed.

Ceanothus, Elderberry

Budget, Costs and Cost-Share

Once a draft plant list has been prepared, a budget can be developed including costs of planning, site preparation, irrigation system installation, soil amendments and mulch, plants, installation, and subsequent maintenance (irrigation, weeding, replanting and rodent control) over several years. A worksheet listing activities, materials and other costs for establishing a planting is shown in Figure 6.

Generally, costs for establishing a hedgerow can range from $1–$4 per linear foot. Most one-gallon plants can be acquired for about $6-$10, and smaller pots, plugs and treebands can be bought for less. Numbers of plants needed can be based on shrub spacing that can be 4, 5 or 6 feet apart, with forbs and grasses in between if more flowering or ground cover is desired. While 5-foot shrub spacing is the most common, the more plants initially installed, the more quickly the ground will be covered. The use of spreading understory plants will also reduce future weeding costs.

One-gallon pots are widely used in restoration plantings.

Examples of Cost Estimates for Installation and Maintenance

- *UCCE Central Coast Conservation Practices Estimated Costs and Potential Benefits for a Perennial Hedgerow Planting*
  http://cesantacruz.ucanr.edu/files/51430.pdf
- *Bringing Farm Edges Back to Life!*
  http://www.yolorcd.org/nodes/resource/publications.htm
- *Pest Control and Pollination Cost-Benefit Analysis of Hedgerow Restoration in a Simplified Agricultural Landscape*
  http://ccpestmanagement.ucanr.edu/files/257587.pdf
- *Establishing Hedgerows on Farms in California*
  http://ucfoodsafety.ucdavis.edu/files/26499.pdf
- Xerces Society publication *Estimated Costs to Establish Pollinator Hedgerows*
  http://www.xerces.org/wp-content/uploads/2016/10/EstimatedCostFactSheet_Hedgerows_Nov2016_FINAL.pdf

Users will want to consider these studies as guides only and recalculate costs using current rates. For example, a labor cost of $13.40 per hour was used to calculate total costs for the 2003 Central Coast study. The Bureau of Labor Statistics website (https://data.bls.gov/cgi-bin/cpicalc.pl) has a calculator that gives an estimate of the change in dollar value due to inflation from past years to the present.

Figure 6
Estimated Costs to Farm for Planning & Installation of Vegetation Planting

	Date:		**Farm:**		
Activity	**# Hours**	**# People**	**Hourly Rate**	**Total $**	**Comment**
Farmer meetings and planning					
Planning with foreman					
Tractor work—labor					
Other site preparation—labor					
Picking up materials					
Irrigation system installation—labor					
Pre-irrigation—labor					
Planting—labor					
Spreading mulch, compost					
Post-planting monitoring and maintenance					
Irrigation-labor					
Materials	**Cost**			**Total $**	
Tractor work—fuel					
Plants					
Irrigation system—parts					
Compost					
Mulch					
Other site preparation materials: tools, etc.					
Pre-irrigation—water					
Irrigation-water cost, PGE, fuel					
Other (fencing, gopher cages, vehicle use, etc.)					
Other	**Miles**	**Current $/mi**		**Total $**	
Mileage to pick up compost, irrigation supplies, mulch					
Annual Costs	**Rate**	**Amount/Time**		**Total $**	
Estimated yearly water cost					
Estimated yearly maintenance*					
Land Rent					

*Monitoring, weeding/mowing, fixing irrigation system leaks, replanting

There are several programs to help farmers and landowners pay for stewardship and habitat projects, including the installation of hedgerows, windbreaks, field borders, riparian plantings and grassed waterways. Well-known programs include the following:

- Environmental Quality Incentives Program (EQIP), administered by USDA NRCS
- Continuous Sign-up Conservation Reserve Program (CRP), managed by the USDA Farm Services Agency
- Partners for Fish and Wildlife Program, administered by the US Fish and Wildlife Service
- Funds have also been available through the Habitat Enhancement and Restoration Program, which is funded by the California Wildlife Conservation Board, and from CDFA's Healthy Soils Program.
- Information about NRCS financial assistance programs can be found on the website: https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/financial/.

Overall costs may be offset by the reductions in pest control expenses and the economic benefits from increased pollination. Many farmers pay for hedgerows out of their operating expenditures, using existing labor and irrigation supplies. Organizations such as Xerces Society and the RCDs have intermittent funding to cover some or all of the costs of hedgerow and habitat design, installation and maintenance. Their staff may be able to assist with planning, design considerations, native plant selection, local nursery sources and planting techniques.

Jo Ann Baumgartner

Signs can be educational, to give credit for cost-share support.

Fencing for the cows, signs for the people

Nursery Contact

Once a final budget and funding sources for the project are in place, nurseries can be contacted to get availabilities and prices of plant materials. Every region has nurseries that offer local native plants, and some nurseries provide statewide plant resources. The California Native Plant Society has lists of native plant nurseries and seed companies in California (http://www.calscape.org/plant_nursery.php) and (https://www.cnpssd.org/sources-for-seeds-and-bulbs-of-california-natives/). Ordering well in advance can facilitate availability of desired plant stock. Visiting the nursery can help in selecting the healthiest plants.

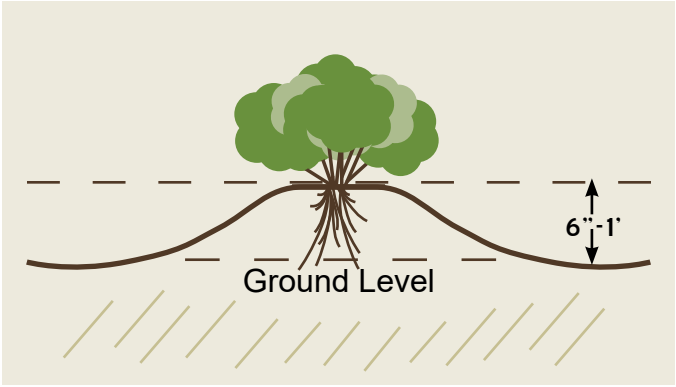
Smaller containers can be more economical for grasses, sedges, rushes and forbs.

Site Preparation and Planting

As with any agricultural operation, the proposed farmscape site needs to be prepared for planting. Different sites will require different levels of work, with some requiring very little, and others substantial effort as much as six months or more before planting. Site preparation should involve weeding the area, and if the soil is heavy or compacted, ripping and adding amendments. In hotter areas, solarization of the beds can eliminate future weedy growth.

