

**Hedgerow Farms** — specializes in producing the finest quality seed of California native grasses, sedges and forbs. Single species, seed mixes, plug plants and native grass straw are available for habitat restoration, erosion control and landscaping. Our services include consulting, custom growing and environmental education.

[www.hedgerowfarms.com](http://www.hedgerowfarms.com)

**Lady Bird Johnson Wildflower Center** — A nonprofit center that is a great resource for native plant information. Can supply lists of suitable plant species for many areas.

[www.wildflower.org](http://www.wildflower.org)

**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](http://www.ca.nrcs.usda.gov)

**NRCS eFOTG** Technical guides are the primary scientific references for NRCS that contain technical information about the conservation of soil, water, air, and related plant and animal resources, including hedgerows and grassed waterways.

[www.nrcs.usda.gov/technical/efotg](http://www.nrcs.usda.gov/technical/efotg)

**NRCS Wildlife Habitat Management Institute** Web site — Information about soils, water, air, plant and animals.

[www.whmi.nrcs.usda.gov](http://www.whmi.nrcs.usda.gov)

**North American Pollinator Protection Campaign** — A consortium of conservation groups, government agencies, universities, and private industries from the United States, Mexico, and Canada. NAPPCC participants share information and work together for the common good of pollinators across our continent.

[www.nappcc.org](http://www.nappcc.org)

**Rana Creek Habitat Restoration** — Rana Creek is an active, sustainable agricultural center for environmental consultation and restoration, specializing in native plant and seed products.

[www.ranacreek.com](http://www.ranacreek.com)

**Resource Conservation Districts (RCDs) Watershed Information Sharing Project** — Local leadership in watersheds begins with RCDs. Very cool visual website. Look up the RCD for your county.

[www.carcd.org/wisp/countyframe.htm](http://www.carcd.org/wisp/countyframe.htm)

**Rincon-Vitova Insectaries** — RVI produces insects and distributes insects and other organisms for biological control of pests of gardens, farms, stables, and compost yards, and provides programs to control key pests of garden, greenhouse, farm and stable.

[www.rinconvitova.com](http://www.rinconvitova.com)

**Salmon-Safe** — one of the nation's leading regional eco-labels with more than 30,000 acres of farmland certified. The Salmon-Safe retail campaign has been featured in 200 supermarkets and natural food stores. Salmon-Safe is a nonprofit devoted to restoring agricultural and urban watersheds so that salmon can spawn and thrive.

[www.salmonsafe.org](http://www.salmonsafe.org)

**San Joaquin Valley Air Pollution Control District (Valley Air District)** — is committed to improving the health and quality of life for all Valley residents through effective and cooperative air quality programs. Information on the Conservation Management Practice Program (CMP) can be found on the Web site.

[www.valleyair.org](http://www.valleyair.org)

**Society for Ecological Restoration (SER)** — is a non-profit organization infused with the energy of 2300 members — individuals and organizations who are actively engaged in ecologically-sensitive repair and management of ecosystems through an unusually broad array of experience, knowledge sets and cultural perspectives.

[www.ser.org](http://www.ser.org)

**Soil and Water Conservation Society (SWCS)** — Fosters the science and the art of soil, water and related natural resource management to achieve sustainability. We promote and practice an ethic recognizing the interdependence of people and the environment. SWCS publishes the Journal of Soil and Water Conservation, a bi-monthly journal of applied research and conservation news.

[www.swcs.org](http://www.swcs.org)



Hedgerows can help stabilize the banks of waterways.

**University of California Agriculture and Natural Resources** — UC ANR conducts agricultural research and outreach through county cooperative extension offices and agricultural experiment stations.

<http://ucanr.org/index.shtml>

**UC ANR Statewide Integrated Pest Management Program** — Information, research and extension projects.

[www.ipm.ucdavis.edu](http://www.ipm.ucdavis.edu)

**University of California Cooperative Extension, Santa Cruz County (UCCE)** — The mission of UCCE is to develop and extend the use of research-based knowledge to improve specific practices and technologies. Local Research and Reports on the Web site has detailed cost information on Conservation Practices, including hedgerows and grassed waterways.

<http://cesantacruz.ucdavis.edu>

**University of Nebraska** — Windbreaks in Sustainable Agricultural Systems

<http://ianrpubs.unl.edu/forestry/ec1772.htm>

**U.S. Department of Agriculture (USDA) Agroforestry Center**, a partnership with USDA Forest Service and USDA NRCS, with technical information about the benefits, planting, maintenance, and impact on wildlife of windbreaks, hedgerows and snowfences.

[www.unl.edu/nac/](http://www.unl.edu/nac/)

**U.S. Fish and Wildlife Service (USFWS)** — developed the Safe Harbor Program with Environmental Defense to encourage private landowners to restore and maintain habitat for endangered species without fear of incurring additional regulatory restrictions. To date, nearly three million acres of land in states across the country have been enrolled in several Safe Harbor agreements, benefiting a variety of imperiled animals.

[www.fws.gov](http://www.fws.gov)

**Yolo County Resource Conservation District** — Bridging agricultural issues with science, education, and government, the RCD is an information network between landowner resource problems and the best solutions. The Yolo county RCD has pioneered hedgerow, grassed waterways and other habitat work, and has published technical manuals.

[www.yolorcd.org](http://www.yolorcd.org)

**Wild Farm Alliance (WFA)** — works to promote a healthy viable agriculture that protects and restores wild nature. WFA envisions community supported ecologically managed farms and ranches that are seamlessly integrated into landscapes that accommodate the full range of native species and ecological processes.

[www.wildfarmalliance.org](http://www.wildfarmalliance.org)

**The Xerces Society** — 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 published *Providing Bee Habitat on Farms: Guidelines for Farmers*.

[www.xerces.org](http://www.xerces.org)



Shrubs and grasses replace weeds and cover bare soil.

## **S U D D E N O A K D E A T H S Y N D R O M E**

**California Oak Mortality Task Force** and others — Information on Sudden Oak Death Syndrome (SODS).

[www.suddenoakdeath.org](http://www.suddenoakdeath.org)

<http://cemar.ucdavis.edu/index2.html>

[http://californiaagriculture.ucop.edu/  
0301JFM/resupd.html](http://californiaagriculture.ucop.edu/0301JFM/resupd.html)

[http://kellylab.berkeley.edu/  
SODmonitoring/](http://kellylab.berkeley.edu/SODmonitoring/)

**USDA Animal and Plant Health Inspection Service (APHIS)** — is responsible for protecting and promoting U.S. agricultural health, administering the Animal Welfare Act, and carrying out wildlife damage management activities. This Web site has information about SODS.

[www.aphis.usda.gov/lpa/news/2004/03/  
sod\\_ppq.html](http://www.aphis.usda.gov/lpa/news/2004/03/sod_ppq.html)

## C O S T   S H A R E   P R O G R A M S

**California Forest Stewardship Program** provides technical and financial assistance to influence positive changes to forestland management, assists communities in solving common watershed problems, and helps landowners. The on-line publication “Cost Share and Assistance Programs for Individual California Landowners and Indian Tribes,” produced by the University of California Cooperative Extension Forestry (UCCE), has a long list of cost share programs.

[www.ceres.ca.gov/foreststeward/html/financial.html](http://www.ceres.ca.gov/foreststeward/html/financial.html)

**Conservation Reserve Program** (USDA Farm Services Agency) — The CRP program provides assistance to encourage farmers to convert environmentally sensitive acreage to vegetative cover.

[www.nrcs.usda.gov/programs/crp](http://www.nrcs.usda.gov/programs/crp)

**Environmental Quality Incentives Program** (USDA Natural Resources conservation Service) — The EQIP program supports the implementation of conservation plans that include structural, vegetative, and land management practices on eligible land.

[www.ca.nrcs.usda.gov/programs/eqip](http://www.ca.nrcs.usda.gov/programs/eqip)

**Natural Resources Conservation Service (NRCS)**

— On the Web site, enter “Financial Assistance” in the Search box to locate numerous entries. NRCS is the federal agency that worked with private landowners to help protect natural resources through voluntary science-based assistance, partnerships, and cooperative problem solving at the community level.

[www.ca.nrcs.usda.gov](http://www.ca.nrcs.usda.gov)

**Natural Resources Conservation Service (NRCS)**

Information on Buffers, continuous Conservation Reserve Program (CRP) and other cost share programs.

[www.nrcs.usda.gov/feature/buffers/pdf/BufferBr.pdf](http://www.nrcs.usda.gov/feature/buffers/pdf/BufferBr.pdf)

**Partners for Wildlife** (US Fish and Wildlife Service)

— This program provides assistance to private (non-federal) landowners to voluntarily restore wetlands or other fish and wildlife habitats on their land.

<http://partners.fws.gov>

**Wildlife Habitat Incentives Program** (USDA Natural Resources conservation Service) — WHIP is a voluntary program for people who want to develop and improve wildlife habitat primarily on private lands.

[www.nrcs.usda.gov/programs/whip](http://www.nrcs.usda.gov/programs/whip)



Photo: Will Stockwin

Tours to hedgerows educate farmers and resource professionals about habitat plantings.

# APPENDIX D

## SUMMARIES OF SELECTED HEDGEROW AND FARMSCAPING ARTICLES

*The following articles have been selected to present a short look at some of the research that is being done to determine to what extent vegetative plantings contribute toward pest control. The Bibliography lists many more references concerning this topic. The use of in-field insectaries (planting annuals within cropped fields) is showing some pest control results, and combining these plantings with perennial borders or hedgerows that act as longer-term refugia for the insects is showing some promise for farmscape plantings to be functioning as a system.*

**Andow, D.A. 1991. Vegetational diversity and arthropod population response. Annual Review of Entomology 36:561-586.**

This article provides an overview of 209 studies on the response of arthropods to vegetational diversity by comparing polycultures to monocultures. "Polycultures" included systems with spatially intimate mixtures of different plant species (multiple crops, crop and weed, or crop and beneficial noncrop), whereas monocultures referred to single crop systems with bare ground. The studies covered a total of 287 herbivore species and 130 natural enemies (predators and parasitoids). Overall, polycultural systems supported lower numbers of herbivores (51%) and higher numbers of natural enemies (53%) when compared to monocultures. The effect, however, is less clear with herbivores that have more than one host plant. Essentially, with increasing complexity (i.e. herbivores that have more than one host plant and perennial systems as opposed to annual), the responses are more difficult to predict. Higher herbivore abundances found in monocultures have been attributed to both the resource concentration hypothesis and the natural enemies hypothesis. The resource concentration hypothesis suggests that herbivore populations, especially those with narrow host ranges, are more likely to colonize where resources are abundant, such as in the case of monocultures. The natural enemies hypothesis, on the other hand attributes lower number of herbivores in polycultural systems to suppression by natural enemies (as opposed to lack of resources). Although current evidence better supports the resource concentration hypothesis, both mechanisms most likely influence arthropod populations. Andow suggests using a demographic analysis to evaluate the relative importance of colonization, fecundity, mortality, etc. on arthropod response. Andow writes "While some of the Gordian knot of vegetational diversity can be perceived, we are a long way from unraveling its complexity.....a theory that predicts when natural enemies will exert significant mortality in polycultures is entirely lacking."

