

Bring Farm Edges Back to Life!

Landowner Conservation Handbook

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Bring Farm Edges Back to Life!

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Introduction

Every farmer has them: odd corners, strips of field, or ditch banks that are too awkward to farm economically. But you can't just let them sit or they become noxious weed patches that compromise your operation. They typically have to be mowed, scraped, sprayed and/or disked several times every year. That's costly maintenance for a weed patch.

The Yolo County Resource Conservation District (RCD) recommends an alternative protocol for these spaces that not only suppresses weeds with less annual maintenance, but stabilizes the soil and brings wildlife and beneficial insects back to your farm. Using native perennial grasses, flowers, shrubs, and trees, you can turn your farm edge liabilities into assets. In this booklet you will find proven techniques for establishing hedgerows, tailwater and wildlife ponds, and permanent non-weedy vegetation on roadsides, canal banks, field edges and creeks.

Over the years, local farmers and landowners have experimented with different conservation practices on their farms that would enable them to meet the multiple objectives of conserving soil and water and improving wildlife habitat while maintaining intensive agricultural production. The practices detailed in this booklet are products of the trials and successes of their efforts to integrate on-farm resource management. All of these practices are possible and easy to implement with basic farming or landscaping equipment. Of course, they do



Western Yolo County

cost time and money. This book contains sections that detail the typical costs of these practices and ways to get private and public cost-share support to implement them. If you have any questions about the information included, please feel free to call us. We're happy to provide planning assistance to help you in your efforts to bring your farm edges back to life!

About the Yolo County Resource Conservation District

Our name sounds official, but our activities aren't. We don't regulate or mandate. Bridging agricultural issues with science, education, and government, the RCD is an information network between landowner resource problems and the best solutions.

The Yolo RCD recognizes farmers and ranchers as key players in all real-world solutions. Because our directors are local producers who know farming, business, and resources, we work to assure community context and relevance, acting as a filter and network for ideas, training, outreach, and partnerships between land and resource users, specialists, regulators, and funders.

The RCD is committed to local control, believing the more we learn about our resources, the more we control our own backyard. The more we work with our neighbors, the less we face outside regulatory solutions that don't work. To this end, we are working to integrate resource management solutions that will:

- Reduce losses of habitat and diversity, both in wildlife and plant species.
- Bring together parties with common goals and interests.
- Create integrated management models to encourage best "multiple" resource use.
- Prevent pollution of waterways and groundwater from pesticide run-off, sediment, and nutrient buildup.

Making Wildlife Habitat and Clean Farming Compatible

John Anderson, Hedgerow Farms

Farmers, land managers, and agricultural advisors have begun to realize the long-term impacts of the traditional approach of “clean farming.” The practice of keeping all land that isn’t planted to a crop either scraped or sprayed clean has resulted in cumulative soil losses and sediment buildup in unwanted areas. In most cases, attempts to keep ground “clean and bare” are unsuccessful, and they instead turn into reservoirs of unwanted weeds and thus seeds that then spread into the cropland. The results include a great monetary cost to the farmer, a cost to the land in the proliferation of weeds and other problems, and an overall loss of valuable habitat.

We all hear increasing complaints from many quarters about the negative impact of modern agricultural practices on the environment, especially on surface and ground water quality. Are there farm-friendly solutions to these challenges that do not threaten productivity and that help reduce erosion, improve water quality, and save labor or chemical costs in the long run? Have we forgotten that the goal of “clean” farming means weed-free, not vegetation-free?

Current clean farming practices in most of Yolo County’s intensively farmed areas are dramatically reducing or eliminating wildlife habitat within the agricultural systems. The impulse to maintain borders, berms, and roadsides without vegetation, as well as use all available farmland for production, results in a brown, barren, landscape that lasts from plowdown in the fall until spring planting. One impact of successful farming is the unfortunate, lifeless state of vast acres once so important to the myriad of species that inhabited the Sacramento Valley. More and more, “productivity” is judged by measuring only intensely cultivated monocultures.

In our view there is no inevitable, long-term conflict between good farming and biodiversity. Quail, raptors, and pest-eating bats are less apparent in many sites. How often does one see a snake or toad on the road anymore? Threats to biodiversity come not so much from increased traffic, but from a lack of natural habitat. When farmers believe that only one version

of “clean farming” is economically viable, one result is a lack of habitat.

The number one reason for bare dirt clean farming is to control the invasion of noxious weeds. This is certainly a valid concern since any area of bare and disturbed soil will be rapidly colonized by a host of nasty and unsightly vegetation. Star thistle, puncture vine, Johnson grass, bindweed, and mustard are but a few of the undesirables that we continually spray, disk, and scrape to eliminate. The number two reason for bare dirt clean farming is that it has become the accepted, automatic practice. Border vegetation implies sloppy farming—what will the landlords, neighbors or bankers think?

What can be done to reverse the current scenario without impacting the agricultural livelihood of the valley? Certainly most farmers appreciate wildlife and evidence suggests that a biodiverse border of plant species provides habitat for many beneficial insects and predators (such as raptors, bats and reptiles). Instead of a high maintenance, bare dirt system, we propose a balanced, self-sustaining perennial grassland that outcompetes any weedy invasion. Corridors of mixed native perennial grasses along roadsides, berms, ditch banks, canals, field borders, and any non-cropped area, provide excellent year-round habitat for wildlife without a negative impact on overall farming practices. Incorporating patches of native shrubs and/or trees into these corridors greatly increases the biodiversity and habitat value.



Hedgerow Farms, Yolo County

These concepts are widely practiced in Midwestern farming areas but have not yet been accepted by the California Valley farmers. Can it be done? Hedgerow Farms, located between Winters and Madison, has been incorporating and testing habitat corridor systems since 1978. Without question, native grasslands provide weed and erosion control, reduce maintenance, and greatly enhance the biodiversity and aesthetics of the farm. Over 100 species of birds use the farm throughout the year and dozens of rooster pheasants and dove are harvested during the hunting season. We now have a well-established quail population and have documented a myriad of songbird and beneficial insect species.

Neighbors Bruce and Charlie Rominger, who farm ground adjacent to the corridors, have not seen any significant negative impact on their crop production. In fact, the most difficult aspect of farming with corridors is training tractor drivers to recognize the borders and avoid disking over newly-established vegetation. We have also found that overall herbicide application decreases. The steps toward shifting away from a clean-farming approach are easy, especially for a farmer. It is simply a matter of farming the corridor to get it established.

A wide variety of native and non-native perennial grass seed is now available. Establishing a stand is similar to growing wheat or barley. Because perennial grasses grow much slower, weed management in the first year is very important. Timing of planting, selective herbicide application, and mowing are all important tools for success. The slow-growing establishment period explains why these grasses are not invasive weeds, and perhaps why they disappeared from much of California's agriculturally-impacted areas.

In short, mixed plant field corridors are certainly a reasonable, workable compromise that could become normal, cost-effective practices for good farmland stewardship. The visual image of clean farming for the future should be borders of perennial grasslands, not lifeless borders of bare dirt. Weed-free does not mean vegetation-free. With the use of mixed plant field corridors, environmental quality and quality of life would be significantly enhanced, especially for those of us that live and work in the agricultural landscape.

Direct Seeding of California Native Grasses in the Sacramento Valley and Foothills

John Anderson, Hedgerow Farms

A mature stand of California native grass provides a robust, self-sustaining vegetation system with multiple benefits to the environment and land management. Unfortunately, early attempts to establish native grasses did not succeed, often due to inappropriate species selection and inadequate weed control before and after planting. Because targeted planting areas frequently contain high density weed seed banks, weed control is the major challenge during the first few years.

Introduction

What follows is a summary of techniques to establish native grasses by direct seeding in the Sacramento Valley and foothills north of Winters in Yolo County. Average yearly rainfall is about 17 inches and soil types vary from Class 1 silty clay loam to Class 4 gravely clay loam with underlying hard-pan. All areas have undergone continuous or intermittent tillage over the past 20 years. These techniques follow basic agronomic principles used to establish other perennial plantings, such as permanent pasture and sod. While all specified techniques have been field-tested in various areas, each site is different. Thus, these techniques are intended as guidelines rather than strict recommendations for all situations.

SELECTION OF SPECIES

Careful selection of appropriate species (perhaps even species ecotypes) for each site and soil quality is of primary importance. Since over 30 species of native grasses are now available from commercial growers, soil type, rainfall, exposure, heat, cold, and flooding tolerance are environmental and climatic factors that determine the best choice of grasses. Soil quality is the prime variable. While species original to the site would be the best choice, in many areas the complete loss of natives makes this a matter of guesswork. Studying remnant stands and documenting the outcome of recent plantings are beginning to provide needed information.

WEED PROBLEMS

Weed competition is the major reason for failure to establish native grasses from seed. Many native grass seedlings have low vigor and are slow to germinate and grow, especially for the long-lived, highly-desirable *Nassella*, *Melica*, *Poa*, and *Festuca* species. By contrast, weedy annuals have short germination periods, high seedling vigor and rapid growth following the first germinating rains in the fall. Additionally, weed seed density is usually very high, with some estimates as high as 10,000 plants per square meter. Thus, weedy annuals can overwhelm the hardiest of the natives even when densely seeded. Unfortunately, in large areas, high rate seeding can be prohibitively expensive.

To be successful, slow-growing native seedlings need time, sunlight, moisture, and nutrients to mature. The most rapidly growing species, *Elymus*, *Hordeum*, and *Bromus*, require at least two years to mature in ideal conditions. The *Nassellas* and *Melics* may require three to four years. While native grasses may require vigilance, they also require no more than standard agricultural methods and tools for reaching planting, establishment, and maintenance goals.

HERBICIDES, TILLAGE AND MOWING

Herbicides are often part of a successful management strategy. Herbicides provide cost-effective solutions to serious weed problems that often plague a grass stand. Appropriate chemicals, especially when integrated with other advanced technologies, provide important tools in the restoration of various altered ecosystems now infested with exotics.

If herbicides are considered undesirable, well-timed cultivations before a planting can greatly reduce the weed seedbank, especially if rain or irrigation has caused a good germination. After planting, a grass stand can be mowed when annual grass or broadleaf weeds are flowering but before seeds are mature. This can eliminate this new set of seeds from the weed seedbank and give the perennials a greater competitive advantage.

PRECAUTIONS

Always observe proper and safe use of herbicides, including safety to humans and to the environment. Read herbicide labels carefully, following all restrictions according to county, state, and federal regulations. Note that permits are required for all large scale pesticide use. Information on the safe handling and use of pesticides is readily available from each county agricultural commissioner's office and agricultural extension agents. Though initially daunting, using herbicides correctly can be learned by a non-expert. If you don't want to do the job yourself, licensed Pest Control Advisors (PCA) and Pesticide Control Operators (PCO) can be contracted privately or through local agricultural chemical distributors. Many landscape contractors also perform the necessary services.

Seedbed Preparation and Weed Reduction Strategies

Weed identification on the site is *critical* in planning management strategies.

COMMON WEEDS

Annual grasses such as Wild oat (*Avena fatua*), Ripgut brome (*Bromus rigidus*) and Annual ryegrass (*Lolium multiflorum*) are some of the most widespread and troublesome. They germinate early and grow very rapidly. High densities of other annual grasses, such as Soft chess (*Bromus mollis*) and annual or Rattail fescue (*Vulpia myuros*) can be equally aggressive and suppressive. When grasses predominate the weed flora, it is very important to adhere to the pre-plant strategies outlined. Broadleaf weeds can be managed with a wide variety of post-emergent selective herbicides that do not affect the grasses. Yellow starthistle (*Centaurea solstitialis*), Prickly lettuce (*Lactuca serriola*), mustards (*Brassica* spp.), knotweed (*Polygonum aviculare*, *P. erectum*), and many more can be effectively managed with broadleaf herbicides.

GOALS

Initial seedbed preparation goals are simple: decrease the weed seed bank and till the soil for seeding. Starting one year prior to seeding is ideal. A controlled burn in spring will kill developing weeds and eliminate a new generation of weeds seeds and litter. By the following March or April, spring disking or tilling

will reduce the number of winter-growing weeds that set seed. The area should be left fallow during summer and tilled or sprayed with herbicide, as necessary, to eliminate late-germinating weeds. One advantage of this spring-summer fallow technique is that deep soil moisture is conserved for the following fall planting. Finally, seedbed preparation may require smoothing with a land plane or scraper and roller if soil clods are large. Rolling with a ring roller provides compaction that will maintain good soil moisture following the first fall or winter rains.