Before planting, an irrigation system should be installed that has the capability of providing water for the first two or three years. A long-term irrigation system may be justified in some instances to extend available floral resources of certain insectary plants or to water plants that are bringing economic returns. Dry areas with very deep groundwater lenses may require permanent irrigation. In non-arid locations, California natives perform best when planted on a berm or bed, that is raised about one foot higher than the surrounding land level. If the entire site is not prepared in this manner, individual plants should be planted on small mounds, so that their root crowns will not be subject to summer water. Planting high on a raised bed can also minimize effects from winter and spring flooding. In arid situations, plants should be installed level with the ground so that they do not dry out too quickly.

Plants in pots from the nursery should be watered and laid out along the site. A small amount of compost should be added to the planting site, and plants should be set into a moist planting hole. Most native plants have evolved in relatively infertile soils, and unless a soil is extremely sterile, fertilizing native plants causes them to grow too rapidly for their stems to support them. Planting in the fall at the beginning of the rainy season helps ensure adequate early watering and early root growth, but as long as irrigation is available and the weather at the time of installation is neither too wet, too cold or too hot, hedgerows and other conservation plantings can be planted in California in any month of the year.



Most CA native plants need to have their root crown elevated on a ridge to stay dry during summer months.


Solarizing beds in hot climates can kill weed seeds; green weeds in foreground would have dominated this planting bed.


Pots are laid out for planting.


Plant to moisture (pre-irrigated planting hole)

The use of native plants ensures that once established, they usually require little if any management other than monitoring the irrigation and some level of weed control. Over-fertilization and over-watering can kill or damage native vegetation. Various mulches, certified to be disease-free from landfills, as well as walnut shells, where they can be locally found, can be used for keeping weeds down and retaining moisture. Tree service companies will often deliver chipped material which serves as a good mulch material, if clean and free from contaminants. Conservation plantings should be designed so that they can be managed easily for weed control, for example straight rows along field edges.

Signs should be posted in English and Spanish to prevent accidental damage to the hedgerow from chemicals, tractors and weeding. Inexpensive signs can be printed, coated with 10 mil lamination and mounted on a post using wood screws. Painted metal stakes can be placed next to plants. Rows of visible indicator plants such as Deergrass or shrubs can be used as an obvious border to delineate a grass planting.

Finally, wire cages or other protective sleeves should be installed to protect young plants in areas where deer, ground squirrels, rabbits, gophers or other animals might cause harm.

Signs can prevent tractor drivers from accidentally destroying a planting.

Identifying native plant hedgerows

Deergrass as a boundary marker

Keith Abeles

Young native plants, with protective sleeves, will connect wildlife areas in riparian zones.

Maintenance and Follow-up

After the planting has been completed, maintaining the irrigation system, managing weeds and controlling rodents are the primary tasks to ensure the survival of the farmscape plantings. Generally, there is a big flush of weedy growth in the late winter and early spring that can overrun a planting. Weed management with mulches, weed fabric, hoeing, mowing, weed-eating, herbicides or flaming is necessary in early stages of hedgerow establishment. **Catching the weeds before they go to seed reduces the weed seed bank and saves a lot of work.** Managing the irrigation needs of the hedgerow is critical for successful establishment. Winters do not always provide even and continuous rainfall, so it is critical to monitor plant moisture during the first winter and sometimes during the second. If a drip system is used, emitters should be checked periodically.

Staying ahead of the rodents by early trapping can prevent their excessive colonization of a planting. Replanting some plants is generally necessary, since a small percentage plants tend to die from rodent damage, accidental injury, water problems, extreme temperatures, or various other causes.

Monitoring the successes and the failures, and recording pertinent information, can inform the grower and the resource manager about plants and processes. Some plants will do very well in certain areas and others will not. **Keeping records and taking photos** of the performance of hedgerow plants can be very helpful for future projects.

Over time, hedgerows and other farmscape plantings will generally require less care as they grow more established. It is easy for growers to neglect farmscape plantings, since the production of income from crops is obviously the top priority. However, these plantings do need some attention and should be thought of as a "crop" in their own right, existing as one of the elements that contributes to production of the entire farm. Once established, a thriving hedgerow, windbreak, beetle bank, riparian planting or grassed waterway brings a wide array of benefits to an agricultural operation, and, apart from its functional components, adds beauty and diversity to the farm.

Controlling weeds in young hedgerows is essential.

Weed fabric as an alternative to mulch can get hedgerow plants off to a weed-free start.

John Anderson, Hedgerow Farms, and friend

Planning and Planting a Hedgerow:
Summary Pull-out Chart

1. Farm Plan — Site Inventory Checklist

a. Regional Setting
b. Land Use
c. Topography
d. Hydrology and Drainage
e. Soils
f. Vegetation
g. Wildlife
h. Climate and Microclimate
i. Existing and Planned Buildings and Structures
j. Crop Production Areas
k. Non-Cropped Areas
l. Views
m. Spaces and Senses
n. Activities and Circulation
o. Utilities
p. Historical and Archaeological Resources
q. Legal Regulations
r. Off-Site Factors
s. Neighbors

2. Site Selection and Evaluation

a. Identify non-cropped areas of the farm suitable for vegetation planting.
b. Exclude from consideration areas that regularly flood, lack access to water or equipment, or may conflict with crop production areas.

3. Site Analysis

a. Description of location
b. Length and width of planting site
c. Ecosystem: complex of native plants and animals historically present
d. Climate
e. Soils
f. Hydrology: drainage patterns; low and high spots; potential for flooding
g. Irrigation system
h. Plant requirements: tall, medium, short; trees, shrubs, forbs, grasses
i. Animal pressure
j. Other considerations: access for equipment; off-site factors; existing trees, overhead power lines or other features that can be incorporated

4. Planning and Design

a. Design and layout
b. Develop plant lists by matching plants to site (riparian, chaparral, irrigated cropland)
c. Develop budget for project
d. Investigate and initiate cost-share possibilities
e. Contact nurseries and order plants in advance, from local ecosystem if possible

5. Site Preparation and Planting

a. Soil preparation: clear weeds, chisel, build bed
b. Installation of irrigation system for 2-3 years of operation
c. Acquire compost, bone meal or rock phosphate, mulch
d. Dig holes; pre-irrigate
e. Lay out and plant plants
f. Install signs in English and Spanish to prevent accidental damage to hedgerow

6. Maintenance and Follow-up

a. Maintain irrigation system
b. Remove weeds while they are small
c. Control rodents where necessary
d. Replant where necessary
e. Track performance of plants