**Azeez, G. 2000. The Biodiversity Benefits of Organic Farming. U.K. Soil Association. [www.soilassociation.org](http://www.soilassociation.org)**

A number of studies have been done comparing the effect of organic and conventional farming on groups of wildlife. Twenty-three studies of lowland farms are reviewed, nine in full and the remainder have the findings briefly presented. Both abundance of plants, birds and invertebrates and diversity of plants and invertebrates were substantially higher on the organic farms than comparable conventional farms.

**Baggen L.R., Gurr G.M., and Meats A. 1999. Flowers in tri-trophic systems: mechanisms allowing selective exploitation by insect natural enemies for conservation biological control. Entomologia Experimentalis et Applicata 91 (1): 155-161.**

Many insects have coevolved with certain angiosperm taxa to act as pollinators. However, the nectar and pollen from such flowers is also widely fed upon by other insects, including entomophagous species (reproducing within insects). Conservation biological control seeks to maximize the impact of these natural enemies on crop pests by enhancing availability of nectar and pollen-rich plants in agroecosystems. A risk with this approach is that pests may also benefit from the food resource. We show that the flowers of some plants (viz., buckwheat, *Fagopyrum esculentum* Moench and dill, *Anethum graveolens* L.), and the extrafloral nectaries of faba bean (*Vicia faba* L.) benefit both the parasitic wasp *Copidosoma koehleri* Blanchard (Hymenoptera: Encyrtidae) and its host, the potato pest, *Phthorimaea operculella* Zeller (Lepidoptera: Gelechiidae). In contrast, phacelia (*Phacelia tanacetifolia* Benth) and nasturtium (*Tropaeolum majus* L.) benefited only the parasitoid. When adult moths of *P. operculella* were caged with flowers of phacelia or nasturtium, longevity of males and females, egg laying life, fecundity, average oviposition rate, and number of eggs in ovaries at death were no greater than in the control treatment with access to shoots without flowers plus water. All the foregoing measures were increased compared to the control when the moths were allowed access to dill, buckwheat or faba bean extrafloral nectaries. Such "selectivity" has the potential to make the use of floral resources in conservation biological control more strategic.

**Bugg, R.L. 1994. Farmscaping: providing habitat for beneficial arthropods. Proceedings of the Association of Specialty Cut Flower Growers, Annual Meeting, November 11, 1994, Red Lion Inn, San Jose, CA.**

Hedgerows and other border plantings can have important impacts on bio-intensive integrated pest management. Properly designed and managed hedgerows and vegetationally diverse field borders can assist in both biological and cultural control of arthropod pests in agriculture. Beneficial arthropods include parasites and predators. Parasites are usually more restricted as to which insects they will attack. Some predators may be fairly specialized, as well, but many are generalists – feeding opportunistically on various insects and mites. Generalist predators may be especially important, because they can persist in the absence of pests, may arrive in the crop first, and may act to prevent or slow down pest outbreaks. Some important beneficial insects have special plant associations. Nectar-bearing plants and those that harbor alternate hosts or prey are particularly important in sustaining various beneficial arthropods; so are plants that afford shelter for dormant phases or for nesting. Such plants, including some that can serve as cut flowers, can be incorporated into farmscaping schemes.

**Chaney, W. 1998. Biological Control of Aphid in Lettuce Using In-Field Insectaries, p. 73-83. In C. H. Pickett and R. L. Bugg, eds. Enhancing biological control: habitat management to promote natural enemies of agricultural pests. University of California Press, Berkeley, CA.**

There has been very limited successful use of traditional biological control methods in commercial fresh market vegetables. Attempts to control aphids, a major pest of lettuce in coastal California, have not been successful in most large scale commercial applications. The importance and impact of plant diversity of providing food and shelter to beneficial insects are well recognized. Presented here are the results of a study designed to evaluate the use of in-field insectaries using sweet alyssum to aid in the biological control of aphid and other pests in lettuce. The field trials demonstrated that the density of beneficial insects could be increased near the insectary planting and that the aphid population could be reduced. It would be appropriate to assume that insectary strips every 33m or so should be effective. This would correspond to every 20th bed in a 1m (40 inch) bed system. Other cultural practices, such as combining sweet alyssum with a taller plant, such as a cereal grain, or leaving small areas of winter cover crops undisturbed through crop production period, might be explored.

**Colley, M.R., and J.M. Luna. 2000. Relative attractiveness of potential beneficial insectary plants to aphidophagous hoverflies (Diptera: Syrphidae). Environmental Entomology: 29(5):1054–1059.**

Establishing flowering plants in and around fields to provide pollen and nectar resources for natural enemies has shown promise as a strategy to enhance biological control of crop pests. Natural enemies are selective in their flower feeding, however, and show preferences for certain plant species. In this study the relative attractiveness of 11 flowering plant species to aphidophagous hoverflies (Diptera: Syrphidae) was evaluated at the Oregon State University Vegetable Research Farm. Six of these plant species were also evaluated at two other farm sites. Of the 12 species of hoverflies collected, *Meliscaeva cinctella* (Zetterstedt), *Toxomerus marginatus* (Say), *Toxomerus occidentalis* (Curran), *Sphaerophoria sulfuripes* (Thomson), and *Scaeva pyrastris* (L.) were common to all three sites. Attractiveness of flowering plants to foraging hoverflies was assessed by conducting timed observations of feeding-visit frequencies. Flowering periods varied between plant species and comparisons were made only for plant species flowering on a particular date. Relative attractiveness of plant species to hoverflies differed between dates and sites. Among early-season flowering species, coriander, *Coriandrum sativum* (L.), was fed from most frequently. Among late-season flowers, yarrow, *Achillea millefolium* (L.), fennel, *Foeniculum vulgare* (Miller), and Korean licorice mint, *Agastache rugosa* (Fischer & C. A. Meyer) were fed from most frequently. These results help in the selection of plants to enhance biological control, but final selection of plants for this purpose requires considering flower, natural enemy, and pest phenologies, and pollen and nectar quality and availability.

**Denys, Christine and Teja Tschardtke. 2002. Plant-insect communities and predator-prey ratios in field margin strips, adjacent crop fields, and fallows. Oecologia 130: 315-324.**

The management of field margin strips for the enhancement of biodiversity of plant-insect communities and natural-enemy populations was studied on experimental farms near Göttingen (Germany). Young and old, sown and naturally developed field margin strips were compared and differences to large fallows established. The five types of field margin strips (around cereal fields) were: (1, 2) 1- or 6-year-old naturally developed strips, (3) strips sown with a Phacelia mixture, (4) strips sown with a mixture of 19 wild flower species, and (5) strips sown with winter wheat or oat as a control. The naturally developed vegetation of the field margin strips was dominated by aggressive weeds, presumably due to the intensive farming practices and the fertile soils. *Cirsium arvense* populations decreased, while *Elymus repens* populations increased with age of habitat. Sowings were suitable to suppress these aggressive weeds. Potted plants of mugwort (*Artemisia vulgaris*)

and red clover (*Trifolium pratense*) were exposed in the field margin strips to study arthropod colonization of these experimentally standardized plant patches. Arthropod species richness did not differ between field margin types, reflecting the overall similarity in floristic diversity, but sprayed and strip-free edges of cereal fields had a reduced diversity. Dispersal of insect populations of red clover into the cereal fields decreased with increasing distance, but benefited from adjacent field margin strips. Populations of predators (mainly spiders) as well as predator-prey ratios were significantly larger in 6-year-old than in 1-year-old strips emphasizing the importance of habitat age for natural enemies and possible biological control. Predator-prey ratios were also higher on old than young fallows. Large fallows had greater predator-prey ratios than small field margin strips emphasizing the trophic-level hypothesis of island biogeography in that the relative importance of natural enemies increased with habitat area.

**Ehler, Les E., C.G. Pease, and R.F. Long. 2002. Farmscape ecology of a native stink bug in the Sacramento Valley. *Fremontia*: Vol. 30: 3-4: pp. 59-61.**

This article outlines the seasonal life history of a native stink bug and describes how replacing exotic weeds with native perennial grasses can be employed in stinkbug management. It also notes the importance of economic benefits linked to the restoration of native vegetation in agricultural landscapes. The consperse stink bug has a complex of natural enemies, which can be slow to colonize tomato crops. An alternative approach to weed management is elimination of exotic weeds and restoration of native vegetation (certain perennial grasses), which outcompete weeds and preclude development of the first generation of consperse stinkbug at that site. Beneficial insects such as hover flies, green lacewings, ladybird beetles, and damsel bugs are found in the perennial grasses. Roadside restoration provides an economic benefit in the form of pest reduction.

**Holland, J. and L. Fahrig. 2000. Effect of woody borders on insect density and diversity in crop fields: a landscape-scale analysis. *Agriculture, Ecosystems and Environment* 78:115-122.**

The relationship between density and richness of herbivorous insects in alfalfa fields, and the amount (total length) of woody field border in the landscapes surrounding the fields was studied. Insects (predominantly herbivorous) were sampled in 35 alfalfa fields in 1995 and 24 fields in 1996, and the total length of woody field borders within the one-kilometer radius circular landscape surrounding each field was measured. There was no effect of amount of woody border in the landscape on insect density. There was a significant positive effect of amount of woody border in the landscape on overall family richness of insects in the alfalfa fields. The results of this study suggest that woody borders increase diversity but not density of herbivorous insects within crop fields in agro-ecosystems. This

suggests that woody borders play a role in maintaining biodiversity in agro-ecosystems, and that this role extends beyond the borders themselves, into the crop fields.

**Long, R.F., A. Corbett, C. Lamb, C. Reberg-Horton, J. Chandler, and M. Stimmann. 1998. Movement of beneficial insects from flowering plants to associated crops. *California Agriculture* 52:23-26.**

Marking studies demonstrated that lady beetles, lacewings, syrphid flies and parasitic wasps fed on nectar and pollen provided by borders of flowering plants around farms; many insects moved 250 feet into adjacent field crops. Studies using the elemental marker rubidium also showed that syrphid flies, parasitic wasps and lacewings fed on flowering cover crops in orchards and that some moved 6 feet high in the tree canopy and 100 feet away from the treated area. The use of nectar of pollen by beneficial insects helps them survive and reproduce. Therefore, planting flowering plants and perennial grasses around farms may lead to better biological control of pests in nearby crops.

**Long R.F., M. Kimball, and P. Thompson. 2003. Establishing a Hedgerow. Video. University of California Agriculture and Natural Resources, Publication No. V02-A.**

There is a great deal of interest in planting hedgerows of shrubs, trees, and perennial grasses around farms for habitat and food for wildlife and beneficial insects, weed control in non-farmed areas, sediment traps, wind breaks, and as barriers between agricultural and urban lands. This video focuses on how to plant hedgerows, including design, plant selection, selecting a location, weed control, irrigation, and costs associated with these practices. Through a three-year research project, we determined that it costs about \$3,200 to establish a 1,200 ft- long single row hedgerow with a 15-foot-wide swath of perennial grasses next to it in the first two years. Plants must be adapted locally to the soil and climate; linear designs worked best for hedgerow management; irrigation was critical for the first two years; and constant weed control was essential.