INITIAL WEED CONTROL

Although the seedbed is now physically ready to be seeded, it may be necessary to control a huge, shallow reservoir of weed seeds near the soil surface. After germinating rains in October or November, weeds can be eliminated with glyphosphate, very shallow harrowing, or flaming. You want to reduce immediate weed competition without bringing weed seeds to the surface. Herbicide use or flaming is most effective. If germinating rains are late, it may be necessary to plant before weeds have emerged, (i.e. 7-10 days after germinating rains). In this case, seed can be planted and weed seedlings sprayed with glyphosphate prior to native seedling emergence. Germination of native grasses takes at least two weeks in late October or early November and up to four weeks if planted later. Monitoring germination progress by digging up planted seeds and watching for germination is critical; as soon as a radical begins to emerge from the native seed, it is time to spray.

Soil tillage is not always necessary, especially where areas have been previously dry farmed such as CRP ground in low elevation foothills. A late summer or early fall hot, controlled burn will eliminate deep thatch and a large number of the surface weed seeds. Following the first rains, seed may be drilled directly into the ground (using a no-till drill) and glyphosate will kill the first flush of weeds either at the time of planting or just prior to native seedling emergence. A variation would be to burn after the first germinating rains at a time when the burn will kill the first germinating weeds. Follow by drilling in the native seed. This technique would eliminate the first fall herbicide. While we have been successful with some no-till plantings, others have been failures and this appears to be related to soil type, especially shallow hard-pan clays.

PLANTING OPTIONS

The “best” time to plant seed is not well documented. The standard is to seed prior to mid-November to maximize first year growth before summer dormancy.

EXPERIENCES

Unfortunately, the first germinating rains may not occur until December. In 1991 and 1992, several December and early January seedings were successful, especially on good soils, but late plantings are not without risks. Wet, cold soil conditions can rot seed and a hard freeze can cause high mortality in young seedlings. During the wet winter of 1992-1993, monoculture seed production plantings of *Nassella cernua* and *Nassella lepida* failed after being seeded in late November into heavy, Class 2 soil. On the same site and seeded at the same time, *Nassella pulchra*, *Melica californica*, *Elymus glaucus*, and *Hordeum brachyantherum* established excellent stands. *Poa secunda* and *Festuca idahoensis* had intermediate success, presumably due to dampoff.

We have performed several large seedings in mid to late January with mixed success. One advantage of later seeding is better control of weeds. A later planting date allows more surface weeds to germinate prior to seeding. By waiting, however, wet conditions may prevent access to the site. Another risk of late seeding is the potential cessation of rains before the grass has enough growth to establish. If an area can be irrigated in the spring or if the soil will hold deep moisture well into June, a late January or early February seeding can be very successful. An additional benefit is that newly-germinated seedlings will not be subject to a slow growth phase in December when significant mortality may occur.

SEEDING TECHNIQUES

Seeding techniques depend on terrain, size of the area, and availability of seeding equipment. The two basic techniques we use are broadcast seeding and precision drilling. Hydroseeding and spreading native grass straw are other techniques that can be effective, especially in small areas.

EQUIPMENT

The long awns of many native grass seeds (*Nassella*, *Hordeum*, *Elymus*, *Bromus*, *Aristida*) frequently cause bridging in standard seeding

equipment. Many standard range drills, as well as broadcast seeders, are not satisfactory without additional mechanical agitation. No-till range drills designed to handle fluffy, “chaffy” seeds are now available and should be used for large acreage seeding (Truax, Inc., Great Plains Manufacturing, Inc.). The Truax drill, designed for prairie restoration in the mid-western states, is ideally suited for the hard-to-handle California natives. The other advantage of using drills is that much less seed is required. This is significant because many California natives are still very expensive.

SEEDING TECHNIQUES

Broadcast seeding followed by shallow harrowing and cultipacking is very effective, especially on well prepared soil. Recently, we have been using a flexible tine harrow (Fuerst) and have found it extremely versatile. A small one can be pulled by a standard ATV and small areas such as steep roadsides and ditch banks may be easily and rapidly harrowed to cover the broadcast seed. In small or inaccessible areas, four pronged cultivator rakes can be used to agitate the soil and cover the seed.

SEED MIXTURES AND RATES

Although more information is needed to set standards for seed mixtures and seeding rates, an updated list of mixes and rates is included at the end of this article.

Strategies for Seeding Mixtures

Many seed mixtures, used where rapid erosion control is important, have included high percentages of annual grasses and total seeding rates of 30-40 pounds per acre. The slow-growing perennials have a slim chance of survival due to the competition from the annuals. Similarly, in a native perennial mixture, the more rapidly growing species have the potential to outcompete the slower growing species if the proportions greatly favor the former. This is frequently the case since the slow growers tend to be more expensive. Our current strategy is to give each species in a mix an equal chance to get established. By using live seeds per pound for each species, coupled with our limited knowledge of seedling survival for each species, we are now formulating mixtures based on a live seeds per square foot basis.

INFLUENCE OF HABITAT

Obviously, the choice of species depends on the habitat being mirrored or restored and other planting goals. For example, short species may be more desirable on a roadside or canal bank, whereas taller species would be more appropriate for habitat areas. Again, soil type and condition are very important considerations. Most species thrive on good loamy soil and the lesser quality soils will tend to eliminate species not adapted to them. In many situations we use “best guess” mixtures, anticipating that the most appropriate species will thrive and become self-perpetuating.

Post-Planting Management

YEAR 1

By February or early March, while grass seedlings should be up and growing, so will a new flush of weeds. Many of these weeds may be insignificant or perhaps even desirable forbs, but others could pose threats to establishment. Access to sunlight is the most critical factor for the small grass seedlings. Star thistle, Bull thistle (*Cirsium vulgare*), and mustard will grow quickly and, if abundant, can over-top and shade out the slow growing perennials. Knotweed is a very common low-growing annual that starts germinating in late February. If not controlled, it may smother perennial seedlings by June. Late-germinating grasses such as Annual ryegrass, Wild oats, Canary grass (*Phalaris minor*) and others can do the same. Weed management options include use of selective herbicides, wick herbicides, and mowing. In range situations managed grazing is also an option.

Selective herbicide spraying for broadleaf weeds is most effective when the weeds are small, generally by February to mid March. Perennial grasses must be past the 3-leaf stage before application. Wick application of glyphosphate consists of wiping a concentrated solution on the tops of tall weeds while leaving shorter perennials untouched. The wick is an absorbent material or rope that is in contact with a reservoir of herbicide solution. This technique works especially well with weedy grasses, but can also be used for broadleaf weeds in small areas. Hand-held wick applicators are available through many garden suppliers. Tractor-mounted wick applicators for large areas are available from distributors of agricultural spray equipment.

Depending on weed type, density and location, mowing alone, or mowing combined with herbicides, offers excellent control of late-season weeds. Be aware that some species, such as Annual ryegrass, Yellow starthistle, and Foxtail barley can produce seed heads low to the ground following mowing. Mowing alone has been successful in cooler coastal areas but we have experienced mixed results in the Central Valley, and little success when weeds are dense. Mowing in late February through April reduces the height of weeds, giving young perennials access to light. Mowing should not be lower than 3-4 inches. If mowing alone is used, a second mowing is usually needed in May or early June.

Haying (cutting and baling) the site before weed seeds shatter removes weed seed that would contribute to the soil seed bank. Haying also removes the cut biomass that would shade growing perennials. This is an excellent option that also produces a usable hay crop. Grazing the establishing grassland in spring of the first year can help reduce fast-growing competitive annual grasses. It both mows and removes potential thatch and when animals are managed properly, results can be very successful.

YEAR 2

Second-year management frequently continues the battle against annual weeds. Weed seeds remain in the soil and many are viable for many years. Yearling native grasses do not yet have the competitive biomass to inhibit weed growth and shading the young perennials can eliminate them. Management practices include pre-emergent herbicides, post emergent herbicides, mowing, grazing, and fire. Pre-emergent herbicides prevent seed germination and seedling establishment. Applied in fall to a first-year stand of native grasses, pre-emergents aid weed control, especially when Annual ryegrass, Ripgut brome, Foxtail barley, and Wild oats have been present in high density for a number of years. There are many pre-emergents available and we are in the process of testing their efficacy for native grasses. First-year native grasses, unlike second- and third-year stands, are easily injured and it is important to use the proper material and rates. An article by Tom Lanini et. al. in the September 1996 edition of *California Agriculture* details a study of preemergence herbicides and perennial grasses.

Selective herbicide application, mowing, and grazing during the second year are similar to the first. Trained persons with four gallon backpack sprayers may cover large areas, eliminating hot spots of weeds while not affecting surrounding flora. Warm season perennial weeds, such as Johnsongrass (*Sorghum halepense*) and Bermudagrass (*Cynodon dactylon*) are controllable by spot spraying.

Fire is a post-establishment management tool whose exceptional value is verified by the midwestern prairie restorationists who rely on burning. Because most low elevation grasslands evolved with fire, established perennial grasses rebound after fire while weed seeds are destroyed. In California bioregions, frequency and timing are the important factors; their benefit or detriment on native grasses varies from species to species. Burn research by The Nature Conservancy in the Jepson Prairie and the Santa Rosa Plateau has shown the best overall weed suppression and lowest mortality rate of native perennial grasses with late spring burns not applied more than once every two to three years. Burning can also affect native annual forbs positively or negatively, so a burn regime must be



Prescribed burn in grassland

tailored to the plant species you are managing. The Nature Conservancy is an excellent resource in this regard and can be contacted at The Nature Conservancy, California Field Office, 201 Mission Street, 4th Floor, San Francisco, CA 94105, tel: 415.777.0487.

Another strategy is late spring burns in these natural areas. This appears to significantly reduce annual

competition by killing unshattered seeds. Burn guidelines will soon be coming from these sources.

YEAR 3 AND BEYOND

A frequently-asked question is how long newly established, weedy sites require intensive management before they become self sustaining. Findings are not yet conclusive, but a reasonable estimate would be 3-6 years. Periodic management will always be required. Certainly, intensive herbicide use will be unnecessary over time, but grazing, mowing, and burning will be an important part of long term management in most areas. Grazing and burning will continue to be the most cost effective on the larger areas. Mowing farm corridors, sloped ditches, and roadsides is easy in agricultural environment and certainly more cost effective than disking and herbicides.

Concluding Remarks

Since 1989 we have been successfully planting native grasses on roadsides, canal banks, farmland hedgerows, riparian restoration sites, wetland habitat areas, and upland meadows. The total area to date is approaching 500 acres in our area of Yolo County.

Having begun with only a few grass species, we now work with over 20. Our gauge of success is a weed-free and biodiverse grassland that is self-perpetuating and sustainable. Only now are we appreciating that it is working. We are still experimenting, learning from mistakes, and establishing what works best. We are certain that there will be continuing modifications to practices and approaches as more and more farm sites *become* homes for native vegetation.



Native grasses stabilizing an irrigation canal bank

Native Grass Seed Mixes

Examples only. Mix should be customized per site. Seeding rates are for drill seeding into well-prepared soil. Rates should be increased for broadcast seeding.

VALLEY DRYLAND MEADOWS ON GOOD SOIL (ALSO HEDGEROWS, EQUIPMENT YARDS, BORDERS, ODD CORNERS)

Species	Common Name	Ht	GF	Approx Live Seed/lb.	Rate lbs/acre	Approx Seeds/sq. ft.
<i>Nassella pulchra</i>	Purple Needlegrass	TI	B	70,000	6.0	9.6
<i>Melica californica</i>	Onion grass	I	BR	240,000	2.0	11.0
<i>Elymus glaucus</i>	Blue wildrye	T	B	110,000	2.0	5.1
<i>Leymus triticoides</i>	Creeping wildrye	T	R	120,000	2.0	5.5
<i>Elymus trachycaulus</i>	Yolo Slender wheatgrass	T	B	80,000	2.0	3.7
<i>Bromus carinatus</i>	California brome	T	B	64,000	1.0	1.5

DRY ROADSIDES- NEXT TO PAVEMENT BERM

Species	Common Name	Ht	GF	Approx Live Seed/lb.	Rate lbs/acre	Approx Seeds/sq. ft.
<i>Nassella pulchra</i>	Purple Needlegrass	TI	B	70,000	5.0	8.0
<i>Nassella cernua</i>	Nodding needlegrass	I	B	185,000	3.0	10.7
<i>Nassella lepida</i>	Foothill Needlegrass	S	B	350,000	2.5	20.1
<i>Hordeum californicum</i>	California barley	S	B	140,000	2.5	8.0
<i>Poa secunda</i>	Pine bluegrass	S	B	600,000	2.5	34.0

DRY ROADSIDES-SWALE AND OUTER BERM

Species	Common Name	Ht	GF	Approx Live Seed/lb.	Rate lbs/acre	Approx Seeds/sq. ft.
<i>Nassella pulchra</i>	Purple Needlegrass	TI	B	70,000	6.0	9.6
<i>Elymus glaucus</i>	Blue wildrye	T	B	110,000	2.0	5.1
<i>Leymus triticoides</i>	Creeping wildrye	T	R	120,000	2.0	5.5
<i>Hordeum brachyantherum</i>	Meadow barley	S	B	75,000	4.0	6.9

VALLEY WETLAND BERMS AND EDGES/RIPARIAN (TOLERANT OF SHORT DURATION FLOODING)

Species	Common Name	Ht	GF	Approx Live Seed/lb.	Rate lbs/acre	Approx Seeds/sq. ft.
<i>Elymus glaucus</i>	Blue wildrye	T	B	110,000	5.0	12.6
<i>Leymus triticoides</i>	Creeping wildrye	T	R	120,000	4.0	11.0
<i>Elymus trachycaulus</i>	Yolo Slender wheatgrass	T	B	80,000	3.0	5.5
<i>Hordeum brachyantherum</i>	Meadow barley	S	B	75,000	4.0	6.9

KEY

Ht	plant height	GF	growth form	T	tall	B	bunching
I	intermediate	R	rhizomatous	S	short		

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.