Appendices

Appendix A:
Plants Suitable for Various Regions

Common Name	Scientific Name	Comment	Nectar and Pollen Source for Predators and Parasites (X); Bees (B); Hummingbirds (H)	Suitable for Region: C-Coastal; CV-Central Valley; F-Foothill
Large Shrubs and Trees				
Alder, White	*Alnus rhombifolia*	Riparian; Deciduous	X	C,CV,F
Bay/Calilfornia Laurel	*Umbellularia californica*	Windbreak	X	C,CV,F
Big Leaf Maple	*Acer macrophyllum*	Riparian; Deciduous	X	C,CV,F
Black Walnut, California	*Juglans californica*	Deciduous	X	C,CV,F
Box Elder	*Acer negundo*	Riparian; Deciduous	X	C,CV,F
Buttonwillow	*Cephalanthus occidentalis*	Moist areas	X, B	C,CV,F
Catalina Cherry	*Prunus lyonii*		X,B	C,CV,F
Ceanothus, California Lilac	*Ceanothus thrysiflorus*		X,B,H	C,CV,F
Ceanothus, Deerbrush	*Ceanothus intergerrimus*		X,B,H	F
Ceanothus 'Ray Hartman'	*Ceanothus 'Ray Hartman'*		X,B,H	C,CV,F
Citrus	*Citrus spp.*	Non-native, fruit	H, B	C,CV,F
Coffeeberry	*Frangula californica (Rhamnus)*		X,B	C,CV,F
Desert Willow	*Chilopsis linearis*	Deciduous	H, B	C,CV,F
Dogwood, Western	*Cornus sericea*	Riparian	X, B	C,CV,F
Elderberry	*Sambucus nigra ssp. caerulea*	Deciduous	X,B	C,CV,F
Flannel bush	*Fremontodendron californicum*		X,B	C,CV,F
Giant Sequoia	*Sequoiadendron giganteum*	Windbreak		C,CV,F
Hollyleaf Cherry	*Prunus ilicifolia*		X,B	C,CV,F
Hollyleaf Redberry	*Frangula ilicifolia (Rhamnus)*		X,B	C,CV,F
Incense Cedar	*Libocedrus decurrens*	Windbreak; slow growing		C,CV,F
Lemonade Berry	*Rhus integrifolia*		X,B,H	C,CV,F
Madrone	*Arbutus menziesii*	Windbreak	X,B,H	C,CV,F

Manzanita	*Arctostaphylos spp.*	Many choices	X,B,H	C,CV,F
Monterey Cypress	*Cupressus macrocarpa*	Windbreak		C
Mountain Mahogany	*Cercocarpus betuloides*		X	C,CV,F
Oak	*Quercus spp.*	Several choices,ev-ergreen and deciduous	X	C,CV,F
Pepper Tree	*Schinus molle*	Windbreak, Non-native	X,B	C,CV,F
Persimmon	*Diospyros virginiana*	Non-native, fruit	X,B	C,CV,F
Pineapple Guava	*Feijoa sellowiana*	Non-native, fruit		C,CV,F
Pomegranate	*Punica granatum*	Non-native, fruit	H, B	C,CV,F
Redbud, Western	*Cercis occidentalis*		X,B,H	C,CV,F
Redwood, Coast	*Sequoia sempervirens*	Windbreak		C,CV,F
Saltbush, Quailbush	*Atriplex lentiformis*		X,B	C,CV,F
Silktassel Plant	*Garrya elliptica*		X	C,CV,F
Silktassel Plant, Fremont	*Garrya fremontii*		X	F
Soapbark Tree	*Quillaja saponaria*	Windbreak, Non-native	X,B	C,CV,F
Sugar Bush	*Rhus ovata*		X,B,H	C,CV,F
Sycamore	*Platanus racemosa*	Deciduous	X,H	C,CV,F
Toyon	*Heteromeles arbutifolia*		X,B	C,CV,F
Tree Mallow	*Lavatera assurgentiflora*		B,H	C
Wax Myrtle	*Myrica californica*		X	C,CV,F
Willow	*Salix spp.*	Riparian; Deciduous	X, B	C,CV,F
Medium Shrubs and Perennials				
Bee Plant, California	*Scrophularia californica*		X,B,H	C, F
Blackberry, California	*Rubus ursinus*	Riparian; Can be invasive	X,B	C,CV,F
Bladderpod	*Isomeris arborea*		B,H	C,F,CV
Buckbrush	*Ceanothus cuneatus*		X,B,H	F
Buckwheat, Giant	*Eriogonum giganteum*		X,B	C,CV,F
Buckwheat, California	*Eriogonum fasciculatum*		X,B	C,CV,F
Buckwheat, Seacliff	*Eriogonum parvifolium*		X,B	C

Bush Anemone	*Carpenteria californica*		B	C,CV,F
Ceanothus, California Lilac	*Ceanothus spp.*	Many choices	X,B,H	C,CV,F
Ceanothus Yankee Point	*Ceanothus griseus horizontalis*		X,B,H	C,CV,F
Chamise	*Adenostoma fasciculatum*		X,B	C,CV.F
Coffeeberry, Eve Case	*Frangula californica (Rhamnus)*		X,B	C,CV,F
Coyote Brush	*Baccharis pilularis ssp. consanguinea*		X,B	C,CV,F
Coyote Brush, Pigeon Point	*Baccharis pilularis*		X,B	C,CV,F
Currant, Chaparral	*Ribes malvaceum*	Deciduous	H, B	C,CV,F
Currant, Red-Flowering	*Ribes sanguineum*	Deciduous	H, B	C,CV,F
Gooseberry, Fuschia-flowered	*Ribes californicum*		H	C,CV,F
Hazelnut	*Corylus cornuta*	Deciduous	X	C,F
Island Snapdragon	*Galvezia speciosa*		X,B,H	C,CV,F
Lavender, English	*Lavandula angustifolia*	Non-native, herb	X,B	C,CV,F
Lavender, Spanish	*Lavandula stoechas*	Non-native, herb	X,B	C,F,CV
Lupine, Silver Bush	*Lupinus albifrons*		H, B	C,CV,F
Manzanita	*Arctostaphylos spp.*	Many choices	X,B,H	C,CV,F
Manzanita Howard McMinn	*Arctostaphylos densiflora*		X,B,H	C,CV,F
Manzanita, Whiteleaf	*Arctostaphylos viscida*		X,B,H	F
Mock Orange, California	*Philadelphus lewisii*	Deciduous	H, B	C,CV,F
Mountain Mahogany	*Cercocarpus betuloides*		B	F, CV
Mulefat	*Baccharis salicifolia*	Riparian	X,B	C,CV,F
Oregon Grape	*Berberis aquifolium*		X,B,H	C,CV,F
Rabbitbrush	*Chrysothamnus nauseosus*		X,B	F, CV
Redberry	*Frangula crocea (Rhamnus)*		X,B	C,CV,F
Rose, Wild	*Rosa californica*	Can be invasive	X, B	C,CV,F
Rosemary	*Rosemarinus officinalis*	Non-native, herb	B	C,CV,F
Sage, Black	*Salvia mellifera*		X,B,H	C,CV,F
Sage, Cleveland	*Salvia clevelandii*		X,B,H	C,CV,F
Sage, White	*Salvia apiana*		X,B,H	C,CV,F
Sagebrush, California	*Artemisia californica*		X	C,F