**Long R.F. and C.G. Pease. 2001. Quantifying pest and beneficial insects in hedgerows. Yolo County University of Cooperative Extension. <http://ceyolo.ucdavis.edu>.**

A two-year project was conducted to look at the abundance and diversity of insects associated with hedgerows of perennial shrubs and native grasses planted on field crop farms. Bi-weekly sampling in the hedgerows throughout the growing season in the Northern Sacramento Valley showed that most of the visitors to the shrubs were beneficial insects. Pests that were found on the shrubs were present mid-to-late in the growing season. Bi-weekly sampling of insects in nearby weedy vegetation showed an abundance of pests compared with the low levels in our hedgerow shrubs and native grasses. Presumably the pests preferred the seed pods of the weedy vegetation over our woody shrubs because of the higher energy source.

**Patt, J.M., G.C. Hamilton, J.H. Lashomb. 1997. Impact of strip-insectary intercropping with flowers on conservation biological control of the Colorado potato beetle. *Advanced Horticultural Science*, 11:175-181.**

Predators of Colorado potato beetle (*Leptinotarsa decemlineata*) (CPB) are an important component of CPB suppression by biological control in New Jersey (USA) eggplant fields. Here we report the results of a preliminary study on the effects of strip-insectary intercropping with flowers on predator abundance and CPB suppression in experimental eggplant fields. Strip-insectary intercropping with flowers is known to increase beneficial insect survivorship, fecundity and retention and crop pest suppression in agroecosystems. However, little is known about the compatibility of predator foraging ability with floral architecture, i.e., the spatial relationship of the nectary with other floral parts. This is a critical factor in the selection of "proper" floral host plants, i.e., those having pollen and nectar that is accessible to predators. To measure the effect of strip-insectary intercropping with "proper" flowers on CPB suppression, the fate of 120 eggmasses and resultant larvae placed on individual sentinel eggplant plants was followed during two nine-day periods in 100 m x 40 m eggplant fields intercropped with two rows of either dill or coriander and in a flowerless control field. In addition, coccinellid species richness and abundance was censused weekly in each test field from early July to mid-August. Throughout this study, the numbers of coccinellids observed during each census were significantly higher in the fields interplanted with dill and coriander than in the flowerless control field. Although there were not differences among treatments in the number of hatched CPB eggmasses, significantly more CPB eggmasses were consumed in the dill-intercropped fields than in the control fields. Survivorship of CPB larvae at the end of each survey was highest in the control field and lowest in the dill field. These results suggest that strip-intercropping with "proper" flowers can greatly enhance CPB predator conservation and augmentation in vegetable cropping systems.

**Pfiffner, L., and H. Luka. 2000. Overwintering of arthropods in soils of arable fields and adjacent semi-natural habitats. *Agriculture, ecosystems & environment*. v. 78:p. 215-222.**

In order to determine the significance of field margins for the overwintering of arthropods in agricultural landscapes, different sites of an integrated and of an organically managed farm were investigated in the northwest of Switzerland. The abundance of arthropods in the arable fields was significantly lower than in the adjacent semi-natural habitats. Highest abundances and species diversities were found in a sown wildflower strip, a hedge, a permanent meadow and a meadow under the cherry trees of the organic farm. With a total of 90 arthropod species in the semi-natural habitats, five times more species were found

than in the arable fields. Staphylinids, carabids, spiders and chilopods were the most abundant arthropod groups. The data showed that undisturbed semi-natural habitats and extensively managed field margins play a key role as overwintering sites for many predatory arthropods.

**Sengonca, C., J. Kranz and P. Blaeser. 2002. Attractiveness of three weed species to polyphagous predators and their influence on aphid populations in adjacent lettuce cultivations. *Anz. Schadlingskunde/ Journal of Pest Science* 75, 161-165.**

The utilization of olfactory responses of predators and parasitoids to the allelochemicals emitted by phytophagous arthropods (insects which feed on plants) and their host plants is becoming more important in biological pest control. The effects of three weed species, i.e. wormwood (*Artemisia vulgaris*) L., tansy (*Tanacetum vulgare*) L. and stinging nettle (*Urtica*) L., which were planted as accompanying vegetations into a lettuce field, were examined for the predatory species *Coccinella septempunctata* L., *Adalia bipunctata* L., *Propylea quatuordecimpunctata* L. (Coleoptera, Coccinellidae) and *Chrysoperla carnea* (Steph.) (Neuroptera, Chrysopidae), as well as for aphids during the summer of 2000. The presence of weeds significantly increased the density of adults and larvae of the predators on the lettuce plants in relation to the control (lettuce field without weeds). However, the differences remained smaller for eggs and pupae. *C. septempunctata* tended to be the most abundant species, followed by *P. quatuordecimpunctata*. Remarkable differences among the attractiveness levels of the weeds in the 3 treatments were not observed. The increased populations of predators were accompanied by significantly reduced infestation rates with aphids in the treatments in relation to the control.

**Steffan, S. A. 1997. Flower-visitors of *Baccharis pilularis de Candolle* subsp. *consanguinea* (de Candolle) E.B. Wolf (Asteraceae) in Berkeley, California. *The Pan-Pacific Entomologist* 73(1): 52-54.**

Coyote brush (*Baccharis pilularis* De Condolle subspecies *consanguinea* (De Conadolle) C.B. Wolf (Asteraceae)) is a dioecious evergreen perennial, native throughout cismontane California, Baja California, and as far north as Oregon. This paper provides a list of insect flower-visitors collected in Strawberry Canyon in 1992. Representatives of at least 55 insect species were collected (five orders and 32 families). Hymenoptera (wasps) comprised approximately 81% of all insect specimens, Diptera (flies) accounted for 10%, and the remaining orders, 9%.

Wratten, S., H.F. van Emden, and M.B. Thomas. 1998. Within-field and border refugia for enhancement of natural enemies, p. 375-403, In C. H. Pickett and R. L. Bugg, eds. *Enhancing Biological Control: Habitat Management to Promote Natural Enemies of Agricultural Pests*. University of California Press, Berkeley, CA.

The idea that diversification of a crop or its margins can benefit the natural enemies of pests is intuitively logical and seems to involve common-sense ecological principles. However the mechanisms behind these purported interactions are usually barely understood. Among the mechanisms involved in the interaction between pest dynamics and within-field or border refugia are: the provision of overwintering or aestivation sites; the enhancement of the quantities of pollen and/or nectar available to predators and parasitoids; the provision of alternative prey for predators or alternatively the hosts of parasitoids. All of these pro-

cesses have potential negative as well as positive effects on population dynamics of pests. Sometimes the improvement or creation of refugia benefits beneficial arthropods other than those with potential in biological control. It does not follow that making an agricultural landscape more diverse will necessarily lead to greater predator-prey stability. Margin strips of *Sinapsis arvensis* and *Phacelia tanacetifolia* led to higher densities of polyphagous predators (those that have more than one host plant) in the strips and in adjacent fields than in wheat plots without strips. There was a trend toward lower aphid populations in the field with adjoining strips. We need to understand better three related processes: 1) the spatial dynamics of beneficial arthropods on farmland; 2) the potential negative effects of refugia; and 3) the mechanisms involved in the functioning of refugia.



Native grass production at Hedgerow Farms, Winters, California



# APPENDIX E

## NURSERIES & SEED COMPANIES

### NURSERIES

#### **Alternatives Nursery**

P.O. Box 1100  
Nevada City, CA 95959  
(530) 263-2874

#### **Appleton Forestry Nursery**

1369 Tilton Road  
Sebastopol, CA 95472  
(707) 823-3776

#### **Aquatic Resources**

P.O. Box 2169  
Sebastopol, CA 95472  
(707) 829-1194

#### **Blue Oak Landscape Supply**

2731 Mountain Oak Lane  
Rescue, CA 95672  
(530) 677-2111

#### **Cache Creek Nursery**

2815 Road 40A  
Rumsey, CA 95679  
(530) 796-3521

#### **California Conservation Corps-Napa**

**Native Plant Nursery**  
P.O. Box 7199  
Napa, CA 94588  
(707) 253-7783

#### **California Department of Forestry & Fire Protection**

**L.A. Moran Reforestation Center**  
P.O. Box 1590  
Davis, CA 95617  
(530) 753-2441

#### **California Flora Nursery**

P.O. Box 3  
Fulton, CA 95439  
(707) 528-8813  
www.calfloranursery.com

#### **Central Coast Wilds**

114 Liberty Street  
Santa Cruz, CA 95060  
(831) 459-0656/Fax 459-1606  
www.centralcoastwilds.com

#### **Circuit Rider Productions, Inc.**

9619 Old Redwood Highway  
Windsor, CA 95492  
(707) 838-6641

#### **Cornflower Farms Wildland/Agriculture Catalog**

P.O. Box 896  
Elk Grove, CA 95759  
(916) 689-1015  
www.cornflowerfarms.com

#### **Elkhorn Native Plant Nursery**

P.O. Box 270  
Moss Landing, CA 95039  
(831) 763-1207/Fax 763-1659  
www.elkhornnursery.com

#### **Freshwater Farms**

5851 Myrtle Avenue  
Eureka, CA 95503  
(800) 200-8969  
www.freshwaterfarms.com

#### **Hartland Nursery**

13737 Grand Island Road  
Walnut Grove, CA 95690  
(916) 775-4021  
www.hartlandnursery.com

#### **Hedgerow Farms**

21740 County Road 88  
Winters, CA 95694  
(530) 662-4570

#### **Intermountain Nursery**

30443 N. Auberry Road  
Prather, CA 93651  
(559) 855-3113/Fax 855-8809  
www.intermountain@psnw.com

#### **Lockeford Plant Materials Center**

21001 North Elliott Road  
Lockeford, CA 95237  
(209) 727-5319

#### **Morningsun Herb Farm**

6137 Pleasants Valley Road  
Vacaville, CA 95688  
(707) 451-9406  
www.morningsunherbfarm.com

#### **Mostly Natives Nursery**

27235 Highway One  
Tomales CA 94971  
(707) 878-2009  
www.mostlynatives.com

**Native Here Nursery**  
101 Golf Course Drive  
Tilden Park, CA 94708  
(510) 549-0211

**Native Oak Nursery**  
45 Webb Road  
Watsonville, CA 95076  
(831) 728-8662

**Native Revival**  
2600 Mar Vista Drive  
Aptos, CA 95003  
(831) 684-1811  
www.nativer revival.com

**North Coast Native Nursery**  
P.O. Box 660  
Petaluma, CA 94953  
(707) 769-1213  
www.northcoastnativenursery.com

**Rana Creek Habitat Restoration**  
**Native Grasses & Plants**  
35351 East Carmel Valley Road  
Carmel Valley, CA 93924  
(831) 659-3820  
www.ranacreek.com

**Royal Oaks Nursery**  
1070 San Miguel Canyon Rd.  
Watsonville, CA 95076  
(831) 724-7032

**Sierra Azul/Rosendale Nurseries**  
2660 E. Lake Avenue  
Watsonville, CA 95076  
(831) 728-2599  
www.sierrazul.com

**Sierra Valley Farms**  
P.O. Box 79  
Beckworth, CA 96129  
(530) 832-0114

**Specialty Gardens**  
P.O. Box 567451  
Modesto, CA 95357  
(209) 527-5889

**Suncrest Nursery**  
400 Casserly Road  
Watsonville, CA 95076  
(831) 728-2595/Fax 728-3146  
www.suncrestnursery.com



Elderberry provides nectar, pollen and cover for insects.