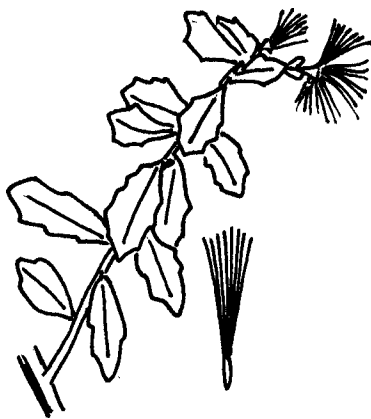
Another important factor in site selection is vulnerability to flooding and/or standing water. As previously discussed, many native plant species are very sensitive to overwatering, and if a site is known for its tendency to flood or have standing water during the winter months (or due to overwatering 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 fenceline

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												
Silverlace vine												
Toyon												
Golden sticky monkeyflower												
Elderberry												
California Buckwheat												
Deergrass												
Creeping boobiialla												
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

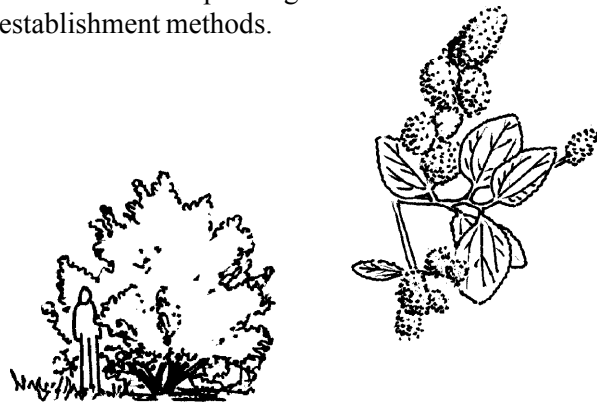
After the initial spraying of glyphosphate after planting, you must carefully monitor weed pressure in native grass stands. In most cases, winter annuals such as annual rye grass, chickweed, yellow star thistle, annual sow thistle, wild oats, and mustard species can be prevalent and cause major problems. 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

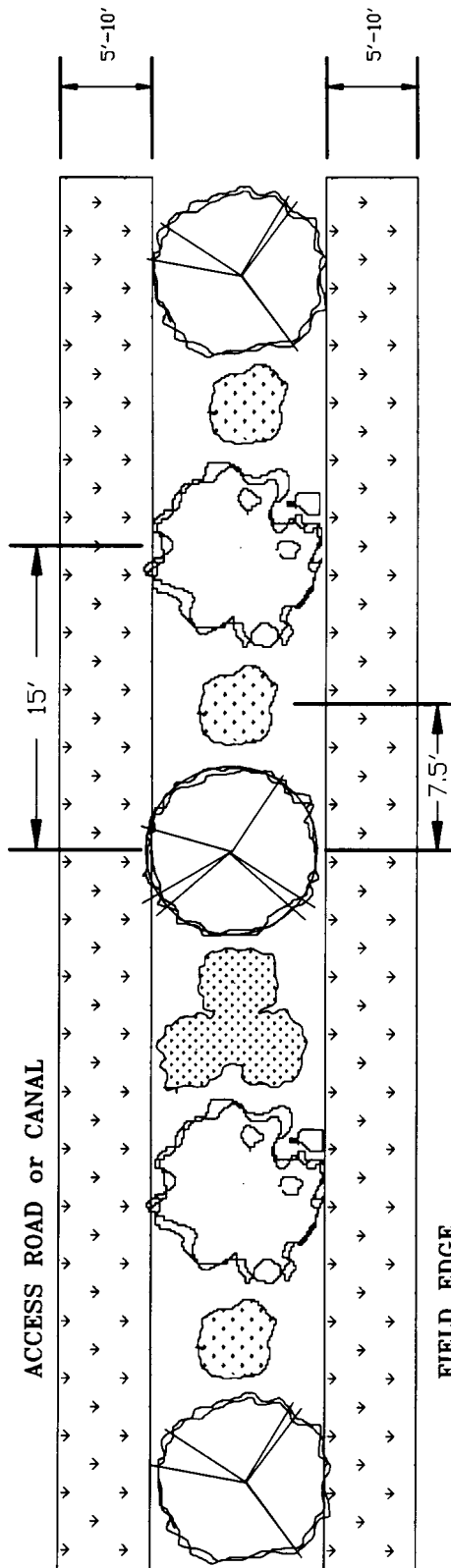
Find out the water needs of your plants from your supplier. Native grasses do not need summer watering because they become dormant at that time. Most shrubs and trees will need watering about every 2-4 weeks during drought months (March-November, depending on the year). After the 2-3 year establishment 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

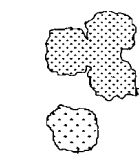
Jae Lee, NRCS



- Optional Tree Species for Larger Areas**
- Red willow
 - Black willow
 - Fremont cottonwood
 - Valley oak
 - California sycamore
 - California box elder
 - California buckeye

- Perennials**
- Yarrow
 - Narrowleaf milkweed
 - California buckwheat
 - St. Catherine's lace
 - Deergrass

- Native Grass Mix**
- Purple needlegrass
 - California oniongrass
 - Blue wildrye
 - Creeping wildrye
 - Slender wheatgrass
 - California brome
 - Meadow barley



- Deciduous Shrubs**
- Elderberry
 - Mulefat
 - Buttonbush
 - Western redbud

- Evergreen Shrubs**
- Coffeeberry
 - Toyon
 - Coyotebrush
 - Hollyleaf cherry
 - 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> <i>ssp. 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</i> 'Concha'	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</i> g. var. <i>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</i> var. <i>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</i> 'Rio'	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
Hedgerow Installation					
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
TOTAL INSTALLATION		\$640.00	\$1,319.00	\$44.54	2,003.54
Hedgerow Maintenance					
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
TOTAL MAINTENANCE		\$1,160.00	\$411.95	\$38.65	\$1,610.60
TOTAL COST		\$1,800.00	\$1,730.95	\$83.19	\$3,614.14

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

Roadside Establishment of Native Perennial Grasses

Jeanette Wrynski, Yolo County RCD

Perennial bunchgrasses that are native to California can go a long way toward helping solve a series of problems associated with roadside maintenance. At the same time, they can improve the appearance of a part of rural landscapes that are typically weedy in one season or scraped bare in another.

Most road rights-of-way, whether county roads, state highways or interstate freeways, are covered with vegetation that consists primarily of noxious, invasive weeds. These weeds are considered to be a problem source of weed seeds that move into agricultural fields—resulting in herbicide treatments—and continue to reinfest the same roadsides. Efforts to clean up the roadsides usually involve multiple herbicide sprays and/or scrapings. These measures either contribute to pesticide runoff into waterways or leave soil stripped bare and subject to erosion during winter storms or heavy winds.

Bunchgrasses can be very effective competitors with these noxious weeds through shading and competition for nutrients. Their extensive root systems anchor soils during erosive rainstorms, keeping road shoulders more stable and firm, and provide pathways for surface water to percolate into the soil.

In addition to these benefits, native bunchgrasses also provide excellent wildlife habitat, encouraging greater biodiversity. Mature stands of these grasses can harbor a large variety of small mammals, reptiles, game birds, songbirds and insects - including important food crop pollinators.

Establishment

Establishing native grasses requires using some standard farming practices for the first few years. Because of their slow germination, low seedling vigor and slower growth rates, they must be managed as many agricultural crops are with efforts made to reduce competition by more vigorous, non-native, annual weeds. Reduction of weed competition is so important that the process could be started up to a year in advance of the actual planting.

One way to begin site preparation is with a controlled burn in the summer or fall to destroy surface weed seeds and trash. Weeds that germinate later through the winter and spring can be disked under in March or April, before they set seed. The area should be left fallow throughout the growing season, but any additional weeds that germinate should be controlled either with herbicides sprays, tillage, or burning before seeds are mature. Final seedbed preparation in the fall, done by disking or other tillage equipment, may also serve to remove persistent weeds. If clods are large, a scraper or roller may be needed to provide seedbed uniformity and to close up air spaces so as to help conserve soil moisture.



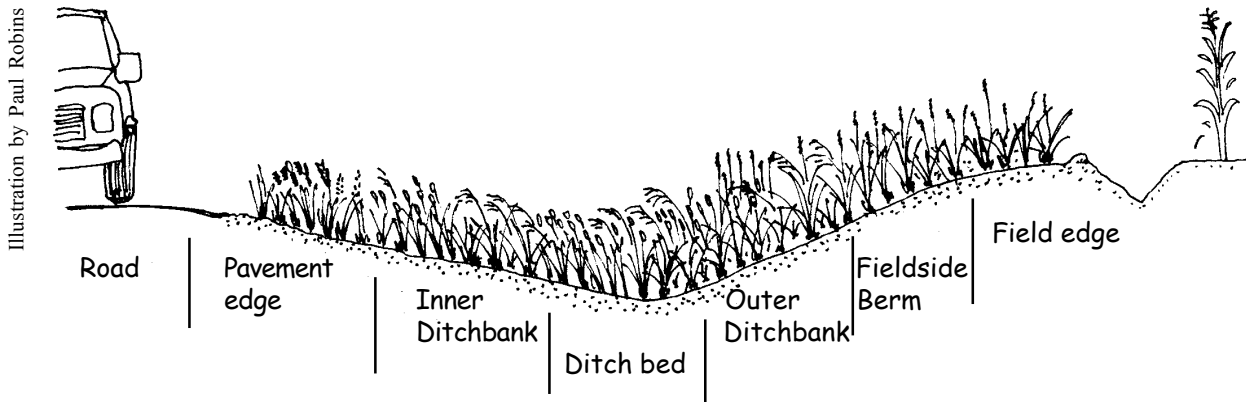
Illustration by Paul Robins

The type of seed selected or the mixture of species will depend on location, soil type and moisture conditions expected throughout the season. Suppliers of native grass seed can provide good information on species to select for different situations. A mixture of varieties, with differing moisture adaptations, is often recommended for roadsides where a ditch or swale is present. Grasses suited to drier conditions will predominate on the higher ground, whereas those that tolerate occasional flowing water will thrive in the lower areas.

Seeding is usually done in the fall, to allow rains to provide the moisture needed for germination. Seed can be drilled directly into the seedbed, as prepared, or into soils managed under no-till situations. Where no-till management has been used, weed control before and shortly after planting can and should be accomplished with herbicides or burning.

Broadcasting is another means of planting native grass seed. After seeding by this method, a light

Cross-section of roadside habitat with sample selections.



Pavement edge: California barley (*Hordeum californicum*), Pine bluegrass (*Poa secunda*), Purple needlegrass (*Nassella pulchra*), Nodding needlegrass (*Nassella cernua*), California oniongrass (*Melica californica*).

Roadside berm and inner ditchbank: California barley, California oniongrass, Meadow barley (*Hordeum brachyantherum*), Nodding needlegrass, Pine bluegrass, Purple Needlegrass, and Squirreltail (*Elymus elymoides*).

Ditch bed: Meadow barley, Purple needlegrass, and sedges and rushes.

Outer ditchbank and fieldside berm:

Deep, Good Soils: Blue wildrye (*Elymus glaucus*), Purple needlegrass, Slender wheatgrass (*Elymus trachycaulus* ssp. *trachycaulus*), California barley, and Deergrass (*Muhlenbergia rigens*).
 Poor Soils: Purple needlegrass, Nodding needlegrass, California barley, and Pine bluegrass.