Saltbush, Fourwing	*Atriplex canescens*		X,B	C,CV,F
Serviceberry, Western	*Amelanchier alnifolia*	Deciduous	X,B,H	C,CV,F
Snowberry	*Symphoricarpos albus*		X,B	C,CV,F
Spicebush	*Calycanthus occidentalis*		X	C,CV,F
Spirea	*Spirea douglasii*	Deciduous	X,B,H	C,CV,F
Squaw Bush	*Rhus trilobata*		X	F
Wooly Sunflower	*Eriophyllum staechadifolium*	.	X,B	C
Yerba Santa	*Eriodictyon californicum*		X,B,H	C,CV,F
Small Shrubs and Forbs				
Aster	*Symphyotrichum chilense*	Spreading	X,B	C,CV,F
Baby Blue eyes	*Nemophila menziesii*	Annual	X,B	C,CV,F
Blanket Flower	*Gaillardia grandiflora*		X, B	F, CV
Buckwheat, Coast	*Eriogonum latifolium*		X,B	C
Buckwheat, Seacliff	*Eriogonum parvifolium*		X,B	C
Buckwheat, Sierra Sulfur	*Eriogonum umbellatum Sierra*		X,B	F, CV
California Poppy	*Eschscholzia californica*		X, B	C
Ceanothus Carmel Creeper	*Ceanothus griseus horizontalis*	Prostrate	X,B,H	C,CV,F
Clarkia	*Clarkia spp.*	Many species	X,B,H	C,CV,F
Coffeeberry, Mound San Bruno	*Frangula californica (Rhamnus)*	Low growing	X,B	C,CV,F
Coyote Brush, Twin Peaks II	*Baccharis Twin Peaks II*	Prostrate	X,B	C,CV,F
Coyote Mint	*Monardella villosa*		X,B,H	C,CV,F
Fuschia, California	*Epilobium canum*		X,B,H	C,CV,F
Goldenrod, California	*Solidago californica*	Spreading	X,B	C,CV,F
Golden Yarrow	*Eriophyllum confertiflorum*		X,B	C,CV,F
Gumplant	*Grindelia camporum*		X,B	C,CV,F
Gumplant	*Grindelia stricta*		X,B	C
Hedge Nettle	*Stachys ajugoides*	Spreading	X,B	C
Hedge Nettle	*Stachys bullata*	Spreading	X,B	C
Hummingbird Sage	*Salvia spathacea*	Spreading	X,B,H	C,CV,F
Lemon Verbena	*Aloysia triphylla*	Non-native, herb	X, B	C,CV,F
Lupin	*Lupinus spp*	Many choices	X,B,H	C,CV,F
Manzanita, Emerald Carpet	*Arctostaphylos Emerald Carpet*		X,B,H	C,CV,F

Milkweed, Narrowleaf	*Asclepias fascicularis*		X,B,H	C,CV,F
Milkweed, Showy	*Asclepias speciosa*		X,B,H	C,CV,F
Milkweed, Woolypod	*Asclepias eriocarpa*		X,B,H	C,CV, F
Monkeyflower, Seep	*Mimulus guttatus*	Riparian, spreading	B,H	C,CV,F
Monkeyflower, Sierra Bush	*Mimulus bifidus*		B,H	F
Monkeyflower, Sticky	*Mimulus aurantiacus*		B,H	C,CV, F
Mugwort	*Artemisia douglasiana*	Riparian	X	C,CV,F
Oregano	*Origanum vulgare*	Non-native, herb	X,B	C,CV,F
Penstemon, Foothill	*Penstemon heterophyllus*		X,B,H	C,CV,F
Phacelia	*Phacelia californica*		X,B,H	C,CV,F
Phacelia	*Phacelia spp.*	Many choices	X,B,H	C,CV,F
Sage, Black, Terra Seca	*Salvia mellifera*	Prostrate	X,B	C,CV
Seaside Daisy	*Erigeron glaucus*		X, B	C
Strawberry	*Fragaria chiloensis*		X,B	C,CV,F
Sunflower	*Helianthus sp.*	Annual	X,B,H	C,CV,F
Thyme	*Thymus vulgaris*	Non-native, herb	X,B	C,CV,F
Vinegar Weed	*Trichostema lanceolatum*	Annual	X,B,H	C,CV,F
Wooly Blue Curls	*Trichostema lanatum*		X,B,H	C,CV,F
Yarrow	*Achillea millefolium*	Spreading	X	C,CV,F
Vines				
Clematis, Chaparral	*Clematis lasiantha*		X,B	C,CV,F
Dutchman's Pipe	*Aristolochia californica*		X	C,CV,F
Honeysuckle	*Lonicera hispidula*		X,B,H	C,CV,F
Twinberry	*Lonicera involucrata*	Moist areas	X,B,H	C,CV,F
Wild Grape	*Vitis californica*		X	C,CV,F
Grasses, Sedges and Rushes				
Bentgrass	*Agrostis exarata*	Moist	X,B	C,CV,F
Blue Wildrye	*Elymus glaucus*		X,B	C,CV,F
California Oniongrass	*Melica californica*		X,B	C,CV,F
Creeping Wildrye	*Leymus triticoides*	Spreading	X	C,CV,F
Deergrass	*Muhlenbergia rigens*		X,B	C,CV,F
Giant Wildrye	*Leymus condensatus*		X,B	C,CV,F
Meadow Barley	*Hordeum brachyantherum*		X,B	C,CV,F
Nutka Reed Grass	*Calamagrostis nutkaensis*		X,B	C
Purple Needlegrass	*Nassella pulchra*		X,B	C,CV,F
Red Fescue	*Festuca rubra*	Spreading	X,B	C,CV,F