**Sweetland Farm & Nursery**  
27443 Sweetland Road  
North San Juan, CA 95690  
(530) 292-9033

**Valley Transplants**  
23000 Bruella Road  
Acampo, CA 96220  
(209) 368-6093

**Yerba Buena Nursery**  
19500 Skyline Blvd.  
Woodside, CA 94062  
(650) 851-1668

**You Bet Farms**  
15595 You Bet Road  
Grass Valley, CA 95945  
(530) 292-9450

## **SEED COMPANIES**

**Comstock Seed**  
917 Highway 88  
Gardnerville, NV 89410  
(775) 746-3681

**Conservaseed**  
P.O. Box 455  
Rio Vista, CA 94571  
(916) 775-1676

**Clyde Robin Seed Company**  
P.O. Box 2366  
Castro Valley, CA 94546  
(510) 785-6463

**Environmental Seed Producers**  
P.O. Box 2709  
Lompoc, CA 93438  
(805) 735-8888

**Harmony Farm Supply**  
P.O. Box 460  
Graton, CA 95444  
(707) 823-9125  
[www.harmonyfarm.com](http://www.harmonyfarm.com)

**Hedgerow Farms**  
21740 County Road 88  
Winters, CA 95694  
(530) 662-4570

**Kamprath Seeds**  
205 Stockton Street  
Manteca, CA 95337  
(800) 325-4621

**Larner Seeds**  
P.O. Box 407  
Bollinas, CA 94924  
(415) 868-2592  
[www.larnerseeds.com](http://www.larnerseeds.com)

**Native Solutions**  
P.O. Box 222652  
Carmel, Ca 93922  
(831) 214-0711

**Pacific Coast Seed**  
6144 Industrial Way, Bldg. A  
Livermore, CA 94550  
(925) 373-4417

**Peaceful Valley Farm Supply**  
110 Springhill Boulevard  
Grass Valley, CA 95945  
(530) 272-4769  
[www.groworganic.com](http://www.groworganic.com)

**Rana Creek Habitat Restoration**  
35351 E. Carmel Valley Road  
Carmel Valley, CA 93924  
(831) 659-3820  
[www.ranacreek.com](http://www.ranacreek.com)

**S & S Seed**  
P.O. Box 1275  
Carpenteria, CA 93014-1275  
(805) 684-0436

**Stover Seed Company**  
P.O. Box 21488  
Los Angeles, CA 90021  
(800) 621-0315  
[www.stoverseed.com](http://www.stoverseed.com)

**TS & L Seed Company**  
37331 Highway 16  
Woodland, CA 95776  
(530) 666-1239



Fence line hedgerow.

# APPENDIX F

## BOTANICAL GARDENS

Refer to Sunset Western Garden Book for a complete listing of California botanical gardens.

### **Luther Burbank Home & Gardens**

Santa Rosa Avenue at Sonoma Avenue  
Santa Rosa, CA 95402  
(707) 524-5445  
[www.lutherburbank.org](http://www.lutherburbank.org)

### **Rancho Santa Ana Botanic Garden**

1500 N. College Avenue  
Claremont, CA 91711  
(909) 625-8767  
[www.rsabg.org](http://www.rsabg.org)

### **Regional Parks Botanic Garden**

Tilden Regional Park  
Wildcat Canyon Road  
Berkeley, CA 94708  
(510) 841-8732  
[www.nativeplants.org](http://www.nativeplants.org)

### **Santa Barbara Botanic Garden**

1212 Mission Canyon Road  
Santa Barbara, CA 93105  
(805) 682-4726  
[www.sbbg.org](http://www.sbbg.org)

### **Strybing Arboretum & Botanical Gardens**

Golden Gate Park  
Ninth Avenue at Lincoln Way  
San Francisco, CA 94122  
(415) 661-1316  
[www.strybing.org](http://www.strybing.org)

### **UC Botanical Garden**

200 Centennial Drive  
Berkeley, CA 94720  
(510) 643-2755  
[www.mip.berkeley.edu/garden](http://www.mip.berkeley.edu/garden)

### **UC Santa Cruz Arboretum**

1500 High Street  
Santa Cruz, CA 95064  
(831) 427-2998  
[www2.ucsc.edu/arboretum](http://www2.ucsc.edu/arboretum)



Successful establishment of shrubs and grasses on High Ground Organic Farms, Watsonville.

# NOTES

# ADDITIONAL RESOURCE MATERIALS

*Included in Hedgerows for California Agriculture Manual, A Resource Guide*

- **Establishing Hedgerows for Pest Control and Wildlife**, from “Bring Farm Edges Back to Life,” Yolo County RCD.
- **Farmscaping to Enhance Biological Control**. National Center for Appropriate Technology (NCAT)/ Appropriate Technology Transfer for Rural Areas (ATTRA)
- **Hedgerow Establishment. Practices and Costs for Field Crop Farms in the Sacramento Valley**. Brochure from UC Cooperative Extension and Yolo County RCD
- **Hedgerow Planting: Conservation Practice Standard**, Code 422. 2002. Natural Resources Conservation Service.
- **Hedgerow Planting: Practice Requirements**. USDA Natural Resources Conservation Service, California.
- **Hedgerow Planting: Practice Specifications**. USDA Natural Resources Conservation Service.
- **Hedgerows: Benefits to Farmers, Benefits to Wildlife**. Brochure from Santa Cruz County NRCS/RCD and CAFF.
- **Insects Associated with Native Hedgerows**. Pamphlet by Corin Pease, UC Davis.
- **Dietrick Institute for Applied Insect Ecology**. Perennial Plants Selected to Attract Beneficial Insects to Manage Aphids, Caterpillars Mites, Thrips, and Whitefly
- **Project Description**. Extending Hedgerow Systems in California Agriculture



NATURAL RESOURCES CONSERVATION SERVICE  
CONSERVATION PRACTICE STANDARD

**HEDGEROW PLANTING**

(Ft.)

CODE 422

**DEFINITION**

Establishment of dense vegetation in a linear design to achieve a natural resource conservation purpose.

**PURPOSE**

Providing at least one of the following conservation functions:

- Food, cover and corridors for terrestrial wildlife.
- Food and cover for aquatic organisms that live in watercourses with bank-full width less than 5 feet.
- To intercept airborne particulate matter.
- To reduce chemical drift and odor movement.
- To increase carbon storage in biomass and soils.
- Living fences
- Boundary delineation
- Contour guidelines
- Screens and barriers to noise and dust
- Improvement of landscape appearance

**CONDITIONS WHERE PRACTICE APPLIES:**

This practice applies wherever it will accomplish at least one of the purposes stated above.

**CRITERIA**

**General Criteria Applicable to All Purposes**

Hedgerows shall be established using woody plants, or perennial bunch grasses producing erect stems attaining average heights of at least 3 feet and persisting well over winter.

Plants selected must be suited and adapted to the soils, climate and conservation purpose.

No plant listed by the state as a noxious weed shall be established in a hedgerow.

The practice shall be protected from livestock grazing and trampling to the extent necessary to ensure that it will perform the intended purpose(s).

Competing vegetation shall be controlled until the hedgerow becomes established. Control shall continue beyond the establishment period, if necessary.

All planned work shall comply with federal, state and local laws and regulations.

**Additional Criteria for Wildlife Food, Cover and Corridors**

Establish at least two species of native vegetation.

Selected plants shall provide cover and/or food to support the landowner's wildlife objectives.

Minimum hedgerow width, at maturity, shall be 15 feet. This may necessitate the establishment of more than one row of plants.

In plantings adjacent to small watercourses, the plantings shall be site-adapted, large enough at maturity and installed close enough to shade the watercourse.

Conservation practice standards are reviewed periodically, and updated if needed. To obtain the current version of this standard, contact the Natural Resources Conservation Service.

**NRCS, NHCP  
October 2003**



### **Additional Criteria for Living Fences**

Selected plants shall attain a size adequate to create a barrier to contain livestock or humans, as needed.

If the purpose is to contain livestock, selected plants shall not be poisonous or hazardous to the animals.

### **Additional Criteria for Boundary Delineation**

Hedgerows shall be aligned along boundaries of fields, or forestlands to differentiate land management units.

### **Additional Criteria for Contour Guidelines**

Hedgerows shall be aligned so they provide permanent contour markers supporting implementation of Contour Farming (330) or Stripcropping (585). Refer to those conservation practice standards for alignment criteria.

### **Additional Criteria for Screens and Noise Barriers**

Screening hedgerows provide privacy, hide unsightly areas from view or reduce noise.

Hedgerows shall be located where they most completely obstruct a line of sight or offensive sound.

Selected plants shall attain a height and fullness sufficient to break the line of sight or baffle sound.

### **Additional Criteria for Improvement of Landscape Appearance**

The hedgerow design shall meet the aesthetic objectives of the landowner.

Plants shall be selected based upon the landowner's preferences for color, texture and growth habit.

### **Additional Criteria for Reducing Particulate Matter Movement**

The hedgerow will be oriented as close to perpendicular to the prevailing wind direction as possible.

Hedgerow density on the upwind side shall be at least 50% at maturity.

Hedgerow density adjacent to the particulate source shall be at least 65% at maturity.

### **Additional Criteria to Reduce Odor Movement and/or Chemical Drift**

Orientation of the hedgerow shall be as close to perpendicular to the prevailing wind direction during the period of concern, and between the source of the odor or chemical drift and the sensitive and the sensitive areas.

Hedgerows shall be located upwind of the odor producing area and the chemical application area.

Tree and shrub species used shall have foliar and structural characteristics that optimize interception, adsorption and absorption of airborne chemicals or odors.

## **CONSIDERATIONS**

### **General**

Planting a hedgerow larger than the minimum length and width will increase the amount of carbon stored in the soil and biomass.

Hedgerows can be planned in combination with other practices to develop complete conservation systems that enhance landscape aesthetics, reduce soil erosion, improve sediment trapping, improve water quality and provide wildlife habitat.

Hedgerows following land contours create meandering lines on the landscape, produce a natural appearance and increase the availability of "edge" wildlife habitats.

Hedgerows containing a mixture of native shrubs and small trees provide greatest environmental benefits.

Use of bareroot and containerized seedlings will accelerate hedgerow development.

Consider the amount of shading a hedgerow will provide at maturity. Shading may impact growth of adjacent plants, microclimate and aesthetics.

Limiting renovation events to one-third of a hedgerow's length or width will prevent sudden elimination of the practice's wildlife habitat function.