Field edge: Creeping wildrye (*Leymus triticoides*).

harrowing and rolling is usually necessary in order to cover the seed and settle it well into the seedbed. Mulching lightly with native grass straw is often done to seeded areas to aid in erosion control as well as keeping the seedbed moist during dry periods.

Maintenance

Germination of native grass seeds usually occurs in about two weeks for early fall plantings when temperatures are warmer. Later plantings may take up to four weeks. Spraying of any non-selective herbicides for weed control must be done before the young seedlings emerge. Afterwards, weed control options include selective herbicides, rope-wick applications, or timed mowings that will affect taller annual weeds, reducing their canopy and allowing the shorter, less vigorous natives greater access to sunlight.

Long-term maintenance of native grass stands is mostly weed control. This is needed for 2-6 years, depending on the grass species, conditions, and prior weed levels. However, after 3-4 years, when the perennials are well-established, maintenance needs should be minimal. Grazing, mowing and burning are effective, low-cost options for vegetation management. An annual, well-timed treatment may be sufficient to maintain these grasses at a desired height or to reduce dry matter. This type of long-term management could ultimately cost less than the repeated sprays and cultivations traditionally used for roadside weed control.

The table on the following page summarizes the management steps needed for the establishment of native, perennial bunchgrasses along roadsides over a three-year period. Ideally, weed control should start up to one full year in advance of planting.

Native Grass Establishment Schedule

Year 1

Month	Project	Description
March-September	Prepare Seed Bed	<ul style="list-style-type: none"> • disking in spring and/or burning in fall removes weeds and prepares the soil for planting
September-March	Seeding & First Weed Control	<ul style="list-style-type: none"> • drill or broadcast and harrow seed • spray glyphosphate on 1st flush of weeds before native grasses emerge
February-March	Broadleaf Weed Control	<ul style="list-style-type: none"> • spray phenoxy herbicides to eliminate broadleaf weeds in planted area
March-June	Late Grass Weed Control	<ul style="list-style-type: none"> • mow, hay, or lightly graze planted area to remove annual grasses before they go to seed

Year 2

October-December	Fall Weed Control	<ul style="list-style-type: none"> • pre-emergent herbicides (consult Ag Extension) or a broadleaf herbicide after weed emergence
April-June	Spring Weed Control	<ul style="list-style-type: none"> • broad-leaf herbicides, mowing, burning, or grazing can be used, depending on the weeds that are present

Year 3 and Beyond

October-November	Fall Weed Control	<ul style="list-style-type: none"> • pre-emergent herbicide or burning
April-July	Spring or Summer Management of Grasses	<ul style="list-style-type: none"> • mowing, burning, or grazing (grass lands are healthiest when these management practices are alternated from year to year)

Grassed Roadside Installation and Maintenance Cost Estimate (1999)

For one mile of roadside, 15 feet wide (approx. 1.8 acres)

	Cost/hr.		Time		Total Cost	
	Low Range	High Range	Low Range	High Range	Low Range	High Range
Installation						
Earthwork*	\$70.00	\$70.00	2	8 hrs.	\$140.00	\$560.00
Bed preparation	50.00	50.00	2	4 hrs.	100.00	200.00
Pre-plant Herbicide		60.00	0	0.5 gal.	30.00	
Labor		10.00	0	2 hrs.		20.00
Spray rig		25.00	0	2 hrs.		50.00
Seeding:						
20-40 lbs./acre for 1.8 ac.	10.00	35.00	36	72 lbs.	360.00	2,520.00
Broadcast/Harrowing Seed	35.00	35.00	2	8 hrs.	70.00	280.00
Total Installation Cost					\$670.00	\$3,660.00
Maintenance Costs (first three years):						
Mowing	40.00	40.00	2	2 hrs.	80.00	80.00
Spot spray broadleaf weeds	10.00	10.00	1	3 hrs.	10.00	30.00
Herbicide	22.00	60.00	.125	.25 gal.	2.75	15.00
Second mowing		40.00	0	2 hrs.		80.00
Controlled Burn (once in 3 yrs)		10.00	0	7 hrs.		70.00
Annual Cost					\$92.75	\$275.00
Perpetual Costs:**						
Mowing	40.00	40.00	2	4 hrs.	80.00	160.00
Spot spraying		10.00	0	4 hrs.		40.00
Herbicide		60.00	0	.25 gal.		15.00
Controlled burn (every 2nd yr. max.)		10.00	0	10 hrs.		100.00
Annual Cost					\$80.00	\$315.00
Average annual maintenance cost over 10 years					\$83.83	\$303.00

For comparison, standard roadside management in Yolo County (a combination of “blading,” spraying, and/or mowing) costs between \$140 and \$490 per year depending on the roadside and management system. This does not include the secondary weed control costs to landowners or downstream water quality problems.

* Depending on your roadside’s existing configuration, there may be minimal or extensive regrading required. This grading estimate assumes work done by a county roadside blade operator (in which case, the cost is theirs).

** The degree of long-term maintenance can depend on the individual landowner’s tolerance for some weeds or no weeds.

Native Grass Establishment Program Checklist

(reproduce for project reference)

Project/Location _____ Date _____

- ___ Choose a site that will not be awkward to protect and that can be accessed with equipment for maintenance
- ___ Minimize weed generation and seed production on proposed site for at least one year
- ___ Order seed (see vendor list)

Year 1 (Summer/1st Fall-2nd Fall)

- ___ Prepare seed bed by disking in spring and/or burning in fall
- ___ Kill first flush of fall weeds after early rains
- ___ Drill or broadcast seed (preferably before December, but sometimes OK as late as March)
- ___ Spray out weed seedlings that germinate within two weeks of seeding
- ___ In mid-to-late winter, spray phenoxy herbicides to eliminate broadleaf weeds in planted area (use only herbicides such as MCPA that won't burn perennial grass seedlings)
- ___ In spring, mow, hay, or lightly graze planted area to remove annual grasses before they produce viable seed (in a wet spring, this may need to be repeated)
- ___ Late-spring/summer weed control by hoeing, mowing, or with chemicals (as needed)

Year 2 (2nd Fall-3rd Fall)

- ___ (Optional) Apply preemergent herbicides (consult Ag Extension) or a broadleaf herbicide after weed emergence in fall
- ___ In late winter, spot spray phenoxy herbicides or hoe to eliminate broadleaf weeds in planted area
- ___ Mow, hay, or lightly graze planted area to remove annual grasses before they produce viable seed (in a wet spring, this may need to be repeated)
- ___ Late-spring/summer weed control by hoeing or with chemicals (as needed)
- ___ (Optional) Late spring/summer/fall burn to reduce weed seed production and thatch; timing depends on the available fuel (dry matter to carry a fire) and type of weeds present

Year 3 and Beyond

- ___ Fall weed control with preemergent herbicide or fire
- ___ Selective hoeing and spot spraying for winter broadleaf and grass weeds
- ___ Spring mowing, burning, or grazing (grasslands are healthiest when these management practices are alternated from year-to-year)
- ___ Selective hoeing and spot spraying for summer broadleaf and grass weeds

Tailwater Ponds for Water Quality, Habitat and Farmland Benefits

John Anderson, Hedgerow Farms & Jeanette Wrynski, Yolo County RCD

Background

Tailwater ponds, especially those of two stage design, are changing how row crop farmers manage runoff water in Yolo County. While ponds built over the last decade may not have shared the same objectives, their cumulative success demonstrates the excellent multi-purpose benefits from well designed tailwater ponds. Not only do ponds offer solutions to widely-recognized surface water quality problems, they provide valuable wildlife habitat and enhance ground water recharge.

Without intervention, irrigation water turns into unrestricted runoff, thus bringing about a series of problems. Irrigated row crop fields that drain to one or several main low spots often empty into an initial drainage system that then dumps into a main water conveyance channel (canal or slough). Silt-laden runoff results both from summer irrigation and, even more so, from winter storms. Runoff not only removes topsoil from farmland but deposits this resource downstream, at unwanted places throughout the watershed and beyond.

Ditch maintenance is perhaps the most visible impact of this sediment-laden run-off, but not the only one. First, public works crews must constantly remove silt from roadside ditches. Sloughs and canals also need periodic expensive excavation. Furthermore, water quality flowing into the Sacramento River, Delta, and Bay is seriously degraded, thus adding to non-point source pollution. A third result of unrestricted runoff is the loss of the water itself. For Yolo farmers, it makes much more sense to recapture this lost resource and re-use it or return it to our groundwater storage systems.

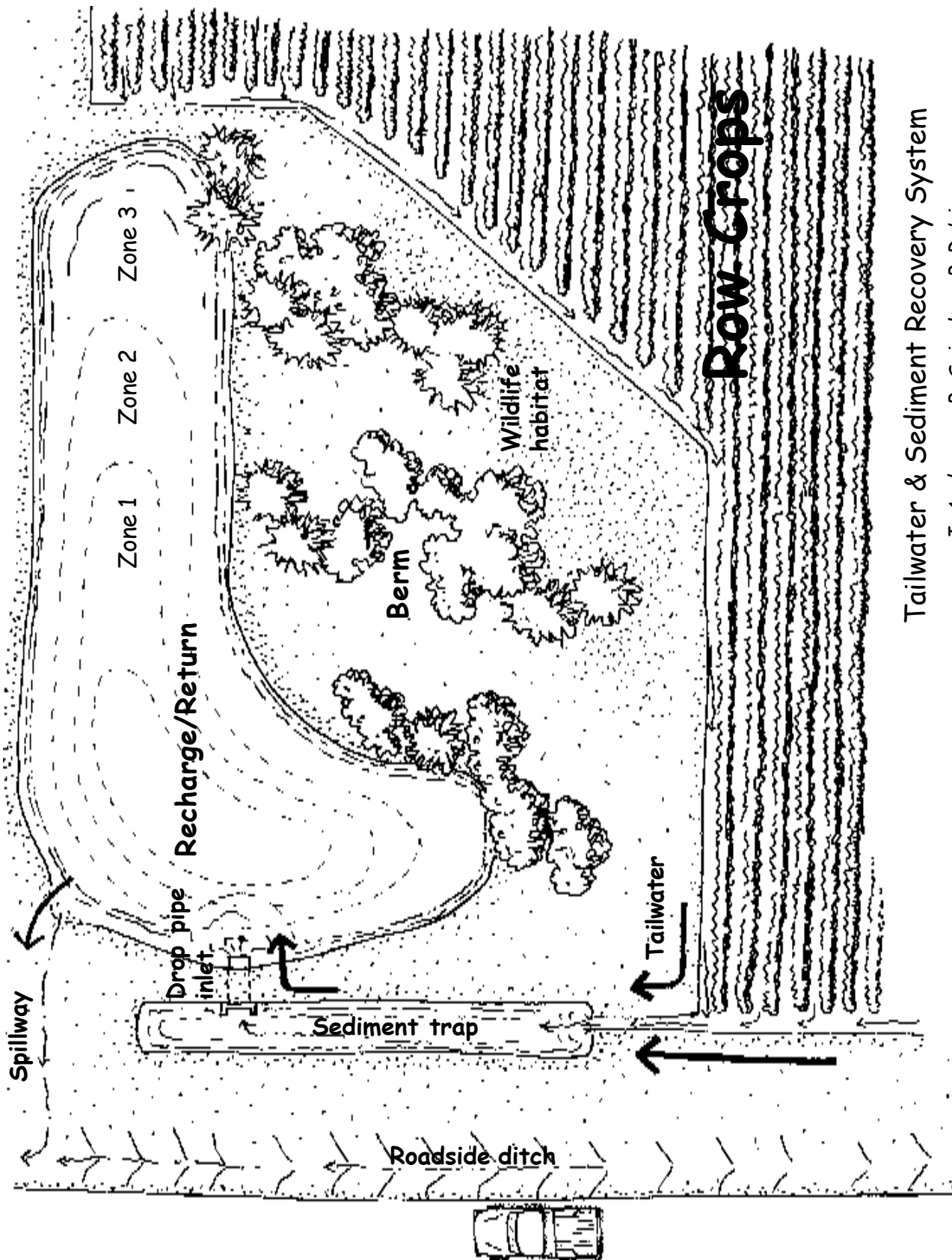
Design

A straightforward, cost-effective solution to all these widespread problems is the construction of a small double-pond system that catches and stores at least part of the runoff water. The double-pond design works efficiently by making the first, small pond work as a sediment trap, engineered for easy excavation of silt

that is easily replaced on the field during fall groundwork. The second, larger pond serves many other purposes: water storage, ground water recharge, water return systems, and plant and wildlife habitat (see illustration).