Rush	*Juncus spp.*	Many species	X	C,CV,F
Saltgrass	*Distichlis spicata*		X	C,CV,F
Sedge	*Carex spp.*	Many species	X	C,CV,F
Slender wheatgrass	*Elymus trachycaulus*		X,B	CV
Spike rush	*Heleocharis spp.*	Riparian	X	CV
Three-Week Fescue	*Vulpia microstachys*		X	C,CV,F
White Root Sedge	*Carex barbarae*		X	C,CV,F
Wire Rush	*Juncus balticus*		X	C,CV,F

Appendix B:
Perennial Plants Selected to Attract Beneficial Insects to Manage Aphids, Caterpillars, Mites, Thrips and Whitefly

Plant	Attracts these Beneficials	Pest Managed	Flowers	Description	Height
Achillea millefolium Common Yarrow	Hoverflies, wasps, lady beetles	Mites, scale	Apr-Jul	Spreading fern-like	2-3 ft.
Achillea millefolium 'Paprika' Red Yarrow	Same as above	Same as above	Apr-Jul	Spreading fern-like	8-12"
Achillea 'Salmon Beauty' Salmon Yarrow	Same as above	Same as above	Apr-Jul	Spreading fern-like	8"
Asclepias fascicularis Narrowleaf milkweed	Same as above also Host to Monarch butterfly	Same as above	Jul-Oct	Upright, long narrow leaves	2-3'
Atriplex lentiformis Brewer saltbush, big leaf form	Lady beetles, Cover for quail	Mites, scale	Jul-Oct	Semi-deciduous shrub	5-10'
Baccharis 'Centennial' Hybrid Coyote Brush	Wasps, tachinid flies, hoverflies	Caterpillars, Whitefly, mites	Oct-Jan	Evergreen shrub, Very heat tolerant	5' X 3' wide,
Baccharis pilularis Coyote Brush	Same as above	Same as above	Oct-Jan	Evergreen shrub	4-8' X 4-8' wide
Baccharis pilularis Coyote Brush, compact form	Same as above	Same as above	Oct-Nov	Low-growing shrub	12-18"X 5-6'
Baccharis viminea (*B. salicifolia*) Mule Fat	Hoverflies, lady beetles	Same as above	Mar-May	Erect shrub, Long foliage	6-10'
Ceanothus 'Concha' Wild Lilac	Wasps, lady beetles, hoverflies	Mites, thrips, whitefly	Mar-Apr	Evergreen shrub, Tolerant coast/inland/ summer watering	6-8'
Ceanothus cuneatus Buckbrush	Same as above	Same as above	Feb-Apr	Upright evergreen, Very drought tolerant	8'
Ceanothus *g.* var *h.* 'Yankee Point' Yankee Point Carmel Creeper	Same as above	Same as above	Mar-May	Evergreen shrub, large leaves, Coastal and inland	3-5' X 6-8'
Ceanothus 'Ray Hartman' Treasure Island Blueblossom	Same as above	Same as above	Feb-Apr	Small tree, Evergreen	8-15' X 10-15 wide
Ceanothus thyrsiflorus Blue Blossom	Same as above	Same as above	Mar-May	Evergreen shrub Hardy	6-20' X 8-30' wide
Eriogonum arborescens Santa Cruz Island Buckwheat	Hoverflies, wasps, minute pirate bug, tachinid flies	Caterpillars, whitefly, mites	May-Oct	Evergreen shrub, loosely branched	2-5' X 2-5' wide
Eriogonum fasciculatum var. *foliolosum* California Buckwheat	Same as above	Same as above	May-Dec	Evergreen shrub, Narrow wooly leaves	2-5'
Eriogonum giganteum St. Catherine's Lace	Same as above	Same as above	Jun-Nov	Large open shrub	4-5' X 3-4' wide

Courtesy of The Dietrick Institute for Applied Insect Ecology

Plant	Attracts these Beneficials	Pest Managed	Flowers	Description	Height
Heteromeles arbutifolia Toyon	Hoverflies, wasps, tachinid flies	Caterpillars	May-Jun	Evergreen shrub, Small tree, Tolerates sun, partial shade, smog, wind, heavy or light soils	8-15' up to 25'
Isomeris arborea Bladder Pod	Stinkbug predators		Feb-May	Dense evergreen, mounding shrub	3-6' X 3-6' wide
Myoporum parvifolium Creeping Boobialla	Wasps, hoverflies, tachinid flies	Caterpillars	Jun-Oct	Ground cover, Fast-growing	3" X 9' wide
Polygonum aubertii Silverlace Vine	Same as above, big eyed bug	Mites, whitefly, caterpillar	Apr-Nov	Deciduous vine, hardy, fast- growing	
Prunus ilicifolia Hollyleaf Cherry	Lacewings, lady beetles, hoverflies, wasps	Mites, thrips, whitefly	Apr-May	Evergreen shrub/tree	20-40'
Quillaja saponaria Soapbark Tree	Same as above	Mites, thrips, whitefly	May-Jun	Evergreen tree, Dense to ground when young, Can be pruned to tall hedge	30'
Rhamnus californica Coffeeberry	Lady beetles, hoverflies, wasps	Caterpillars	Apr-May	Evergreen shrub	12-15'
Rhamnus californica Coffeeberry Var. 'Eve Case'	Same as above	Same as above		More compact	3-8' X 3-8'
Rhamnus californica Coffeeberry Var *tomemtella*	Same as above	Same as above		Greyer foothill form	
Rubus vitifolius (*R. ursinus*) California Blackberry	Parasitic wasps		Spring	Deciduous vine, mounding, Large trifoliate leaves	
Salix goodingii Gooding's Black Willow	Lady beetles, wasps, hoverflies	Mites, scale	Mar-Apr	Deciduous tree, Narrow leaves	20-30'
Salix laevigata Red Willow	Same as above	Same as above	Mar-May	Large deciduous tree	20-40'
Salix lasiandra (*S. lucida* ssp *lasiandra*) Western Black Willow	Same as above	Same as above	Mar-Apr	Deciduous tree, Large leaves	20-30' X 20' wide
Salix lasiolepsis Arroyo Willow	Same as above	Same as above	Jan-Feb	Deciduous shrub/tree	6-20'
Sambucus mexicana Mexican Elderberry	Hoverflies, wasps		Apr-Nov	Deciduous shrub/tree	4-10' to 40'

The Dietrick Institute for Applied Insect Ecology, based in Ventura, is committed to educating the public in methods for natural pest control. If your group would like a speaker for a meeting or material for a school project please contact us.