Periodic root pruning can reduce nutrient and water robbing from adjacent cropland.

Consider avoiding the use of plants that spread by root suckers as hedgerow may expand beyond the desired treatment area.

#### **Wildlife Food, Cover and Corridors**

Hedgerows can provide travel lanes, or corridors that allow wildlife to move safely across a landscape.

Generally, wider corridors accommodate more wildlife use.

Linking fragmented habitats may increase wildlife use of an area.

In grassland ecosystems, hedgerows may adversely affect area-sensitive nesting birds by fragmenting habitat patches and increasing the risk of predation.

Hedgerows can complement the availability of naturally occurring wildlife foods.

Hedgerows can provide wildlife with cover for feeding, loafing, nesting and caring for young.

Dense or thorny shrub thickets provide songbirds with important nesting sites and a refuge to escape predators.

Establishment of evergreen plants provides year-round concealment and thermal cover for wildlife.

Establishment of herbaceous vegetation along the edges of a hedgerow can further enhance the habitat functions of a hedgerow.

Installation of artificial nest boxes with predator guards can encourage cavity-nesting birds and small mammals to utilize a hedgerow.

#### **Living Fences**

Thorny shrubs and trees can improve a living fence's barrier effect.

#### **Screens and Noise Barriers**

From eye-level, hedgerows reduce the line-of-sight across open areas, concealing objects behind them from view.

Consider the design from viewpoints on both sides of the screen.

Locate noise barriers as close to the source of noise as possible.

Combination of shrubs and/or trees can create more effective screens than single species plantings.

Evergreens provide foliage that can maintain a screen's year-round effectiveness.

#### **Improving Landscape Appearance**

Consider plants' seasonal display of colors on bark, twigs, foliage, flowers and fruit.

Consider plants' growth habits (outline, height and width).

#### **Water Quality and Quantity**

Water quality benefits may arise from:

- Arresting sediment movement and trapping sediment-attached substances.
- Infiltration and assimilation of plant nutrients.
- Water cooling effects resulting from increased shade on small watercourses.

A hedgerow will increase surface water infiltration by improving soil structure around its root zone. However, evapotranspiration may reduce groundwater recharge benefits.

#### **Incidental Trapping of Snow or Soil**

Although not a primary purpose, hedgerows may incidentally trap wind blown snow or soil.

Consider installing hedgerows on alignments that prevent trapping and accumulation of snow and sand on public roads.

Refer to the Windbreak/Shelterbelt Establishment (380) standard for criteria when snow or sand trapping is a primary conservation purpose.

#### **PLANS AND SPECIFICATIONS**

Plans and specifications for this practice shall be prepared for each site. Plans and specifications shall be recorded using approved specification sheets, job sheets, or narrative documentation in the conservation plan, or other acceptable documentation.

## **OPERATION AND MAINTENANCE**

Vegetation shall be maintained to ensure continued control of odor movement and chemical drift.

Supplemental planting may be required when survival is too low to produce a continuous hedgerow.

Vegetation shall be protected from unwanted fire and grazing throughout its life span.

Pests shall be monitored and controlled.

Periodic applications of nutrients may be needed to maintain plant vigor.

Renovation activities shall be scheduled to prevent disturbance during the wildlife nesting season.

## **REFERENCES**

National Biology Handbook, Part 614.4, "Conservation Corridor Planning at the Landscape Level". Natural Resources Conservation Service, August 1999.

U.S DEPARTMENT OF AGRICULTURE  
NATURAL RESOURCES CONSERVATION SERVICE  
CALIFORNIA

**PRACTICE REQUIREMENTS  
FOR  
422 - HEDGEROW PLANTING**

For: Business Name \_\_\_\_\_  
Job Location \_\_\_\_\_  
County \_\_\_\_\_ RCD \_\_\_\_\_ Farm/Tract No. \_\_\_\_\_  
Referral No. \_\_\_\_\_ Prepared By \_\_\_\_\_ Date \_\_\_\_\_

**IT SHALL BE THE RESPONSIBILITY OF THE OWNER TO OBTAIN ALL NECESSARY PERMITS AND/OR RIGHTS, AND TO COMPLY WITH ALL ORDINANCES AND LAWS PERTAINING TO THIS INSTALLATION.**

Installation shall be in accordance with the following drawings, specifications and special requirements. NO CHANGES ARE TO BE MADE IN THE DRAWINGS OR SPECIFICATIONS WITHOUT PRIOR APPROVAL OF THE NRCS TECHNICIAN.

1. Drawings, No. \_\_\_\_\_

2. Practice Specifications \_\_\_\_\_, \_\_\_\_\_, \_\_\_\_\_

3. Planting Stock: \_\_\_\_\_

Planting Stock: \_\_\_\_\_

Planting Stock: \_\_\_\_\_

4. Fertilizer: \_\_\_\_\_ rate: \_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

5. Special Requirements: \_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_

**PRACTICE APPROVAL:**

Job Classification: (Ref: Section 501 NEM)

Show the limiting elements for this job. This job is classified as, Class \_\_\_\_\_

Limiting elements:	Units
Area Planted _____	_____ ac
Lenth of Row _____	_____ ft
_____	_____
_____	_____

Approved by: \_\_\_\_\_ Date: \_\_\_\_\_

**LANDOWNER’S/OPERATOR’S ACKNOWLEDGEMENT:**

The landowner/operator acknowledges that:

- a. He/she has received a copy of the drawings and specifications, and that he/she has an understanding of the contents, and the requirements.
- b. He/she has obtained all the necessary permits.
- c. No changes will be made in the installation of the job without prior concurrence of the NRCS technician.
- d. Maintenance of the installed work is necessary for proper performance during the project life.

Accepted by: \_\_\_\_\_ Date: \_\_\_\_\_

**PRACTICE COMPLETION:**

I have made an on site inspection of the site (or I am accepting owner/contractor documentation), and have determined that the job as installed does conform to the drawings and practice specifications.

Completion Certification by:

/s/ \_\_\_\_\_ Date \_\_\_\_\_

**NATURAL RESOURCES CONSERVATION SERVICE  
CONSERVATION PRACTICE SPECIFICATION**

**422 - HEDGEROW PLANTING**

**I. SCOPE**

The work shall consist of furnishing all materials and placing them in the designated areas to the limits as shown on drawings or staked in the field and performing all the cultural operations to grow and maintain healthy p

lants.

**II. SITE PREPARATION**

The land on which trees and shrubs will be planted must be essentially free of sod and perennial weeds before planting. Where grass sod or alfalfa exist, they are to be destroyed. This may be accomplished by mechanical and/or chemical control.

**A. Sites with sod or perennial vegetation:**

Where no wind erosion hazard exists, destroy sod or perennial vegetation on the entire site the year prior to planting by mechanical or chemical means.

Where an erosion hazard exists, destroy sod or perennial vegetation by mechanical or chemical means on an area extending a minimum of three (3) feet (6 feet total strip) from where the seedling is to be planted.

**B. Sites that have been in row or small grain crops the year prior to planting:**

Where no erosion hazard exists, sites may be prepared just prior to planting.

Where an erosion hazard exists, prepare seedbed, leave stubble over the winter, and prepare a six-foot strip prior to planting by mechanical or chemical means on an area extending a minimum of three (3) feet (6 feet total strip) from where the seedling is to be planted .

**C. Where wind erosion is a problem, the plants may be planted directly into the site and a 3-foot diameter circle cleared around each plant at the time of planting. Methods of control include chemical and mechanical control.**

**D. Fallowing will be accomplished in areas having less than 20 inches of annual precipitation.**

**E. The irrigation system will be planned and installed prior to planting. Set up will be just after planting**

**III. PLANTING STOCK AND CARE OF SEEDLINGS**

Proper care of seedlings at all times, from lifting at the nursery to the actual planting, cannot be over-emphasized. Negligence at any of these stages can cause complete failure regardless of the care taken when planting. Do not obtain seedlings from the nursery until shortly before planting is to begin.

Keep seedling roots moist at all times, from the time they are removed from the bale until they are planted. Seedlings may be stored in bales for a short period of time: two or three days. Extreme care must be taken, however, to make sure roots do not dry out, that the seedlings do not heat, and reasonable efforts must be made to keep them from freezing. Seedling bales must be watered at least once every 48 hours and protected against sun and wind, yet well ventilated. Seedling bales should be examined daily and shifted as necessary to avoid heating. Where freezing occurs the bales should not be handled, but left until completely thawed out by warmer weather. Where it is necessary to store seedlings for periods in excess of three days, it is better to heel them out in thin layers and bed them in a sandy or loamy soil and make sure they remain moist.

Extreme care must be taken to keep seedling roots from becoming dried out while planting. Dry soil on the roots is evidence that seedlings are not being cared for properly. Ample water, or a water saturated material, must be kept in all planting containers to make sure the seedling roots remain moist.

NRCS, CA  
July 2000

Only viable planting stock grown from locally adapted seed or vegetative material should be planted. Planting stock should be maintained in good condition from the time received until planted. This will include, but not limited to, unpacking, storage, heeling in, transport to the planting site, and keeping plants protected and moist until and during planting.

### **Care of Seedlings.**

1. Bareroot stock care before planting:
  - (a) Store plants in enclosed areas from 34 to 40 degrees F. off the floor.
  - (b) If ice is utilized, do not allow contact with the roots.
  - (c) Bales of plants should not be piled higher than 3 feet.
  - (d) Roots will be facing one way for periodic watering and fungicide treatment. Seedling roots will be kept moist.
  - (e) Heel-in beds. Make a trench with one 30 to 45 degree backslope. Line out planting stock against sloped side and backfill. Pack soil firmly around the roots. Keep roots 1 to 2 inches below the ground line. Water as needed. A moderately course-textured soil is preferred. The heel-in bed should be shaded and protected.
2. Bareroot stock care during planting. Keep seedlings covered and moist while planting. Ample water, or a water saturated material (burlap, sawdust moss, etc.) must be kept in all planting containers to insure the seedlings remain moist.
3. Containerized stock care - including all stock in any type of container (tar paper, gallon cans, containers, etc).
  - (a) Seedlings will be stored at 34 to 40 degree F temperatures.
  - (b) The soil medium will be kept damp.
  - (c) The seedlings will be shaded and protected.

### **IV. PLANTING**

Machine planting or hand planting with any tool that will accomplish desirable results is acceptable.

The hedgerow will be staked or otherwise marked to assure proper alignment of rows and spacing.

Machine furrows or holes made with hand tools must be free of trash. Do not plant during freezing weather or when the ground is frozen.

Plantings will be made after the danger of heavy freezing has past and soil conditions are proper.

Plant in adequately sized, sod-free holes or furrows for proper root development.

Special attention to the actual planting operations is essential to the establishment of hedgerows:

#### **Depth**

Plant each seedling at the same depth or slightly deeper (1/2 to 1 inch) than it grew in the nursery.

#### **Condition of Roots**

Plant seedling roots straight down, not twisted, balled, or U-shaped. Roots must extend 8 to 12 inches below the ground surface.

#### **Pruning**

Do not prune tops or roots. The nursery practice of pruning the roots to about 10 inches when lifting has made further pruning unnecessary and is, therefore, not required.