The larger pond can be designed with a natural shape rather than the usual long, narrow trench of some return systems. The curved 'L' shape in the accompanying illustration is easy to construct with standard scrapers. A gradual 3:1 or 4:1 slope (meaning for every 3 or 4 feet of distance there is 1 foot of fall)-with a deep center portion is preferable. For stability purposes, no slopes should be steeper than 1:1. The pond should also not be less than 5 feet deep, to minimize the encroachment of unwanted weeds. As water percolates or evaporates, the pond surface simply decreases in circumference. Wildlife will continue to use it even when it turns into a puddle. The gradual slope also creates several moist soil planting zones for the establishment of wetland species that can compete against unwanted weeds.

The overall size of your pond could vary greatly, depending on whether it will be used to capture and hold tailwater for wildlife only or to also recirculate that water for irrigation. If you are planning a tailwater recirculating system (tailwater return system), pond and pump sizing will depend strongly on how you manage crop irrigations. Factors to consider in the design of the pond and the sizing of the pump and flashboard risers are the amount of irrigation water you will be running, (measured in cubic feet per second (cfs) or gal./min.), whether you will be running half or full sets, and the amount of runoff. For pond design purposes runoff is usually considered to be approximately 25% of the amount of water applied in a surface irrigation. Another important factor is whether you will be returning the water to the upper end of the same field or sending it downstream to another field. With such a variety of scenarios for recirculating systems, it is important to consult with someone that has experience in pond design, such as your local NRCS engineer or a private consultant.



Tailwater & Sediment Recovery System

J. Anderson, B. Snieckus, P. Robins

If you plan to have your pond simply capture and retain irrigation runoff, sizing and design becomes simpler. The deciding factors may simply be how much space you have or how much land you are willing to take out of production. A common size would be a 1-acre area in a 100 acre field, usually in the lowest corner. Half of the 1-acre pond site would be occupied by the pond, and the other half by a landscaped mound created by excavation spoil. The mound provides structural diversity to the landscape which will in turn encourage the establishment of a wider variety of plants and animals. The mound also reduces the expense of moving the dirt during excavation. However, in order to maintain slope stability, any berms or mounds created from the pond spoils should not be closer than 12 feet from the pond edge. If you want to minimize the loss of farmable acres, the pond spoils could also be redistributed over the field.

Water control structures, such as drop pipes, flashboard risers, or weir boxes, are important for controlling water movement and water levels in the sediment trap and pond. A flashboard riser, for example, should be used as the entry point from the sediment trap to the pond and should also be used at the pond outlet. The pipe barrel should not be less than 12 inches in diameter to reduce clogging from debris. The riser, or upright part of the structure, is always larger (approx. 1.5 x barrel diameter) and is based on the maximum water expected to come through the structure during a given storm or irrigation event. Riser heights are standard at three or four feet and up, but it should always be high enough to see in order to avoid equipment damage. A steel stake can be a good marker.

Vegetation

The plant species incorporated into a tailwater pond system influence its functional and biological value. A pond initially established with the right plant materials becomes a self-sustaining, weed-free system. The planting areas within a system include the deep water that rarely goes dry (zone 1), a moist soil area that is intermittently under water (zones 2 and 3), edges adjacent to the high water level, and dryland areas with or without mounds. Dryland areas with mounds have slope and exposure zones. The three zones in the moist soil area will vary considerably depending on permeability of the soil and how often the pond is filled during the irrigation season. The accompanying

plant list names some of the species that can be established and managed.

Water Quality and Storage Benefits

The degree of ground water recharge in these systems will vary according to soil permeability. One pond alone is probably not significant, but one pond for every hundred acres increases recharge range. Out of the volume of water that a single small pond holds, perhaps half of this water may return to the ground every time the pond is filled either from winter storms or irrigation. If this happened six times in a season and there were ten 1 acre-foot ponds on 1000 acres, 30 acre feet of water would recharge into the ground.

By acting as biological filters, as vegetation absorbs excess chemical nutrients, ponds help improve water quality. This has become a high priority mandate for the '90s. Agricultural practices have been identified by the EPA as a leading cause of poor water quality in the Sacramento-San Joaquin River systems. In short, the installation of tailwater ponds has excellent potential to improve the quality of ag water runoff while at the same time enhancing wildlife and recharging ground water.

The Yolo County RCD promotes this land stewardship practice and we encourage farmers and land owners to consider installation of these valuable systems. Cost-sharing is available through Natural Resources Conservation Service (NRCS) conservation programs. Technical assistance is also available through the NRCS office.

Suggested Plant Materials for Tailwater Ponds

Moist Soil Vegetation Zone 1 and 2

Spikerush (*Eleocharis macrostachya*)

Sedges (*Cyperus* species)

Rushes (*Scirpus americanus*, *Juncus effusus* and *J. balticus*)

(Establishing short-statured rushes and sedges will keep out unwanted species such as cattails and bulrushes which will dominate a small wetland if allowed to proliferate.)

Moist Soil Vegetation Zone 3

Species listed in Zones 1 and 2

White-root sedge (*Carex barbarae*)

Clustered field sedge (*C. praegracilis*)

Meadow barley (*Hordeum brachyantherum*)

Hairgrass (*Deschampsia caespitosa*)

Bentgrass (*Agrostis exarata*)

Pond Edge

Meadow barley

Bentgrass (*Agrostis exarata*)

Hairgrass

Slender wheatgrass (*Elymus trachycaulus majus*)

Creeping wildrye (*Leymus triticoides*)

Clustered field sedge

White-root Sedge

Dryland Native Grass Mixture

Blue wildrye (*Elymus glaucus*)

Purple needlegrass (*Nassella pulchra*)

Oniongrass (*Melica californica*)

Pine bluegrass (*Poa secunda*)

Trees

Willows (*Salix* spp.)

Valley Oak (*Quercus lobata*)

Sycamore (*Platanus racemosa*)

Black Walnut (*Juglans californica* var. *hindsii*)

Cottonwood (*Populus fremontii*)

Interior Live Oak (*Quercus wislizenii*)

Buckeye (*Aesculus californica*)

Shrubs

Button Willow (*Cephalanthus occidentalis*)

Coyote Brush (*Baccharis pilularis*)

Wild Rose (*Rosa californica*)

California Lilac (*Ceanothus* spp.)

Mulefat (*Baccharis viminea*)

Elderberry (*Sambucus mexicana*)

Toyon (*Heteromeles arbutifolia*)

Redbud (*Cercis occidentalis*)

Note: The grass, tree, and shrub species listed are all commercially available. Many of the wetland sedges and rushes are also commercially available but can be otherwise obtained by transplanting from natural stands. Vendors are listed at the end of this book as potential commercial sources.

Tailwater Pond Installation and Maintenance Costs (1999)

with return system and banks vegetated for wildlife benefit

Task	Cost/Unit in \$		Units		Total Cost in \$	
	Low	High	Low	High	Low	High
Pond						
Planning/Engineering	50.00	50.00	10	10 hours	500.00	500.00
Pond Excavation & pipe install ¹	1.15	1.40	2500	7500 cu. yds.	2,875.00	10,500.00
Flashboard riser ²	175.00	525.00	1	1 each	175.00	525.00
Pipe/Barrel extension ³	9.00	15.00	20	100 feet	180.00	1,500.00
<i>subtotal pond construction cost</i>					<i>3,730.00</i>	<i>11,525.00</i>
Return System						
Lay pipe		2.00	1800	1800 feet	3,600.00	3,600.00
Return pipe materials ⁴	1.25	1.35	1800	1800 feet	2,250.00	2,430.00
Pump installed ⁵	4,000.00	10,000.00	1	1 each	4,000.00	10,000.00
<i>subtotal return system construction</i>					<i>9,850.00</i>	<i>16,030.00</i>
Vegetation Management						
Planning & design	50.00	50.00	2	6 hour	100.00	300.00
Bed preparation	50.00	50.00	1	2 hour	50.00	100.00
First weeds spray ⁶	25.00	25.00	1	1 hour	25.00	25.00
Herbicide material	60.00	60.00	0.125	0.25 gallons	7.50	15.00
Seeding/incorporation	25.00	25.00	1	3 hours	25.00	75.00
Seed (20-30 #/ac. for 0.25 ac.) ⁷	10.00	30.00	5	7.5 pounds	50.00	225.00
Winter weed mgmt.(spot spray)	10.00	10.00	1	2 hour	10.00	20.00
Broadleaf herbicide	22.00	22.00	0.125	0.25 gallons	2.75	5.50
Spring weed mgmt.(spot spray)	10.00	10.00	1	2 hour	10.00	20.00
Broadleaf herbicide	22.00	22.00	0.125	0.25 gallons	2.75	5.50
Mowing	40.00	40.00	1	2 hour	40.00	80.00
Spot weeding (hand crew)	10.00	10.00	15	35 hours	150.00	350.00
Irrigation Set-up (drip system)						
Small pump (for multiple sites)	300.00	800.00	1	1 each	300.00	800.00
Irrigation supplies	150.00	150.00	1	1 each	150.00	150.00
Installation labor	10.00	10.00	5	15 hours	50.00	150.00
Irrigation labor	10.00	10.00	5	20 hours	50.00	200.00
Additional plantings:						
Plants (Trees & shrubs)	1.50	2.50	25	50 starts	37.50	125.00
Waterline plants (rushes/sedges)	0.20	0.40	100	300 plugs	20.00	120.00
Labor	10.00	10.00	4	8 hours	40.00	80.00
<i>subtotal vegetation cost</i>					<i>1,120.50</i>	<i>2,846.00</i>
Total Installation Cost					\$14,700.50	\$30,401.00

Annual Management (First 3 years)

2nd Fall pre-emergent ⁸	0	75.00	0	1 treatment		75.00
Application labor	10.00	10.00	0	2 hours		20.00
Winter spot spraying	10.00	10.00	2	4 hours	20.00	40.00
Material	22.00	90.00	0.125	0.25 gallon	2.75	22.50
Spring mowing	40.00	40.00	1	2 hour	40.00	80.00
Irrigation for trees and shrubs (6x)	10.00	10.00	4	8 hours	40.00	80.00
Dredging of pond or sed. ditch	50.00	50.00	2	6 hours	100.00	300.00
<i>Initial Annual Maintenance Costs</i>					<i>202.75</i>	<i>617.50</i>

Perpetual Maintenance Costs (Beyond 3 years)

Winter spot spraying ⁹	10.00	10.00	0	4 hours		40.00
Material	22.00	90.00	0.125	0.25 gallon	2.75	22.50
Spring mowing	40.00	40.00	1	2 hour	40.00	80.00
Dredging pond or sed. ditch ¹⁰	50.00	50.00	2	6 hours	100.00	300.00
<i>Total Perpetual Annual Maintenance Costs</i>					<i>142.75</i>	<i>442.50</i>

Annual Cost of Project Averaged Over Ten Years

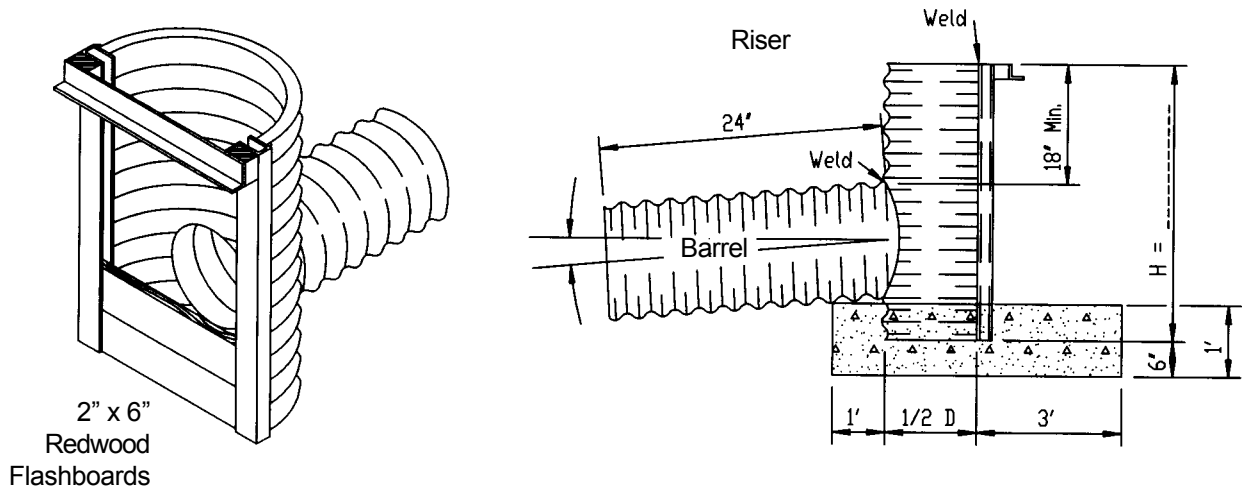
\$1,630.80 \$ 3,535.10

**Annual savings on irrigation water with return system
(for 100ac. tomatoes w/water cost of \$15/ac.ft.):**

\$2,000.00

(See endnotes on following page)

Sample Drop Pipe Isometric & Elevation



Endnotes:

¹This includes cutting the trench and setting in a flash board riser inlet. Cost per cubic yard of soil moved varies depending on the equipment required. A belly scraper type excavator and bulldozer may cost around \$1.10 per cubic yard, while a bucket excavator is in the range of \$1.40 per yard. A bucket excavator would be necessary in locations with shallow ground water. Often, as much as can be dug with bulldozer and scraper will be done until a bucket excavator is needed. This helps to reduce project cost/time.