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Appendix C: Resources

Appropriate Technology Transfer for Rural Areas (ATTRA)
National Sustainable Agriculture Information Service, funded by the US Department of Agriculture, is managed by the National Center for Appropriate Technology. It provides information and other technical assistance to farmers, ranchers, Extension agents, educators, and others involved in sustainable agriculture in the United States. ATTRA has numerous publications on their website pertaining to hedgerows, conservation and ecosystem management.

www.attra.org

California Climate and Agriculture Network (CalCAN)
CalCAN is a statewide coalition that advances state and federal policy to realize the powerful climate solutions offered by sustainable and organic agriculture. The website has resources on conservation and ways farmers can utilize habitat plantings to create resilience on their farms.

www.calclimateag.org/

Community Alliance with Family Farmers (CAFF)
CAFF's mission is to build sustainable food and farming systems through policy advocacy and on-the-ground programs that create more resilient family farms, communities and ecosystems. CAFF has been a membership-based non-profit for 40 years and spent decades working on increasing farm biodiversity with native plant hedgerow and farmscaping projects in the Central Coast, North Coast, and Central Valley regions. CAFF published an earlier version of Hedgerows for California Agriculture in 2004, which contains lists of detailed scientific references and can be found at www.hedgerowsunlimited.com.

www.caff.org

Hedgerows Unlimited
This website has updated Resources about Hedgerows and Conservation Issues. The site has a link to the 2004 version of Hedgerows for California Agriculture, which contains lists of detailed scientific references.

www.hedgerowsunlimited.com

Natural Resources Conservation Service (NRCS)
As part of the US Department of Agriculture, the NRCS provides leadership in a partnership effort to help people conserve, maintain, and improve our natural resources and environment. A wide range of technical information and assistance is available to land users.

www.ca.nrcs.usda.gov

Resource Conservation Districts (RCDs)
RCDs are a leader in on-the-ground conservation efforts. The 97 districts statewide are the center of locally led conservation in their communities and accomplish thousands of practical, hands-on conservation projects every year.

www.carcd.org/home0.aspx

University of California Agriculture and Natural Resources
UC ANR conducts agricultural research and outreach through county cooperative extension offices and agricultural experiment stations. The July-September 2017 Research Brief (http://calag.ucanr.edu/archive/?article=ca.2017a0020) has an extensive list of references for hedgerow research papers.

www.ucanr.edu/

United States Department of Agriculture - Agricultural Research Service (ARS), Organic Research in Salinas
Conservation biological control videos:

- Brennan, E.B., 2014. "Efficient intercropping for biological control of aphids in transplanted organic lettuce" www.youtube.com/watch?v=KVLgt2_J1Wk
- Brennan, E.B., 2015. "A biological control buffet in the salad bowl of America" www.youtube.com/watch?v=zLvJLHERYJI

Conservation biological control publications on alyssum insectary plantings in organic vegetables:

- www.ars.usda.gov/pacific-west-area/salinas-ca/crop-improvement-and-protection-research/

Wild Farm Alliance (WFA)
Wild Farm Alliance educates farmers about on-farm biodiversity conservation, assists them with its practical implementation, and initiates policies that support farm stewardship. Their mission is to promote a healthy, viable agriculture that protects and restores wild nature. The WFA website has numerous resources on biodiversity and food safety issues.

www.wildfarmalliance.org

The Xerces Society
The Xerces Society is a nonprofit dedicated to preserving the diversity of life through the conservation of invertebrates. Xerces runs education and conservation projects and produces information materials. Through its Pollinator Conservation Program, the Society offers practical advice on habitat management for pollinator insects and has many publications, including *Providing Bee Habitat on Farms: Guidelines for Farmers.*

www.xerces.org

ATTRA Sustainable Agriculture
A program of the National Center for Appropriate Technology • 1-800-346-9140 • www.attra.ncat.org

A Pictorial Guide to Hedgerow Plants for Beneficial Insects

By Omar Rodriguez and Rex Dufour, NCAT Agriculture Specialists
Published Oct. 2017

IP547

This publication provides a straightforward pictorial guide to several of the most beneficial hedgerow plant species used in farmscaping for native pollinators and insect predators and parasites in California. It provides plant names, bloom times, heights, and descriptions that note considerations for selection and establishment.

Introduction

When selecting the appropriate perennial plants to use in your hedgerow, it is important to define the benefits you would like to see as a result of adding hedgerows to your farm. This informational piece highlights a collection of native California species (with the exception of lavender) that are both drought tolerant and highly attractive to beneficial insects. In addition to attracting beneficial insects (predators, parasites, and pollinators), hedgerows can serve a number of other functions that include providing overwintering sites for desirable insect species, wind breaks, dust barriers, pesticide barriers, bird nesting and perches, carbon sequestration, stream-bank stabilization or revegetation, and shade for stream cooling and fish habitat, not to mention simply adding some practical beauty to an agricultural landscape.

Consider the effects that each hedgerow species' size and bloom time will have on your farm. The impacts of planting hedgerows are heavily on the positive side, but it's important to understand the exceptions. For example, toyon, which is explored in this publication, is a useful species that attracts many beneficial insects and birds. However, it is also susceptible to fire blight, so it would be inappropriate for a border planting for an apple or pear orchard.

A biodiverse hedgerow provides farm resiliency to the pressures that pests impose, which include not only destructive habits such as eating or boring into plants. Pests are also carriers and transmitters of bacteria, viruses, and fungi that cause disease in the plants we grow. Creating habitat for beneficial insects is one step in better managing and supporting these "mini-livestock," which can provide many benefits to your farm.

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Hedgerow Plants

California Buckwheat

Scientific name: *Eriogonum fasciculatum*

Mature height: 2 to 4 feet

Bloom time: April to September

Notes: Very drought tolerant, an important food source for many native bees and beneficial insects, including syrphid flies (also known as flower flies or hover flies), predatory wasps, pirate bugs, tachinid flies, and lady beetles. Full sun to partial shade. Blooms are creamy white, last through the summer, and turn an attractive rust color when they dry down.

Tachinid fly on California buckwheat. Tachinid larvae are parasites of stinkbugs and other insects. Photo: Rex Dufour, NCAT

Assassin bugs are generalist predators with a wide host range. Photo: Rex Dufour, NCAT

California buckwheat in bloom. Photo: Rex Dufour, NCAT

California Fuchsias

Scientific name: *Epilobium canum*

Mature height: 1 to 4 feet

Bloom time: July to October

Notes: May need help establishing through its first summer. Highly tolerant in a variety of substrates and one of the most attractive flowers to hummingbirds, which consume a variety of insects, including aphids. The bright-red, tubular flowers provide a welcome visual relief during the hottest, driest, and dustiest part of the season, as well as a nectar and pollen resource for beneficials.