#### **Straightness**

Plant seedlings as near vertical as possible.

#### **Firmness**

Pack the soil firmly around the planted seedlings with no air pockets left in machine furrows or dibble holes. Do not overpack on clayey soils.

#### **Seedlings Per Space**

Plant only one seedling per planting space.

Avoid planting on hot, dry, windy days, during freezing weather, or when the ground is frozen.

## **V. IRRIGATION**

The irrigation system for each hedgerow planting shall be designed, installed and operational prior to planting. Except in MLRA 4, plantings shall receive supplemental irrigation for the first three years after planting (see applicable IRRIGATION SYSTEM standards and specifications).

## **VI. MAINTENANCE**

Replace all dead seedlings (annually) for at least three years after the planting is made.

Replant with the same species or one that is suitable to the soils and is compatible with original planting.

Plant competition can be removed by hand, mechanical, or chemical means. Do not disturb or otherwise damage seedlings by the improper use of chemicals, tools or machinery. When mechanical cultivation is used do not cultivate deeper than 3 inches, as the plant roots can be damaged.

Use mechanical and/or herbicides to control weeds, grasses or other competitive vegetation. Control competitive vegetation until the surrounding ground surface is completely or nearly completely shaded by the trees and shrubs during the growing season.

If at all possible, maintain an isolation strip of at least 8 feet for the entire life of the planting.

When weed control is done chemically, 1/ the following precautions will be observed:

Chemicals must be applied on no less than a 24-inch band to each side of the row.

Plantings will be protected from rodents, rabbits, hares, and deer. Means of animal control may include either chemical repellents or mechanical devices such as fences, screens, traps, rodent guards, general cleanup, etc.

Where net wire fencing is used to control rabbits and hares, it will extend at least 4 inches below ground surface. When individual trees are wrapped with burlap or tar paper, the material will be removed in the spring.

Prune and shape storm damaged trees.

Drip irrigation systems must be maintained weekly during irrigation season to make sure emitters are not plugged and restricting water flow.

## **Individual Tree Protection**

Based on limited observation, especially to younger plants, the following species normally require protection to control damage due to wildlife browsing:

native plum, skunkbush sumac, fourwing saltbush, lilac, dogwood, poplar spp., birch spp., willow spp..

Chicken wire tree protection. Chicken wire with a mesh that does not exceed 1 inch will be shaped to form a cylinder a minimum of 5 inches in diameter and 18 inches high. A minimum of one 24 inch 1x2 stake with 18 inches extending above the ground will be used to support the stake by 2 evenly spaced staples or tie wires. The chicken wire will be flush with the ground. The barrier must be removed when the trunk diameter is within one-half inch of the chicken wire diameter.

Rigid polypropylene - mesh tube tree protection. Tubes will be of a diamond pattern with a minimum 30 mil. strand diameter. The tubes will be a minimum of a 5 inch diameter and 18 inches high. The tubes will be fastened to a 24 inch 1x2 stake with 18 inches extending above the ground by one staple or a tie wire. The tubes will be flush with the ground. Tubes must be capable of UV breakdown in 2 to 5 years.

Rigid polypropylene - twin-walled extrusion. Tubes will be a minimum of 3 inches and a maximum of 6 inches in diameter. Height will be a minimum of 24 inches. Tubes will be fastened to a 24 inch 1x2 stake with at least 8 inches extending into the ground. Tubes will be fastened to the stake by at least one tie device. Tubes will be seated appropriately 1 inch into the ground surface. Tubes will be capable of remaining intact for at least five years. Color may range from white (low light conditions) to brown. Where cavity nesting birds or other wildlife entering the tubes may be a problem the tops of the tubes will be covered with a mesh sleeve to prevent entry.

## **VII. OTHER REQUIREMENTS**

The owner, operator, contractor, and other persons shall conduct all work and operations in accordance with proper safety code for the type of construction being performed with due regards to the safety of all persons and property.



**The Districk Institute for Applied Insect Ecology**  
**Perennial Plants Selected to Attract Beneficial Insects to**  
**Manage Aphids, Caterpillars, Mites, Thrips, and Whitefly**

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

The Dietrick Institute for Applied Insect Ecology

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

# PROJECT DESCRIPTION

## Extending Hedgerow Systems in California Agriculture

*A Project of the Community Alliance with Family Farmers, funded by Western Region Sustainable Agriculture Research and Education Professional Development Program 2004*

With funding from the Western Region Sustainable Agriculture Research and Education (WSARE) Professional Development Program, Community Alliance with Family Farmers (CAFF) has prepared this resource guide, as part of the project “Extending Hedgerow Systems in California Agriculture.” The objectives of the project are to: 1) Increase the knowledge of agricultural professionals about hedgerows as a system component that can help reduce pesticide use, increase on-farm biodiversity and on-farm habitat for beneficial organisms and wildlife, reduce wind and water erosion of soil, beautify the environment, and diversify farm products; 2) Extend the use of hedgerows as conservation and management tools to areas of California where they are not currently common; and 3) Create a hedgerow resource base for farmers and agricultural professionals that can be easily utilized throughout the state.

CAFF is partnering with resource personnel in the field of on-farm habitat restoration to hold four training workshops over a two-year period for California agricultural professionals. These workshops will educate staff members of the Natural Resources Conservation Service (NRCS), Resource Conservation Districts (RCD), Pest Control Advisors, 4-H Advisors, University Cooperative Extension Service and others about the use of hedgerows on farms. A team of experts has been formed that includes farmers who have hedgerows on their farms, NRCS and RCD staff who have expertise in hedgerows, employees of the National Center for Appropriate Technology (NCAT), agricultural and environmental consultants, owners of native plant nurseries and CAFF staff members. This team developed educational materials and determined the format for the workshops and served as speakers and evaluators of the project.

Workshops to train agriculture professionals in the creation of on-farm habitat using native plant hedgerows were held in four regions of the state where CAFF is active: North Coast, Central Coast, Northern and Central San Joaquin Valley. Within each of these regions, regional teams were formed to assist in local development and execution of the training sessions. Included as part of the training sessions were subsequent visits to local hedgerow demonstration sites at various stages of development. CAFF developed materials for use by participants after training that will help them discuss hedgerow options with farmers. Resource materials are available to help farmers identify plants and their associated beneficial insects. A list of native plant nurseries statewide is included in resource materials along with steps to building and maintaining a successful hedgerow. All of these resources are available on the CAFF Web site.

A Hedgerow Education Fund was set aside from the WSARE grant money to provide “mini-grants” which were used to encourage the extension of knowledge gained in the workshops to farmers and farm communities within trainees’ regions. In addition to providing incentive to trainees, this tool assisted in the evaluation process of the training sessions. When coupled with periodic surveys, success of the project was measured both by the number of projects resulting and the geographic extent of these projects.

**CAFF/WSARE Extending Hedgerows in California Agriculture Project**

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# Establishing Hedgerows for Pest Control and Wildlife

Mary Kimball & Celia Lamb, Yolo County RCD

Growers in Yolo County have found a solution to the problem of maintaining field borders and other noncrop farm areas. By planting hedgerows of non-invasive native plants, they create wildlife habitat areas that attract beneficial insects and provide competition against invasive weeds. With careful establishment and management techniques, hedgerows can provide a useful and attractive alternative to continuously scraping, spraying, and cultivating field edges and other “unfarmed” areas that would otherwise become sources of weed seeds.

## What is a Hedgerow?

Hedgerows are lines or groups of trees, shrubs, perennial forbs, or grasses that are planted along field edges or other unused areas. For agricultural areas in California, we recommend using a variety of native grasses, perennial forbs, shrubs, and trees that attract different types of beneficial insects, mammals, reptiles, and birds (including raptors). Native plants work extremely well in hedgerows because they require very little care after an establishment period of about three years. Many native plants have deep roots that hold soil and increase water permeability. Hedgerow areas suppress weeds by providing competition, and are less susceptible to wind and water erosion than bare soil. They can also filter surface runoff water, preventing silt, nutrients, and pesticides from entering waterways.



Image by Celia Lamb

Young hedgerow at a Yolo County farm

## Selecting a Site

Any unused farm area with good soil and access to water may make a good hedgerow site. The native plant species that we recommend using in an insectary hedgerow are very water sensitive; some plants like a great deal of water, while others can develop root and crown rot if overwatered. In order to combat this challenge, we recommend using drip irrigation tubes with adjustable emitters. Drip irrigation is the most effective, efficient and successful method of watering your new hedgerow. A secondary, very effective method is furrow irrigation. It is imperative to select a site that can be irrigated by one of these methods; access and availability of water to a new hedgerow planting is the single-most important factor in plant survival in the first year.

Another important factor in site selection is vulnerability to flooding and/or standing water. As previously discussed, many native plant species are very sensitive to overwatering, and if a site is known for its tendency to flood or have standing water during the winter months (or due to overwatering of a field crop), DO NOT use this site for a hedgerow planting. If possible, try to select a site that is either on higher ground or that you are absolutely sure does not collect water at any time of year. Of course, in high water years, this may not be avoided, but do not place a hedgerow on low ground and expect many of the plants to survive.

A third consideration is equipment. Make sure the area is out of the way of equipment; placing the hedgerow too close to a road or high-traveled area may be problematic if the equipment damages the plants. Hedgerows can certainly be planted next to roads, but recognize that many of these shrubs and trees will grow to 10-15 feet in width; be sure to leave enough room for this growth. This may mean planning spaces in the hedgerow for equipment to drive through, or choosing an alternate site that would be less intrusive.

## Choosing Plants

Plants should be selected according to the purpose you want the hedgerow to serve, but local species are likely to be best adapted to conditions on your farm. It is important to look at the water needs of each plant. Some natives, such as Toyon, *Ceanothus* spp., and California buckwheat, are extremely drought-tolerant and will die if their root crowns get wet for too long. These are best planted in well-drained soils. Others, such as willows and cottonwoods, prefer wetter areas. Within a given site, you may have varying soil types or lower areas that are more prone to flooding. In this case, choose plants with these differences in mind; i.e. select water-loving plants for some areas, and drought-tolerant plants for others. If you take the time beforehand to choose plants according to *your* site, rather than just using an “example” hedgerow recommendation, you will have much more success with plant survival; plants will grow faster, be healthier, and be better able to resist disease and pest insect pressure.

If you would like your hedgerow to serve as a windbreak, then you should design a hedgerow with many tall-growing shrubs and trees. Recommended species include cottonwoods, willows, native oaks, redbuds, and elderberry. Remember too, that as these trees grow, their understory will be less vegetated, and you may want to include shrubs in between trees to provide habitat and erosion control closer to the ground. By including shrubs, you will also gain more insectary value to the hedgerow. For lists of possible species for different settings in the Yolo County area, please see the attached list.



*Coyote brush leaf and flower*

If your primary goal is to use plants to attract beneficial insects (i.e. insects that prey on or parasitize crop pests), you should plant species with plentiful nectar and pollen. If you are unsure whether a plant will attract beneficial insects, observe one during

its flowering stage to see if bees and other insects are using it. For example, flowering *Ceanothus* and coyote brush tend to have large quantities of hoverflies and bees feeding on their pollen and nectar, whereas flowering oleander bushes attract very few insects.