²The size of the flash board riser depends on the peak flow anticipated through the pond. Your local NRCS field office can assist you in determining this. Risers are available in plastic and corrugated metal pipe (CMP). In corrosive soils, the NRCS requires (for cost share assistance) dipping CMP pipes and risers in hot asphalt, which adds about 25% to the item cost. Costs in this row reflect the range associated with item size and composition.

³This cost range reflects between 15" CMP (not dipped) and 18" CMP dipped in hot asphalt. Length of pipe depends on pond design.

⁴This estimate is for 8" or 10" PVC low-head pipe run underground to the top of a field with a 1/4 mile run. In a flat enough field, water could be returned to the head with a reverse ditch, but it moves slowly and will seep a lot of water unless it is lined. It also requires periodic cleaning and recutting.

⁵The range of installed pump costs is that between a 5 Hp submersible electric capable of 520 gpm with 20' of lift and a diesel motor, pump and suction line. The latter is much more costly, but it can be used at multiple sites.

⁶Mechanical means of weed control can substitute for the chemical means in this example. To minimize post-project weed pressure, the project site should be kept clean of weeds for at least one season before breaking ground. After the pond is built and ground prepared, it is best to let fall rains bring up the first weeds, kill them, and then plant.

⁷Prices for native grass seed vary greatly between species, from \$5 to \$50 per pound. The appropriate mix for a site depends on pond design, soil, and climatic conditions. Broadcast seeding rates can also be varied, depending on the project goals, but under 20 pounds per acre is not recommended.

⁸If annual weed pressure is tremendous, application of a preemergence herbicide can offer relief to a young native grass stand. However, the herbicide will also suppress any germination of native grass seed produced in the first year.

⁹Spot treatment of weeds is necessary in order to suppress undesirable broadleaf and grass weeds. This example gives a range of costs from a common broadleaf herbicide to that of a glyphosate/oxylflourfen mix. Spot treatment can also be accomplished manually and/or mechanically, although at a greater labor expense.

¹⁰If a sediment ditch is successful in catching sediment, it must be dredged out periodically. Depending on the site, this could be multiple times per season or only once every year or two. This is typically accomplished with a bucket excavator to dig out the ditch and a scraper to pick up and distribute the soil once it has dried. A tailwater pond without a sediment ditch will require similar maintenance in order to remain functional. Because this poses a conflict with wildlife habitat goals for a pond, the RCD strongly recommends the two-pond system of a sediment trap and pond.

Hill Ponds for Landowner and Wildlife Benefits

Jeanette Wrynski, Yolo County RCD

Ponds constructed in low hills are easily recognized as having aesthetic value. They can also collect and store storm runoff from small watersheds and provide watering sites for domestic livestock and wildlife. They can provide wintering or pair water for waterfowl and, if properly vegetated, nesting sites as well. There are a host of other wetland species that can benefit from constructed ponds. Installing one involves a few key steps which, if done properly, will provide benefits for generations.

Site Selection

In choosing a location for a hillside pond, the general topography must be considered, especially whether or not the land contours will provide a suitable shape and a variety of water depths for vegetation. The size (acreage) of the drainage/watershed will directly affect the size of the dam needed to form the pond and there must be an appropriate pair of high spots between which to construct the dam. Rainfall records for the area can help in calculating the amount of runoff water that the pond could be expected to carry.

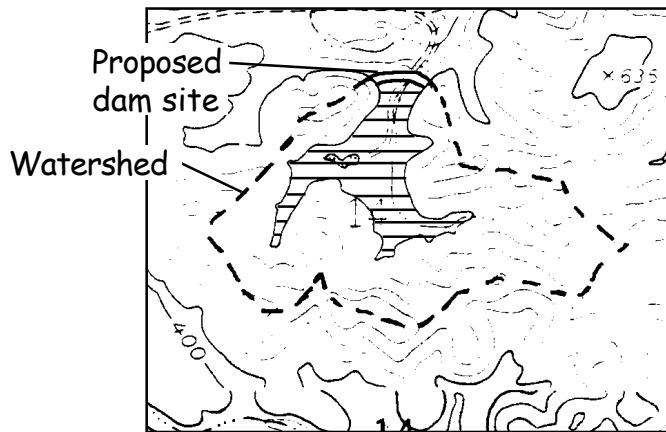
The vegetation in and surrounding a proposed pond site may not necessarily affect your ability to construct the pond, but can sometimes give indications of the soil types. A hill pond constructed on highly permeable soil will be unable to hold water, but can provide groundwater recharge. A pond intended for livestock watering would best be constructed on relatively impermeable soil so as to hold water into the dry season. Small ponds may dry up by June, but shallow ponds warm up sooner, growing important invertebrate food for nesting waterfowl. Reviewing a local soil survey or simply being familiar

with your own soil types could make the difference between success and failure for a new pond.

Water Rights

The successful completion of a pond project will depend upon securing water rights. The State of California **requires** that a water rights permit be obtained prior to constructing and storing water in ponds or reservoirs. The State Water Resources Control Board, Division of Water Rights (916.657.2170) will send you a packet that includes information and application forms. There are three categories of water right applications that could apply to hill pond projects: 1) the Stock Pond program; 2) Small Domestic Registration; and 3) Appropriative Water Rights.

The Stock Pond Registration program was primarily for livestock watering reservoirs constructed prior to January 1, 1969 with a maximum storage capacity of 10 acre-ft. The deadline to submit applications for Stock Pond Registration was December 31, 1997



Small Domestic Registrations cost \$100.00. Water stored under the Small Domestic Registration program (maximum storage capacity of 10 acre-ft.) is primarily for household domestic use on the property but may also include water for irrigating up to 1½ acres of lawn and garden, domestic stock, aesthetic and recreational uses.

Appropriative Water Rights, which are not limited by a 10 acre-ft. maximum, are the water rights most likely needed for typical hill ponds. The cost for this type of water right can exceed \$1,000 and may take several years to obtain, so one must plan ahead. These permits must receive environmental clearance from the state. Contact your local Natural Resources Conservation Service (NRCS) or RCD office for assistance with completing the paperwork for the individual permits.

Technical Assistance and Cost Sharing

Several public and private agencies can provide support to those wishing to construct a pond with multiple benefits that include wildlife. Support could include anything from surveying and pond design by an engineer, a site visit to discuss placement, configuration, habitat, slopes and vegetation, or cost-share programs that pay for varying portions of construction. Organizations providing this support include your local Resource Conservation District, California Waterfowl Association, Ducks Unlimited, the USDA Natural Resources Conservation Service, the US Fish and Wildlife Service, and California Department of Fish and Game, as well as local native plant suppliers and construction companies. Any of these organizations can provide more detailed information about their respective support programs. Please see our lists of local vendors and cost-share sources located at the end of this book.

Construction

The first step toward construction, once a proper site has been selected, is to survey the site and set stakes for the equipment operators. Soil disturbance directly under the dam site and excavation of the keyway (a trench across the dam-site that is below the existing ground level) are important steps for getting good soil contact and preventing seepage under the dam (see drawing 1, “core trench”). During the dam construction, each layer of soil pushed up should be compacted with an implement such as a sheep’s-foot roller, but good compaction can’t be accomplished unless the fill soil is moist. Careful attention to dam slopes, bank slopes and pond contours will give the best result in terms of function and bank stability. Typical slopes would be 2:1 (2 feet of run for each 1 foot rise in height) on the dry side and 3:1 on the wet side to reduce erosion. These features will allow good growth of the emergent wetland vegetation that provides good wildlife habitat. Most ponds require both a pipe spillway (drawing 1, left) and an emergency overflow with gradual slopes to prevent erosion during overflow events. A simple earthen overflow could suffice for a small pond in an ideal location. Engineers at the NRCS can help with design criteria.

Vegetation

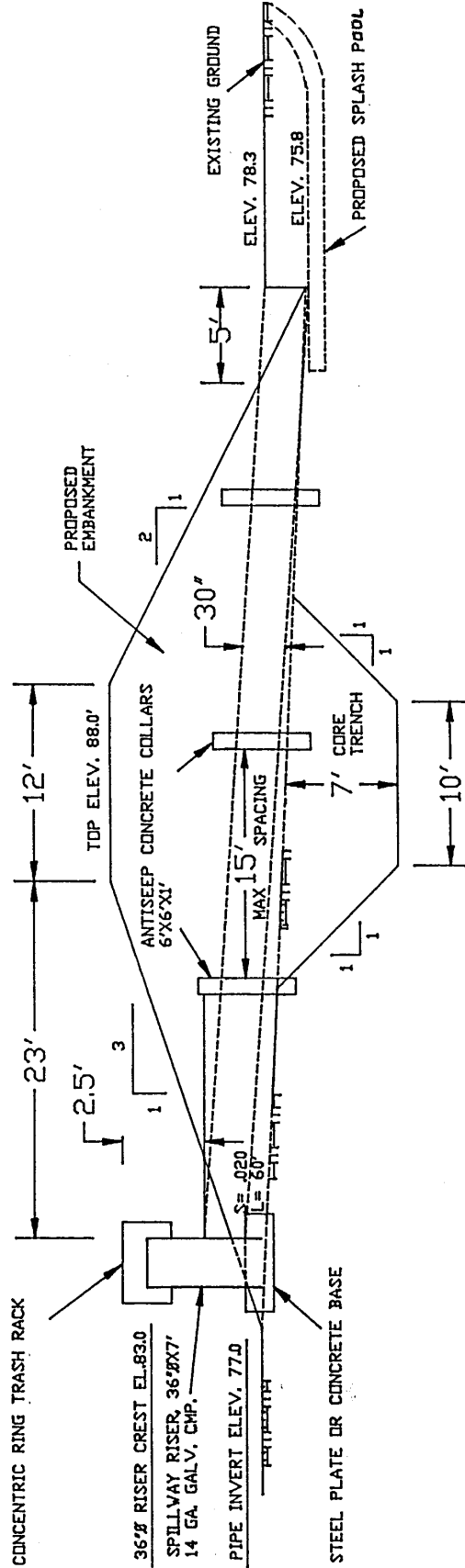
A pond site can be planted with a large variety of trees, shrubs, forbs and grasses for aesthetic value, biodiversity and soil stabilization. Attention need only be paid to matching the plants’ living requirements (especially its water needs) to conditions around the pond. Islands constructed within the pond can provide special opportunities to create safe, well-vegetated resting places for wildlife. Plants like Swamp timothy can be important food sources and water-loving plants like Spikerush and Cattail are important emergent vegetation for nesting or brood habitat. Ideally, the right combination of plants can be selected to be self-sustaining for minimal maintenance costs. A Resource Conservation District, public or private conservation organization, or native plant nursery can provide helpful input on plant selection.

Maintenance

Most ponds, if constructed according to design criteria, should be maintenance-free. Initially, when the pond is new, the levee (dam) could settle and earthen spillways could erode, so repairs may be needed. If the pond regularly catches silt or has excessive unwanted plant growth, occasional cleaning may be necessary. If erosion above the pond is expected, a silt-trap could be important to include in the pond design to reduce the need for dredging of the pond itself.

Hillside ponds can provide a series of benefits to landowners and non-landowners alike. Numerous water catchments above the valley floor can slow down storm flows, provide food and water sources for livestock and wildlife, and improve the overall appearance of the local landscape.