California fuschia. Photo: Rex Dufour, NCAT

The bright red-orange flowers can offer beneficials a pollen and nectar source during the drier, dustier parts of the season, August and September. Photo: Rex Dufour, NCAT

Close up of California fuschia. Photo: Rex Dufour, NCAT

Honey bee gathering nectar and pollen from early spring ceanothus bloom. Photo: Rex Dufour, NCAT

Ceonothus/California Lilac

Scientific name: *Ceanothus sp.* (many varieties exist)

Mature height: 2 to 20 feet (depends on variety)

Bloom time: March to May

Notes: These plants are nitrogen fixers and occur naturally on dry slopes across North America and as far south as Guatemala. Ceanothus does not require summer irrigation after it has been established. Its blue flowers attract many pollinators early in the season, and its foliage maintains a dense green color all year long. Comes in tall and prostrate cultivars. Deer like to browse on this plant.

Ceonothus in full bloom. Photo: Rex Dufour, NCAT

Syrphid fly on ceonothus flower. Syrphid larvae are aphid predators. Photo: Rex Dufour, NCAT

Cleveland sage in bloom. It will spread nicely to cover ground and smother weeds. Photo: Rex Dufour, NCAT

Cleveland Sage

Scientific name: *Salvia clevelandii*

Mature height: 3 feet

Bloom time: April to August

Notes: Has attractive flowers, inviting to several bee species, butterflies, and hummingbirds. Leaves are very aromatic. Prefers good drainage; can tolerate full sun. Watering in early stages will help it establish, but it does well in drought conditions.

Carpenter bee getting nectar from Cleveland sage. Photo: Rex Dufour, NCAT

Lady bird beetles resting on Cleveland sage leaves in early spring. Photo: Rex Dufour, NCAT

Coffee Berry

Scientific name: *Frangula californica*

Mature height: 6 to 15 feet

Bloom time: April to June

Notes: An insect-pollinated plant that attracts a large range of beneficial insects: honey bee, native bees, and flies. It has a relatively short bloom period.

Coffee berries ripening. Photo: Rex Dufour, NCAT

Coffee berry flowers and berries with lady bird beetle. Photo: Rex Dufour, NCAT

Green lacewing adult feeding on coffee berry nectar and pollen. Lacewing larvae are voracious predators of aphids and other soft-bodied insects (mealybugs, small caterpillars, psyllids). Photo: Rex Dufour, NCAT

Coyote Bush

Scientific name: *Baccharis pilularis*

Mature height: 6 to 12 feet

Bloom time: November to February

Notes: Beneficial insectary and wildlife habitat, which hosts many insects even when not in bloom. Very good winter pollen/nectar source. Has male and female plants, and female flowers develop "fluffy" blooms once they develop seeds. Choose between prostrate (up to 3.5 feet high) and non-prostrate (12 feet high) varieties.

Lady bird beetle on female coyote bush flower. Photo: Rex Dufour, NCAT

Coyote bush in bloom. Photo: Rex Dufour, NCAT

Tachinid fly feeding at male coyote bush flower. Photo: Rex Dufour, NCAT

Praying mantis egg mass in the interior of deer grass bunch. Several dozen small praying mantids will emerge from this egg mass. Photo: Rex Dufour, NCAT

Deergrass

Scientific name: *Muhlenbergia rigens*

Mature height: 4 to 5 feet and 4 to 6 feet wide

Bloom time: May to September

Notes: Clumping grass; interior is good overwintering habitat for ladybird beetles, and seed spikes are good resting places for damsel and dragon flies. Native to most of California, Texas, and Mexico. Resilient to different soil types. It does best with full sun exposure but will tolerate some shade and is drought tolerant. Due to its abundant yield of seed, it is a great host plant for birds, as well as beneficial insects.

Lady bird beetles overwintering in deer grass. Groups of beetles emit an aggregation pheromone that attracts additional lady bird beetles. Photo: Rex Dufour, NCAT

Deergrass in a farm hedgerow. Photo: Rex Dufour, NCAT

Elderberry buds and blooms. Photo: Rex Dufour, NCAT

Elderberry

Scientific name: *Sambucus nigra*

Mature height: 6 to 14 feet

Bloom time: May to August

Notes: Can be found in many riparian habitats throughout California and New Mexico. It grows quickly and will need regular watering in drier regions, about once every two weeks during the summer. Its flowers attract many beneficials. Flowers give way to fall berries that bring in many species of songbirds. Prefers full sun.

Elderberry in a hedgerow. Ideal as windbreak, dust barrier, and bird habitat, but may need some pruning of multiple stem base. Photo: Rex Dufour, NCAT

Elderberry fruit, attractive to birds, and some jam makers. Photo: Rex Dufour, NCAT

Flannel Bush

Scientific name: *Fremontodendron californicum*

Mature height: 8 to 25 feet

Bloom time: April to June

Notes: Has many large, bright-yellow blooms that attract bees, wasps, and flies of many species. Grows rapidly and is drought tolerant.

Flannel bush in full bloom. Photo: Rex Dufour, NCAT

The large flowers with easily accessed pollen are very attractive to honey bees. Photo: Rex Dufour, NCAT

Flannel bush flowers are large (3-4" across) and eye catching. Photo: Rex Dufour, NCAT

Hollyleaf Cherry

Scientific name: P*runus ilicifolia*

Mature Height: 8 to 20 feet

Bloom Time: April to May

Notes: Very attractive to native bees and parasitic flies. Can grow quite large under favorable growth conditions; prune to shape.

Syrphid fly on hollyleaf cherry blossom. Although the bloom time is a relatively short two weeks for an individual plant, when these are in bloom, the buzz of thousands of insects can be heard. Photo: Rex Dufour, NCAT

A holly leaf cherry tree in full bloom represents a gold mine of pollen and nectar for beneficial insects. Photo: Rex Dufour, NCAT

Holly leaf cherry fruit. Photo: Rex Dufour, NCAT

Lavender in bloom. Although not native to California, it does very well in this Mediterranean climate. Photo: Rex Dufour, NCAT

Lavender

Scientific name: *Lavandula sp.*

Mature height: 1 to 4 feet

Bloom time: June to August

Notes: Lavender is not native to California, but it is a favorite of both native bees and honeybees. This woody shrub is drought tolerant and flourishes in dry, well-drained soils.