Image by Celia Lamb

*Installing a hedgerow along a fence line*

Consider the time of year during which each species flowers, and try to use a good variety of plant species so that flowering will take place almost year-round. Many beneficials are looking for nectar and pollen in early spring and late fall, when nearby crops are just being planted or are being harvested. By using plant species that flower during these times, you will encourage greater use of the hedgerow, as these insects do not have other habitat in the area. The diagram on the following page contains information you may use to plan a hedgerow with staggered flowering periods.

## Design, Site Preparation and Planting

Unless the future hedgerow site has been kept free of weeds, it is best to begin regular disking, burning, and/or spraying at least one year before you intend to plant. Reducing the weed seed bank in this way will be especially important if you intend to plant grasses. Depending on the layout of your hedgerow and your irrigation method, you may need to prepare one or more planting beds for native grasses. Preparation for seeding is no different than preparing a seed bed for wheat, alfalfa, or most other crops. It is important to cultivate the area, depending on the soil type, by disking thoroughly and then harrowing to prepare an even, well-drained bed that is free of large clods of soil that can impede grass germination.

The best time to plant native grass seed is during the fall. You may want to wait for a rainstorm to bring up the first flush of weeds, and then spray, burn and/or

*Flowering Periods of California Native Insectary Plants*

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Willow spp.												
Ceanothus spp.												
Coffeeberry												
Hollyleaf cherry												
Yarrow												
Silverface vine												
Toyon												
Golden sticky monkeyflower												
Elderberry												
California Buckwheat												
Deergrass												
Creeping boobialla												
California fuchsia												
Narrowleaf milkweed												
St. Catherine's lace												
Coyotebrush												

harrow the weeds before planting. You can also control weeds in the first 1-2 weeks after planting by spraying glyphosphate before the native grasses emerge. Native grasses tend to take 2-3 weeks to emerge, but this is very weather dependent; be sure to inspect the site for germination before spraying. Native grass seed can be drilled, but most often the seed is broadcast with the use of a "belly grinder" (available from the RCD or your native grass supplier). After spreading, the grass seed should be harrowed in lightly (only 1/8" is necessary), so that seeds won't dry out and die. If harrowing isn't possible, a light covering of hay can also be used. The harrowing can be done with a 4-wheel ATC and light chain harrow, which also allows for getting on the site even after numerous rains. Please refer to the article "Strategies for Establishing California Native Grasses by Direct Seeding in the Sacramento Valley and Adjacent Foothills," (in this book) for more specific instructions.

Most native forbs, shrubs, and trees should be planted in the fall, although some become dormant at that time. Consult with your plant supplier for the best transplanting time. When planting, be sure to allow the shrubs and trees enough room to spread. A good rule of thumb is to plant them at centers 13-15 feet apart from each other. If you are using perennial forbs and small shrubs in your hedgerow, these can be placed in between the larger shrubs and trees, at a center spacing of 7-8 feet. Placing any of these plants any closer can inhibit growth in years to come, and is not necessary both economically and physically.

Before transplanting shrubs and trees, you may need to pre-soak the area to be planted to make hole-digging easier. Pre-soaking holes before transplanting is also a good way to reduce the likelihood of transplant shock. You may want to consider using fertilizer tablets for woody shrubs and trees. Dig a hole about twice the width and 1 1/2 times the depth of the original root

ball, drop the fertilizer tablet in, and cover with a small amount of soil so that the tablet is not in direct contact with the roots. Mound soil in the base of the hole so that the top of the root ball is roughly at the surrounding ground level. Remove the plant gently from its container and place it in the hole. If you need to loosen the root ball from the sides of the container, roll the container around in your hands, but *never* pull the plant out by its stem. Pack soil gently around the rootball to ensure good soil contact and minimize settling. Cover the top of the rootball with 1/4"- 1/2" of soil to prevent it from drying out. Be sure not to cover the top of the rootball too much, especially if the plant is a drought-tolerant shrub; the soil can hold water against the root crown, killing the shrub. Soak the new plantings well to minimize transplant shock and settle any air pockets around the rootball.

### Hedgerow Maintenance

Hedgerows need to be "farmed" during the first 2-3 years. This entails controlling invasive weeds and irrigating during dry periods. The most important maintenance that is necessary for hedgerow success is weed control. Even though you've planted native grasses, shrubs and trees, weeds will still be a problem for several years.

#### NATIVE GRASSES

After the initial spraying of glyphosphate after planting, you must carefully monitor weed pressure in native grass stands. In most cases, winter annuals such as annual rye grass, chickweed, yellow star thistle, annual sow thistle, wild oats, and mustard species can be prevalent and cause major problems. Since native grasses are slower growing, the annual weed growth can quickly surpass that of the natives and shade them out, thus preventing them from becoming established. Use selective herbicides for broadleaf weeds in the early spring to make sure that they don't get too large and produce seed. Annual grasses are hard to manage, but the best method is to mow your native grass stand before the annuals go to seed so that they are unable to reproduce for the following year.

#### HEDGEROW PLANTS

In the first year of growth, we have found that applying the pre-emergent herbicide Oxadiazon (granular formulation--see label for application restrictions) along the hedgerow just after planting is the most effective in controlling winter annuals throughout the winter season and even beyond. You can use glyphosphate and 2-4D to spot spray (using a backpack-sprayer), but must be extremely careful to not hit any of the shrubs or trees with any of the herbicide. Be sure to spray on very calm days, and use your judgement as to how close to a plant to spray. Hand-hoeing during the summer months, although labor-intensive, is very effective.

#### IRRIGATION

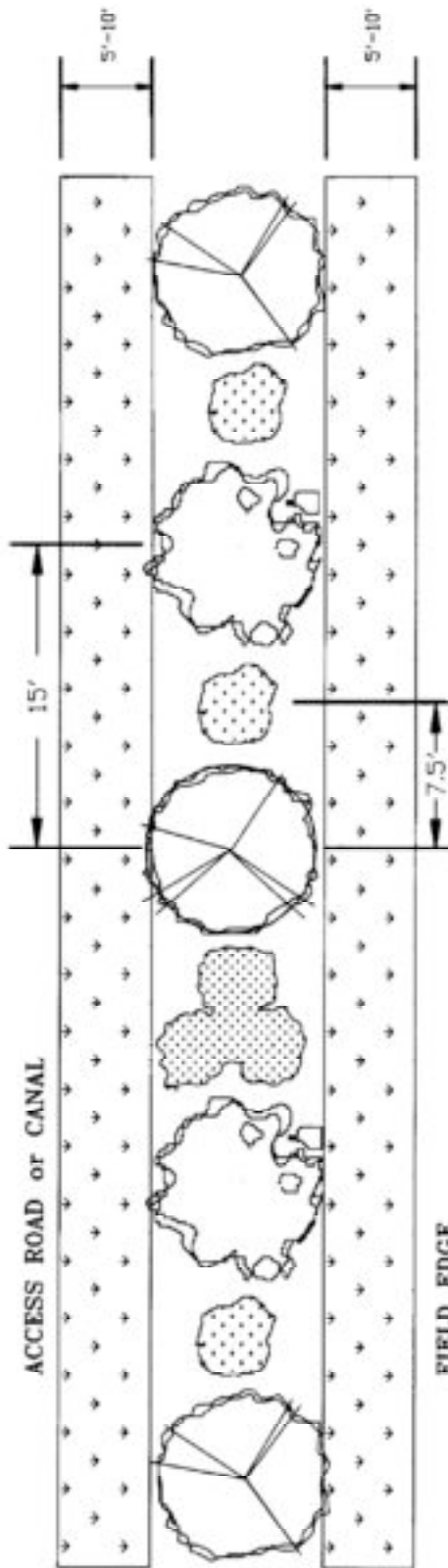
Find out the water needs of your plants from your supplier. Native grasses do not need summer watering because they become dormant at that time. Most shrubs and trees will need watering about every 2-4 weeks during drought months (March-November, depending on the year). After the 2-3 year establishment period, irrigation should no longer be necessary (depending on the plant species), and weed control measures can be considerably reduced. You may wish to keep notes on insect and wildlife visitation, weed problems and control methods you use in the hedgerow, weather conditions, and plant species that seem especially suited to your area, so you can share your results with others. The Yolo RCD has planted several hedgerows, and we would be very interested in hearing your questions and comments regarding your own hedgerow as we continue to monitor our hedgerows and work on improving our establishment methods.



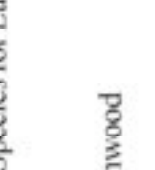











*Treasure Island blueblossom plant (left) and leaf and flower (right)*

## Sample Design of Insectary Hedgerows

Jae Lee, NRCS



- |   |                             |   |                         |  |   |   |                              |   |                     |  |                         |   |                           |   |                         |   |                      |
|---|-----------------------------|---|-------------------------|--|---|---|------------------------------|---|---------------------|--|-------------------------|---|---------------------------|---|-------------------------|---|----------------------|
|    | <b>Deciduous Shrubs</b>     |    | <b>Perennials</b>       |    | <b>Optional Tree Species for Larger Areas</b> |   |                              |   |                     |  |                         |   |                           |   |                         |   |                      |
| Elderberry  | Mullefat                    | Buttonbush  | Western redbud          | Yarrow   | Narrowleaf milkweed                           | California buckwheat  | St. Catherine's lace         | Deergrass   | Red willow          | Black willow   | Fremont cottonwood      | Valley oak  | California sycamore       | California box elder  | California buckeye      |   |                      |
|  | <b>Evergreen Shrubs</b>     |  | <b>Native Grass Mix</b> |  | <b>Purple needlegrass</b>                     |  | <b>California oniongrass</b> |  | <b>Blue wildrye</b> |  | <b>Creeping wildrye</b> |  | <b>Slender wheatgrass</b> |  | <b>California brome</b> |  | <b>Meadow barley</b> |
| Coffeeberry   | Toyon                       | Coyotebrush   | Hollyleaf cherry        | Creeping wildrye   | Slender wheatgrass                            | California brome  | Meadow barley                |   |                     |  |                         |   |                           |   |                         |   |                      |
| Treasure Island blueblossom   | Yankee Point Carmel Creeper |   |                         |  |   |   |                              |   |                     |  |                         |   |                           |   |                         |   |                      |



## Plant List for Oak Woodland and Savannah Situations\*

### (Adaped for "Insectary" Plantings in Small Areas)

Jae Lee, NRCS

The following is a list of possible plants for hedgerow designs in valley oak woodland/savannah situations. The notes provide information to help determine planting combinations that allow individual species appropriate sunlight, water, and adequate space. General growth habits may also be included. Hedgerows comprised of a mix of trees and shrubs are generally long lived. Trees are typically longer lived than shrubs. However, many shrubs can have life spans of more than 15 - 20 years. The *Ceanothus* species have one of the shortest life spans—5-10 years is typical. All of these plants (with the exception of the cool season native grasses) do require irrigation during their establishment period of 2-4 years.