EXAMPLE OF LARGE DAM:
 10 ACRE SURFACE AREA RESERVOIR
 25 ACRE-FOOT STORAGE ON 100 ACRE WATERSHED

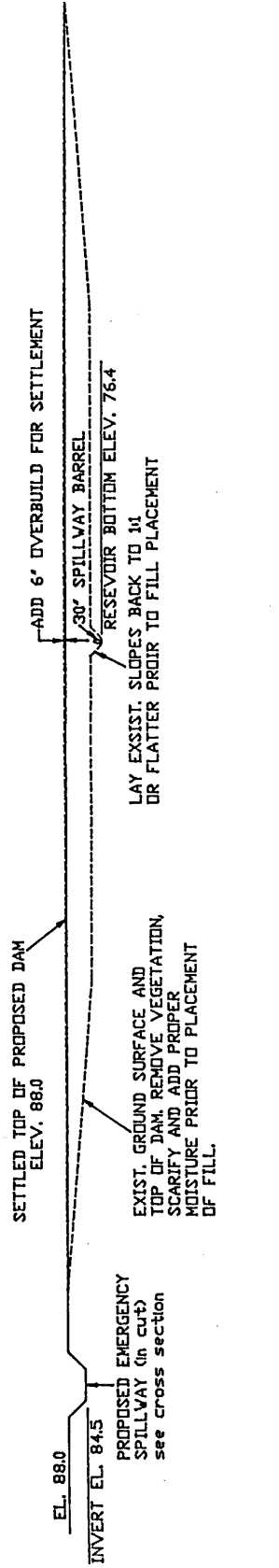


GENERAL DAM STRUCTURES
 CROSS-SECTION

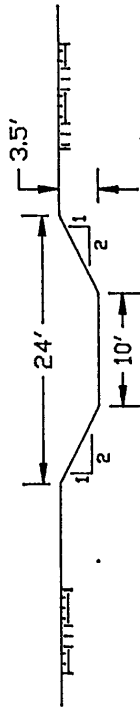
US DEPARTMENT OF AGRICULTURE
 NATURAL RESOURCES CONSERVATION SERVICE

DRAWING 1

PROFILE ON AXIS OF DAM



CROSS SECTION OF EMERGENCY SPILLWAY



GENERAL DAM STRUCTURES CROSS SECTION OF EMERGENCY SPILLWAY PROFILE ON AXIS OF DAM
US DEPARTMENT OF AGRICULTURE NATURAL RESOURCES CONSERVATION SERVICE

Riparian Enhancement on Sloughs

Paul Robins, Yolo County RCD

PROBLEM:

Our current stream channel management techniques in Yolo County have left us with mostly narrow, thinly vegetated streams that house little wildlife and are unable to carry the high flows of winter storms. The bare, eroding banks serve as excellent substrate for noxious weeds such as Yellow starthistle, Giant reed, and Peppergrass, and allow tons of sediment to be carried away downstream only to clog channels or be deposited on adjacent fields. Standard winter maintenance efforts of excavating silt and weeds only perpetuate the problem by leaving the banks bare again for further erosion and weed establishment.

SOLUTION:

One solution to the problem of constant maintenance and degradation of our streams is to reintroduce some of the original natural bank structure and plant systems. The original native riparian plant species that once populated these streams can be reintroduced to serve multiple functions of stream bank stabilization, weed suppression and wildlife habitat. Re-grading banks to a more natural benched slope (see diagram) increases the flood capacity of the stream while making room for vegetation and wildlife. Depending on each individual situation, such channel re-sloping may or may not be necessary. Most landowners will find that “pulling back the levee” for such a project is only necessary on one side of a channel, minimizing the amount of land that would be taken out of production and leaving one side accessible for channel maintenance. If land adjacent to a stream is marginal, often flooded, or difficult to farm, such a channel alteration may have little impact on farm income (beyond installation and maintenance expenses). The rest of this article gives a brief description of some of the steps required to enhance a stretch of slough on your property.

Ideally, any stream restoration project should be part of a coordinated effort along the entire stream or watershed. The California Department of Fish & Game is now required to include an environmental review under CEQA (the California Environmental Quality

Act) as part of the Streambed Alteration Permit process (see below). Cost-sharing opportunities exist for riparian improvement projects through the Natural Resources Conservation Service (NRCS), CDFG, and the California Wildlife Conservation Board (see Cost Sharing article later in this publication). The funding from different sources can be combined and increased, especially when multiple landowners cooperate on a project. The last chapter of this book is a list of landscape contractors and environmental consultants who can assist you with planning or implementing this kind of project.

Permits

Depending on the scale of your project, you will need to consult with different natural resources agencies to do the job with minimal negative environmental impact. This is the step that most growers dread, but it is not necessarily the ordeal it is made out to be. A good first step is to start with your local Resource Conservation District (RCD) and County Planning Department for some basic direction. Permit-wise, the first agency to consult is the CDFG. The local game warden for the CDFG can make a site visit to help you determine what environmental review permits you might need other than a **Streambed Alteration Agreement** (\$132 for small projects). If you intend to leave any disturbed earth or gravel within the stream channel or banks, you should apply for a **Nationwide Permit** (no cost, one month process) from the **Army Corps of Engineers (ACOE)**. Their Nationwide Permits are pre-approved and involve little paperwork. As part of that permit you will also have to contact the California **State Water Resource Control Board (SWRCB)** for a water quality permit (\$500).

Breaking Ground

Once you have determined your project location, scope of work, and have dealt with the appropriate agencies, you're ready to break ground. The ideal time for such work in Yolo County is from late summer through September, when most ephemeral streams have

dried down enough that you don't have to worry about equipment getting stuck. If your project includes reshaping the stream channel, an engineer or landscape architect can help you in determining how best to balance your cutting and filling work. For any permit-approved project, the NRCS provides this service free of charge. (If you have watched the stream in question over a number of years, you are probably aware of its "Ordinary High Water Line" (how high the water gets in an average year after a winter storm). If you can limit your earthwork to the bank above this line, you will decrease your chances for needing an ACOE or SWRCB permit.) You can improve the likelihood of revegetation success if you stockpile your topsoil during earthmoving and replace it as the top layer of soil when filling and shaping. The soil in the lower soil horizons may have good texture, but it is poor in nutrients and organic matter, which will be vital to the success of your revegetation effort.

Why reshape the channel? The primary reasons for channel shaping are to increase the flood capacity of the stream and make planting and maintenance work easier. Streams in lowlands typically develop a channel form that is stepped, consisting of a small, incised, low-flow channel that carries year-round flow and a broader high-flow channel (or flood plain) that carries storm flows. The earth (spoils) that is removed in creating a high-flow channel can be used to build up the levee along the stream to further protect adjacent land from flooding.

Illustration by Paul Robins



Toyon leaf and flower

Vegetation

Vegetation of the site is key to a project's long-term success. A successful revegetation effort will stabilize your new banks and suppress noxious weeds. Riparian plant systems may be more complex than those in traditional agriculture, but any

farmer should be able to manage them easily. All vegetation should be selected to match the soil and

hydrologic conditions of the site—i.e., light or heavy soils, alkalinity, and proximity to the water table. The existing plants near the site are a good indication of what grows best there. The RCD and local NRCS can assist you in developing an appropriate plant list for your site.

Establishing groundcover vegetation for bank stabilization and weed control is an essential aspect of revegetation. Ground cover vegetation includes native grasses, sedges, and rushes that can be planted either by direct seeding or plugs. These plants will require "farming" for their first 2-3 years to aid their establishment, during which weed control is essential. Herbicides, mowing, grazing, and fire are all useful weed management tools. An earlier article in this book offers specific information on perennial grasses establishment.

There are many native, riparian trees, shrubs and forbs that can be included in a riparian enhancement project to increase biodiversity and habitat value. These can be propagated either from cuttings, seeds, or starts. Native plant nurseries and most RCDs have lists and information about them available to the public. Many of these plants need some protection from herbivory and weed competition, for which tree shelters, weed mats, manual weeding, and careful herbicide application are useful tools. A short list of recommended native plants is attached to this article.

Planting Zones

As illustrated in the accompanying diagram, planting should be made in zones to facilitate water movement and maintenance access, and to ensure planting success. Four basic zones are briefly described below, moving from the stream channel up to the bank top.

Bank of Low-Flow Channel - Plants that are tolerant of saturated soils and frequent inundation such as Spikerush, Baltic rush, Alkali bulrush, Slender sedge, Barber sedge, and Creeping wildrye are best in this zone. These plants have an important role in bank stabilization and are the hardest hit by stream flow. Their low profile and ability to fold over minimize restriction of water flow. A number of shrubs and trees can tolerate these conditions to a degree, but placed near the center of the stream channel, they would represent a real reduction in channel flood capacity.

High-Flow Channel or Flood Plain - Naturally-occurring stream benches are typically inundated only during high flows following winter storms when the stream spills over its low-flow channel. During the rest of the year, this portion of the channel typically remains dry. To facilitate storm flows, plantings in this zone should be of low stature. Candidate plantings are any moisture-tolerant perennial grasses (e.g., Meadow barley, Creeping wildrye, and Slender wheatgrass) or low-growing shrubs such as Wild rose and Poison oak. (Note: for property owners concerned about trespassers, brambles and Poison oak look better than a fence and work as well or better.) This zone can also host a two-tire access road for maintenance and should be configured to accommodate equipment the landowner envisions using in the future.

Bank of High-Flow Channel - For soil stabilization and ground cover, this zone should be seeded with perennial grasses similarly tolerant of seasonal flooding. This is the best site for flood-tolerant trees and shrubs such as willows, Cottonwood, Mulefat, Box elder, Valley oak, Black walnut, California sycamore, brambles, and vines. If flood capacity is a concern, the shrubby plantings can be kept higher on the bank. Trees provide valuable weed suppression by shading, and with some training, their trunks provide minimal water flow restriction. The extensive roots of shrub and tree plantings fortify the stability of the bank and levee.

Levee - The top and field-side portion of the levee are appropriate sites for planting shrubs and grasses that are less tolerant of inundation, such as Toyon, Redbud, Elderberry, Blue wildrye, Purple needlegrass, and Onion grass. Many plants could be included in this mix that might provide insectary benefits to the adjacent fields as well. Many farmers use the top of their stream levee as a field access road, which need not be left bare of vegetation. Roads can be maintained with low-stature perennial grasses down their middles and sides, though an extra pass with a mower may be needed in the summer.



Toyon plant

Illustration by Paul Robins

Mulches

Immediate bank stabilization and weed suppression is aided by the use of mulches and mulching fabrics, which reduce the exposure of soil to moving water but allow plants to grow through them. Loose straw and wood chip mulches are common mulching materials, but typically only an anchored fabric would hold up against a consistent stream or sheet flow of water. There are many mulching fabrics available that can withstand various intensities of flow, consisting of materials from woven straw to geotextiles. These require careful anchoring to be effective and are not recommended for streams with high flows. In situations with highly erosive flows, special armoring with bioengineering structures such as willow mattresses or siltation baffles that incorporate willow stakes and quarried rock may be necessary.

Proper stream channel habitat and flow improvements require thoughtful planning, but yield very satisfying results in terms of aesthetics, flood control, animal visitation and maintenance reduction. Although the task may appear overwhelming, your local RCD and NRCS field offices have skills to support you in your effort. They can also provide direction in dealing with other agencies and contractors.

Agency Contacts for the Yolo County Region

California Department of Fish & Game

Gary Hobgood
Region 2 - 1701 Nimbus Road, Suite A
Rancho Cordova, CA 95670
tel: 916.983.5162

US Army Corps of Engineers

Jason Cutler
Regulatory Branch, Sacramento District
1325 J Street
Sacramento, CA 95814-2922
tel: 916.557.5258

State Water Resources Control Board

Central Valley Region
3443 Routier Road, Suite A
Sacramento, CA 95827-3098
tel: 916.255.3000

Plant List for "Riparian" Hedgerows

The following is a list of possible plants for hedgerow designs in riparian-type situations. Abundant water is a prerequisite for establishment and normal growth. The plant's proximity to standing water should vary from species to species (e.g., locate most trees higher on slopes than shrubs). One should consult a planner for appropriate planting schemes. The notes provide information to help determine planting combinations that allow individual species appropriate sunlight 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. Many shrubs, however, can have life spans of more than 15-20 years. **All of these plants require summer irrigation during their establishment period.**

Trees (Deciduous)

common name	scientific name	notes
Box elder	<i>Acer negundo</i>	fast-growing to 40-60' - tolerates full sun or partial shade
Black walnut	<i>Juglans californica</i> var. <i>hindsii</i>	single trunk, broad crown, 45-75' - needs full sun
California sycamore	<i>Platanus racemosa</i>	multiple trunk, fast-growing to 50-100' - needs full sun
Fremont cottonwood	<i>Populus fremontii</i>	fast-growing to 40-60' - needs full sun
Valley oak	<i>Quercus lobata</i>	60-80' and wide, grows up to 3'/year - needs full sun
Red willow	<i>Salix laevigata</i>	20-40' tall - needs full sun
Gooding's black willow	<i>Salix gooddingii</i>	20-30' tall - needs full sun

Trees (Evergreen)

common name	scientific name	notes
Coast live oak	<i>Quercus agrifolia</i>	dense foliage 30-60' and wide, grows up to 25' in 10 years - needs full sun