Lavender in bloom. Many types of bees are attracted to these flowers. Photo: Rex Dufour, NCAT

Lavender is popular with bees and some beekeepers believe lavender nectar provides medicinal benefits to their bees. Photo: Rex Dufour, NCAT

Narrowleaf milkweed in bloom. Planting these will provide habitat for the monarch butterfly. Photo: Rex Dufour, NCAT

Narrowleaf Milkweed

Scientific name: *Asclepias fascicularis*

Mature height: 2 to 4 feet

Bloom time: June to September

Notes: This plant is host for the Monarch butterfly larvae and the bright-yellow oleander aphid, which does not attack commercial food crops in California. The oleander aphids provide alternate prey for syrphid fly larvae, green lacewing larvae, ladybird beetles, and the aphid is an alternate host for several parasitic wasps.

Close up of narrowleaf milkweed flowers in bloom. The yellow dots on the stems are oleander aphids, alternate prey for aphid parasites and predators. Photo: Rex Dufour, NCAT

Monarch butterfly larva, chrysalis and oleander aphids on narrow leaf milkweed. Monarch butterfly populations have recently decreased dramatically and farmers can help provide habitat for these creatures. Photo: Rex Dufour, NCAT

Quailbush/Saltbush

Scientific name: *Atriplex nummularia*

Mature height: Up to 10 feet

Bloom Time: August to October

Notes: Saltbush is a drought-tolerant, native shrub in the daisy family that can be found throughout the western United States. Its services as a native pollinator attractant are valuable in that it flowers at a time of year when most other plants are dormant or have finished blooming. Additionally, it is an important nectar source for migrating monarch butterflies. Saltbush is tolerant of saline soils and competes well against weeds but can be somewhat aggressive in its growth.

Honey bee gathering nectar and pollen from early fall Saltbush bloom. Photo: Rex Dufour, NCAT

Syrphid fly on Saltbush flower. Syrphid larvae are aphid predators. Photo: Rex Dufour, NCAT

Saltbush in full bloom. Photo: Rex Dufour, NCAT

Toyon

Scientific name: *Heteromeles arbutifolia*

Mature height: 8 to 20 feet and equally as wide

Bloom time: June to August

Notes: An evergreen shrub, also known as Christmas berry. White flower bunches attract bees; bright-red berries attract birds. It has a profuse root system that can help with erosion control and stabilizing hillsides. Susceptible to fireblight, so don't plant with apples or pears.

Toyon flowers and buds. Honey bees and many beneficials are attracted to toyon. Photo: Rex Dufour, NCAT

Toyon in bloom. Photo: Rex Dufour, NCAT

December toyon with red berries next to deer grass. It's clear why toyon is also called "Christmas berry." Photo: Rex Dufour, NCAT

Redbud in bloom in early spring. Note the multiple stems. Photo: Rex Dufour, NCAT

Western Redbud

Scientific name: *Cercis orbiculata*

Mature height: 7 to 20 feet

Bloom time: March to May

Notes: Native to parts of California, Arizona, and Utah. It is drought tolerant once established but may require regular watering in desert environments. Full sun to partial shade, and it does best in well-drained soil. Attractive to many pollinators and beneficial insects and generally pollinated by bumble bees and mason bees. Leafcutter bees also like to use its soft new leaves to line their nests. Redbud also resprouts vigorously after fires.

Redbud leaves. Photo: Rex Dufour, NCAT

Red bud is in the legume family, and seeds can be collected for planting from the pods, shown here. Photo: Rex Dufour, NCAT

Yarrow plant in bloom. Photo: Rex Dufour, NCAT

Yarrow

Scientific name: *Achillea millefolium*

Mature height: 1.5 to 3 feet

Bloom time: April to September

Notes: Yarrow, a hardy perennial, is attractive to a number of pollinators and predatory species like lady beetles and syrphid flies. There are pink (salmon-colored), yellow, and white varieties. It is very resilient, water needs are minimal (it doesn't like wet feet), and it will establish itself in a variety of soil types.

Native bee on yarrow. Photo: Rex Dufour, NCAT

Native bees, which are often more effective pollinators than honey bees, are attracted to yarrow. Photo: Rex Dufour, NCAT

Additional Considerations

Potential hedgerow plants are available in a wide range of sizes and types from local nurseries specializing in native plants (see Further Resources, below). Ideally, hedgerows should be designed to include plants that bloom in different seasons to provide pollinators and other beneficial insects with food sources throughout the growing season. Structural diversity is also important in order to support a diverse ecology of beneficials. Finally, remember that hedgerow site preparation is important to successfully establishing a hedgerow. Weed competition needs to be minimized, either through solarizing, use of weed barriers, regular (and heavy) mulching, hand weeding, or use of herbicides.

Further Resources

Suppliers

For a listing of native plant nurseries in California, go to: www.plantnative.org/nd_ca.htm

Publications

Beneficial Insect Habitat Assessment Form and Guide. 2015. By The Xerces Society for Invertebrate Conservation. www.xerces.org/wp-content/uploads/2015/07/HAG_BeneficialInsects_June2015_web.pdf

Companion Planting & Botanical Pesticides: Concepts and Resources. 2016. By George Kuepper, Mardi Dodson, and Justin Duncan. National Center for Appropriate Technology. Publication IP125. www.attra.ncat.org/attra-pub/summaries/summary.php?pub=72

Conservation Buffers in Organic Systems. 2014. By National Center for Appropriate Technology, Oregon Tilth, and The Xerces Society for Invertebrate Conservation. National Center for Appropriate Technology. Publication IP470. www.attra.ncat.org/attra-pub/summaries/summary.php?pub=464

Establishing Hedgerows on Farms in California. 2010. By University of California Agriculture and Natural Resources. Publication 8390. http://ucfoodsafety.ucdavis.edu/files/26499.pdf

Farming With Native Beneficial Insects. 2014. By Eric Lee-Mäder, Jennifer Hopwood, Mace Vaughan, Scott Hoffman Black, and Lora Morandin. The Xerces Society for Invertebrate Conservation. https://xerces.org/farming-with-native-beneficial-insects

Farmscaping to Enhance Biological Control. 2000. By Rex Dufour. National Center for Appropriate Technology. Publication CT065. http://extension.oregonstate.edu/sorec/sites/default/files/farmscaping.pdf

Hedgerows for California Agriculture: A Resource Guide. 2004. By Sam Earnshaw. Community Alliance with Family Farmers (CAFF). www.caff.org/wp-content/uploads/2010/07/Hedgerow_manual.pdf

Pollinator Plants, California. 2014. By The Xerces Society for Invertebrate Conservation. www.xerces.org/wp-content/uploads/2014/09/CaliforniaPlantList_web.pdf

Online Resources

Native Plant Lists by Region. California Native Plant Society. www.cnps.org/cnps/grownative/lists.php

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