### Small Trees (Deciduous)

Common Name	Scientific Name	Notes
Western redbud	<i>Cercis occidentalis</i>	Many branched shrub to multiple trunk tree, 6'-20' tall, 10'-15' wide, tolerates partial shade to full sun. Occasional summer water.
Blue elderberry	<i>Sambucus mexicana</i>	Shrub 4'-10' tall or tall tree to 40', commonly found in moist places but can tolerate some drought. Flowers April - Nov. Occasional summer water.

### Small Trees (Evergreen)

Common Name	Scientific Name	Notes
Treasure Island blueblossom	<i>Ceanothus</i> 'Ray Hartman'	Mounding shrub with 1"-2" leaves; 8'-15' tall, 10'-15' wide, train to small tree, needs full sun. Infrequent summer water. Flowers Feb.-April.
Blue blossom	<i>Ceanothus thyrsiflorus</i>	Hardy, 6'-20', full sun. Flowers March-May. Infrequent summer water.
Toyon	<i>Heteromeles arbutifolia</i>	Dense shrub 6'-10' or multi-trunked small tree, 15'-25', grows in full sun or partial shade. Flowers May-June. Looks better with occasional summer water.
Hollyleaf cherry	<i>Prunus ilicifolia</i>	Moderate growth rate, 20'-40' tall (large and old specimens resemble California live oak), best in full sun, can take light shade. Flowers April-May. Looks better with infrequent deep summer water.
Coffeeberry	<i>Rhamnus californica</i>	Mounding shrub, reaches 12'-15', variety 'Eve Case' is more compact, 3'-8' tall and wide, grows in full sun to half shade. Flowers April-May. Looks better with occasional summer water.

### Shrubs (Deciduous)

Common Name	Scientific Name	Notes
Quail bush	<i>Atriplex lentiformis</i>	Densely branched, sometimes spiny; 3'-10' tall, 6'-12' wide, needs full sun. Flowers July - October. Plant in areas isolated from sugarbeet production.
Brewer saltbush	<i>Atriplex lentiformis</i> ssp. <i>breweri</i>	Almost evergreen, not spiny; 5'-7' high, 6'-8' wide. Plant in areas isolated from sugarbeet production.
Mule fat	<i>Baccharis viminea</i>	6'-10' tall. Flowers March - May. Drought tolerant but looks better with occasional water.

\* This list of native species is for general information only. The Natural Resources Conservation Service does not imply or consent to the use of this information as a recommendation for species selection. Plant establishment success is not implied. Varying environmental and human factors, including, but not limited to, soil type, climate, topography, weed management, and watering regime will invariably affect the establishment of these plants.

## Shrubs (Evergreen)

Common Name	Scientific Name	Notes
Coyote brush	<i>Baccharis pilularis</i>	Tough, 4'-8' wide and high. Looks better with occasional summer water. Males flower Oct.-Nov., females Oct.-Jan.
Wild lilac	<i>Ceanothus 'Concha'</i>	Densely clad, small leaves, 6'-8' tall and wide. Flowers March-April. Infrequent summer water.
Buckbrush	<i>Ceanothus cuneatus</i>	8' tall. Flowers Feb.-April. Very drought tolerant.

## Small Shrubs/Ground Cover

Common Name	Scientific Name	Notes
Common yarrow	<i>Achillea millefolium</i>	Spreading perennial with fernlike foliage and flowers' stems up to 3', needs full sun, care-free. Flowers April-July. Tolerates dry conditions well.
Narrowleaf milkweed	<i>Asclepias fascicularis</i>	Upright perennial, 2'-3' tall with long narrow leaves, needs full sun. Flowers July-Oct. Tolerates dry conditions.
Coyote brush	<i>Baccharis pilularis</i> , compact form	Dense, 12"-18" tall with 5'-6' spread, needs full sun. Can flower Oct.-Jan. Looks better with occasional summer water.
Yankee Point Carmel creeper	<i>Ceanothus g. var. h. Yankee Point'</i>	Fast-growing, 3'-5' tall, 6'-8' wide, good ground cover, needs full sun. Flowers March-May. Looks better with occasional summer water.
California buckwheat	<i>Eriogonum fasciculatum var. foliolosum</i>	Forms 2'-5' tall, 4' wide clump, with wide, woolly leaves, needs full sun. Flowers May-Dec. Best on drier sites.
St. Catherine's lace	<i>Eriogonum giganteum</i>	Large open form, 4'-5' tall. Flowers June-Nov. Best on drier sites.

Grass (Seed combinations, totaling 15 lbs. drilled or 25 lbs. broadcast\*\*, should be mixed according to site conditions. Many species available in plugs.)

Common Name	Scientific Name	Notes
Three-awn	<i>Aristida hamulosa</i>	Warm season clumping, 10" tall. Very drought tolerant.
California brome	<i>Bromus carinatus</i>	Cool season, annual/biennial, 1.5'-3' tall. Deep soils.
Blue wildrye	<i>Elymus glaucus</i>	Cool season perennial bunchgrass, 2'-3' tall. Establishes rapidly, deep good soils.
Yolo slender wheatgrass	<i>Elymus trachycaulus majus</i>	Cool season perennial bunchgrass, 18"-4' tall, tolerates full sun to light shade. Deep good soil.
Idaho fescue	<i>Festuca idahoensis</i>	Cool season tufted perennial, 1'-2', tall. Tolerates dry conditions.
Meadow barley	<i>Hordeum brachyantherum</i>	Tufted, perennial bunchgrass, 1' tall, 8" wide. Adapted to wet conditions.
California barley	<i>Hordeum californicum</i>	Adapted to upland dry meadows, 2'-4' tall. Tolerant of winter and spring flooding.
Creeping wildrye	<i>Leymus triticoides 'Rio'</i>	Cool season, perennial, spreads by rhizomes, 2'-3' tall. Suited to wetter conditions.
Onion grass	<i>Melica californica</i>	Cool season grass growing 1'-2' tall with flower spikes, tolerates full sun to partial shaded. Well-drained soils, deep or shallow.
Nodding needlegrass	<i>Nassella cernua</i>	Cool season spreading bunchgrass, 1'-2' tall. Well-drained soils, deep or shallow.
Purple needlegrass	<i>Nassella pulchra</i>	Cool season bunchgrass, 1'-2' tall, flower stocks to 30" in spring. Widely adapted.
Foothill needlegrass	<i>Nassella lepida</i>	Cool season perennial bunchgrass, 1'- 2' tall. Adapted to dry conditions.
Pine bluegrass	<i>Poa secunda</i>	Cool season tufted perennial bunchgrass, 2.5' tall summer dormant. Adapted to shallow soils.
Squirrel tail	<i>Sitanion jubatum</i>	Cool season, clumping, 1.5'-5' tall, tolerates full sun. Dry soils.

\*\* On challenging sites (e.g. low fertility soil, steep slopes, disturbed areas), use up to 20 lbs. drilled and 30 lbs. broadcast.

### Hedgerow Installation and Maintenance Cost Estimates

For one hedgerow 1400 feet long x 15 feet wide (~ 0.5 ac.) planted with a strip of native grasses next to a line of shrubs.

*Labor Costs are estimated at \$10/hour. The source of hourly Equipment Costs is UCCE's "Sample Costs to Produce Processing Tomatoes in Yolo County--1997." For the purpose of this study, only operating costs are used to portray Equipment Costs (Repairs, Fuel & Lube).*

Task	Date	Labor	Material Cost \$/hour	Equipment Cost	Total
<b>Hedgerow Installation</b>					
Hedgerow design	6-11/96	\$260.00	Survey flags: \$8.00		\$268.00
Glyphosate: summer weed control	8/96	\$20.00	Glyphosate \$30.00	ATV+sprayer: \$8.08	\$58.08
Disc: pre-plant weed control	10/96	\$10.00		Tractor+disc: \$18.09	\$28.09
Bed preparation: plants/grasses	10/96	\$10.00		Tractor+bedshaper: \$14.33	\$24.33
Fertilize - preplant (tablets)	11/96	\$20.00	Fertilizer: \$43.50		\$63.50
Plant trees, shrubs, and forbs	11/96	\$120.00	Plants: \$500.00		\$620.00
Install 2' tree tubes	11/96	\$50.00	tree tubes: \$172.50		\$222.50
Plant grasses (broadcast)	11/96	\$20.00	Seed: \$275.00		\$295.00
Harrow to cover grass seed	11/96	\$10.00		ATV+harrow: \$4.04	\$14.04
Glyphosate: annual weed control	11/96	\$10.00	Glyphosate: \$15.00		\$25.00
Oxadiazon: apply in plant row	11/96	\$10.00	Oxadiazon: \$75.00		\$85.00
Install drip irrigation system	3/97	\$100.00	Drip supplies: \$200.00		\$300.00
<b>TOTAL INSTALLATION</b>		<b>\$640.00</b>	<b>\$1,319.00</b>	<b>\$44.54</b>	<b>2,003.54</b>
<b>Hedgerow Maintenance</b>					
2,4-D: Broadleaf weed control	3/97	\$10.00	2,4-D: \$20.00	ATV+sprayer: \$4.04	\$34.04
Hoe hedge plant row*	3-9/97	\$250.00			\$250.00
Irrigate 2X/month	3-10/97	\$250.00	Emitters/plugs: \$8.25		\$258.25
Mow grasses: annual weed cntrl	4/97	\$10.00		Tractor+mower: \$10.19	\$20.19
Remove tree tubes	4-5/97	\$20.00			\$20.00
Glyphosate: spot-spray	5-6/97	\$20.00	Glyphosate: \$15.00		\$35.00
Fertilize: preplant (tablets)	9/97	\$10.00	Fertilizer: \$8.70		\$18.70
Replant trees, shrubs & forbs	9/97	\$80.00	Plants: \$100.00		\$180.00
2,4-D: spot-spray in grasses	9/97	\$10.00	2,4-D: \$10.00		\$20.00
Flame: annual grass weed cntrl	10/97	\$10.00	Propane: \$15.00	ATV+flamer: \$4.04	\$29.04
Oxadiazon: entire hedgerow	10/97	\$20.00	Oxadiazon: \$225.00		\$245.00
Mow grasses 2X: weed control	3-5/98	\$20.00		Tractor+mower: \$20.38	\$40.38
Hoe hedge plant row	3-5/98	\$120.00			\$120.00
Irrigate 2X/month	4-9/98	\$200.00			\$200.00
Hoe hedge plant row	6-7/98	\$120.00			\$120.00
Herbicide: 2,4-D (in grasses)	8/98	\$10.00	2,4-D: \$10.00		\$20.00
<b>TOTAL MAINTENANCE</b>		<b>\$1,160.00</b>	<b>\$411.95</b>	<b>\$38.65</b>	<b>\$1,610.60</b>
<b>TOTAL COST</b>		<b>\$1,800.00</b>	<b>\$1,730.95</b>	<b>\$83.19</b>	<b>\$3,614.14</b>

\*Use of Oxadiazon in plant row reduced hoeing cost by one-half compared to non-Oxadiazon sites.