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

Small Trees / Tall 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 and should be planted in areas isolated from sugarbeet production
Brewer saltbush	<i>Atriplex lentiformis</i> ssp. <i>breweri</i>	almost evergreen, denser form than quail bush, 5-7' tall, 6-12' wide - needs full sun and should be planted in areas isolated from sugarbeet production
Buttonwillow	<i>Cephalanthus occidentalis</i>	grows to 3-12' and is found along streambanks - tolerates full sun to partial shade
California blackberry	<i>Rubus vitifolius</i>	mounding vine or shrub to 20'
Blue elderberry	<i>Sambucus caerulea</i>	mounding shrub or spreading tree growing 15-20' and wide - tolerates full sun or partial shade

Small Trees / Tall Shrubs (Evergreen)

common name	scientific name	notes
Toyon	<i>Heteromeles arbutifolia</i>	dense shrub or multi-trunk dome tree, 15-25' and wide - grows in full sun or partial shade and should be planted high on slope or drier sites; an uncommon plant in riparian forests
Coyote brush	<i>Baccharis pilularis</i>	dense, many-branched, grows 4-8' tall and spreads to more than 6' - needs full sun and should be planted high on slope or drier sites
Mule fat	<i>Baccharis viminea</i>	erect, willow-like shrub, 6-12' tall and 4-6' wide

Small Shrubs / Ground Cover

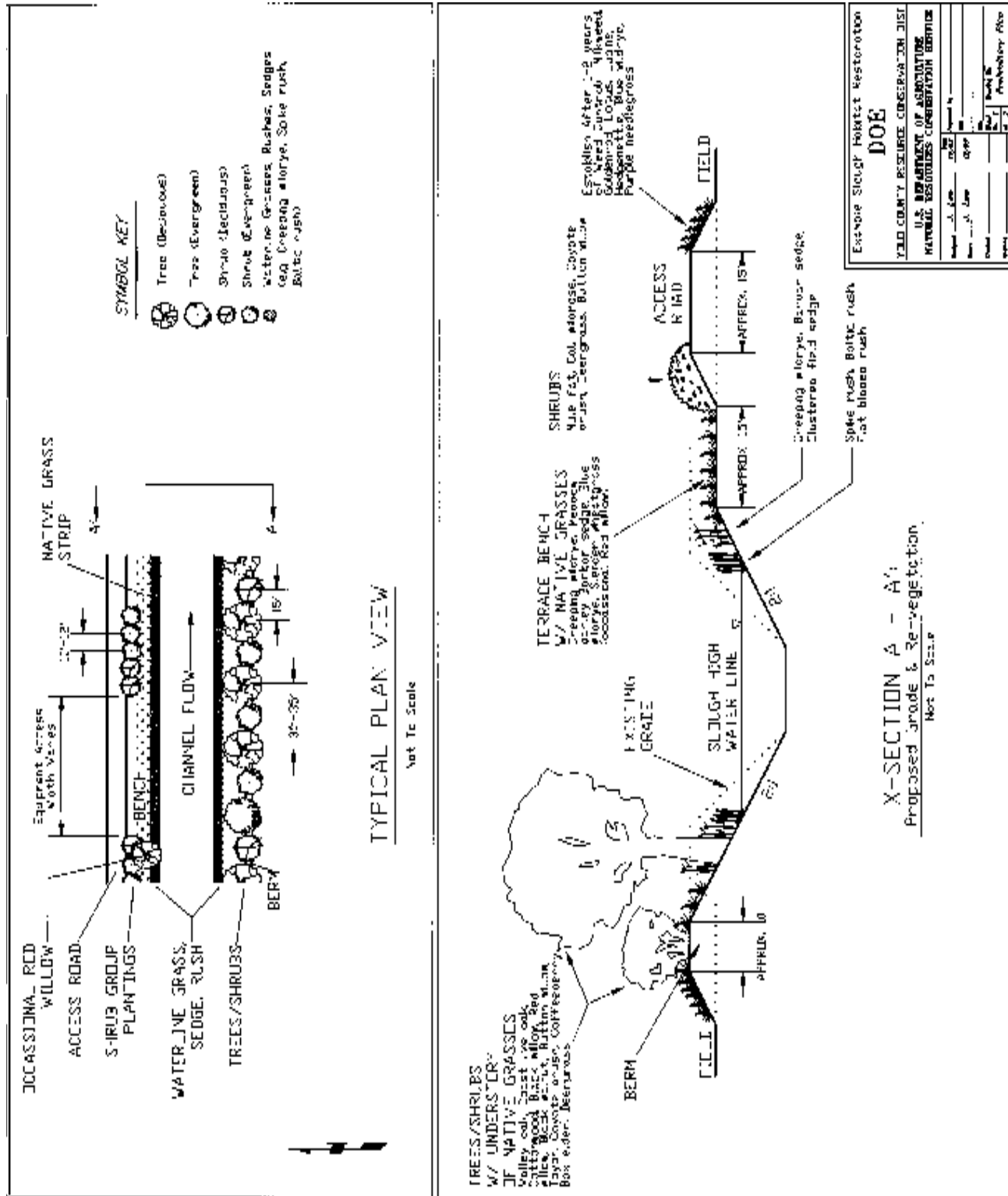
common name	scientific name	notes
Coyote brush	<i>Baccharis pilularis</i> , compact form	dense evergreen, grows 12-18' with 5-6' spread - needs full sun and should be planted high on slopes or drier sites
California wild rose	<i>Rosa californica</i>	deciduous, grows to 6' - tolerates sun or shade
Mule fat	<i>Baccharis viminea</i>	erect, willow-like shrub, 6-12' tall and 4-6' wide

Grass / Sedge (Plugs)

common name	scientific name	notes
Santa Barbara sedge	<i>Carex barbarae</i>	grows to 3' - tolerates full sun to partial shade
Creeping wild rye	<i>Leymus triticoides</i>	cool season grass with blades 2' high and stems reaching 3' in summer, spreads by rhizomes - tolerates full sun to light shade
Deer grass	<i>Muhlenbergia rigens</i>	warm season perennial forming dense clumps from the base, grows 24-30' tall - tolerates full sun to light shade

Grass (seed mixes should total 15-20 pounds if drilled or 25-30 pounds broadcast)

common name	scientific name	notes
Purple needle grass	<i>Nasella pulchra</i>	cool season bunchgrass, 1-2' flower stalks to 30" in spring
Blue wild rye	<i>Elymus glaucus</i>	cool season perennial bunchgrass, 2-3' and establishes rapidly
Meadow barley	<i>Hordeum brachyantherum</i>	tufted, perennial bunchgrass, 1' tall and 8" wide
California brome	<i>Bromus carinatus</i>	cool season, perennial bunchgrass
Yolo slender wheatgrass	<i>Elymus trachycaulus</i>	cool season, perennial bunchgrass 18"-4' - tolerates full sun to light shade



Slough Vegetation and Channel Enhancement Costs (1999)
for 1/4 mile of stream, 20' on one side only

Task	Cost/Unit in dollars	Units	Total Cost in dollars
Planning	50.00	20 hours	1,000.00
Grading with excavator	80.00	50 hours	4,000.00
Bed preparation:			
Harrowing	35.00	3 hours	105.00
Spraying fall weeds (with ATV rig)	25.00	1 hours	25.00
Spraying material (Rodeo)	140.00	0.25 gallons	35.00
Seeding:			
Grass seed (25 lb./ac.)	22.00	25 pounds	550.00
Labor (on ATV w/ seeder and harrow)	25.00	3 hours	75.00
Plug Transplanting:			
Plants (variable)			400.00
Labor (8 people @ 8 hours)	10.00	64 hours	640.00
Cane Cutting and Planting	10.00	18 hours	180.00
Tree tube protectors	1.15	175 piece	201.25
Tree tube installation	10.00	5 hours	50.00
Irrigation Installation (drip option):			
Labor	10.00	25 hours	250.00
Drip irrig. materials			200.00
Portable pump			500.00
First Year Weed Control:			
Spot spraying (Round-up & Garlon)	10.00	4 hours	40.00
Material	90.00	0.25 gallon	22.50
Mowing	40.00	1 hour	40.00
Hoeing	10.00	12 hours	120.00
Installation Cost			\$8,433.75
Annual Maintenance Costs (first several years until establishment):			
Mowing	40.00	2 hours	80.00
Spot spraying (2 x 2 hours)	20.00	4 hours	80.00
Material			45.00
Hoeing	10.00	16 hours	160.00
Irrigation (pumping cost)	0.67	312 hours	209.04
includes amortization of pump and fuel (1 gal/3 hrs. @ 6 hrs/week x 52 weeks/yr.)			
Total annual maintenance costs			\$574.04
Over three years			\$1,722.12
Total cost of project			\$10,155.87
Average annual cost over 20 years			\$507.80

Selected Irrigation Canal Vegetation for Seasonal Summer Systems

John Anderson, Hedgerow Farms

Working irrigation canal banks provide an excellent setting for perennial native plants to support a rich, biodiverse system with multiple benefits. Surveys of undamaged banks on vegetated western streams provide living models that healthy irrigation banks decrease erosion and water problems while functioning as efficient water transport systems. The goals of native bank vegetation systems include the following: suppress weed invasion and thus reduce herbicide use; minimize soil erosion, thus reducing maintenance; support water quality as vegetation filters excess nutrients; and simultaneously enhance biological diversity and aesthetics.

If possible, the slope to be planted should be regraded to no steeper than a 3:1 slope to ease planting and maintenance. If the bank can be seeded, the seed bed should be prepared with a harrow or disk prior to planting. A typical canal bank planting involves seeding in the dry zone and upper high moist soil zones and coming in later with plugs to plant the water line and low, moist soil zones.

Weed control is especially challenging on canal banks with constant summer moisture and a regular influx of weed seed from upstream. At least one prior year of complete weed suppression (no seed produced) is recommended before planting a site, and vigilant weed suppression during the first year after planting is crucial for successful establishment.



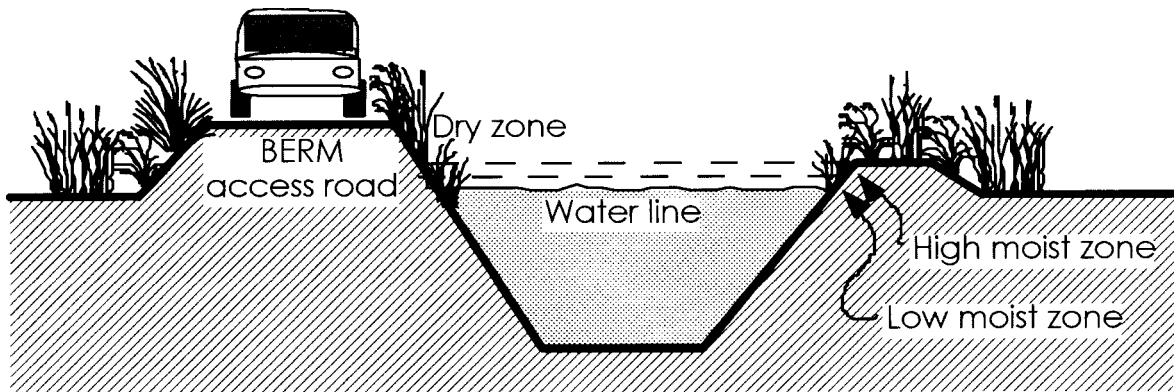
Image by Christopher Rose

Low-statured native plants add beauty and stability to a Yolo County canal

The list below of recommended plants is intended for consideration and choice, not solve all problems: the idea is to initiate innovation and experimentation on specific sites. In fact, there are plant characteristics not included here that may well bear on plant choice: for example, dormancy, soil preference, height or vegetation volume (biomass), root structure, herbicide tolerance, etc. It is important to note that we have had particular success with Creeping wildrye in many canal bank situations. Its tolerance of summer moisture and its rhizomatous growth form provide very effective competition with and suppression of typical weeds.

Four distinct zones have been defined to delineate the planting scheme, as illustrated on the following page.

Canal planting zones



Water Line Zone

This zone is submerged or very wet much of the time during the irrigation season. Here, Cattails (*Typha* spp.) will try to grow in unmanaged systems. Recent experimentation with Baltic rush offer encouraging results since they withstand fluctuating water levels and go dormant in dry, dewatered conditions. Though Baltic rush forms a dense mat of weed suppressing vegetation, its small vertical growing stems do not significantly obstruct water flow.

Common name	Scientific name	Planting method
Common spikerush	<i>Eleocharis macrostachya</i>	Transplants
Alkali bulrush	<i>Scirpus americanus</i>	Transplants/Seed
Baltic rush	<i>Juncus balticus</i>	Transplants
Three-square bulrush	<i>Scirpus americanus</i>	Transplants

Notes:

- Other species of *Eleocharis* should also be considered.
- In fluctuating water systems, creeping species may inhabit up to three zones depending on the water level.

Low, Moist Soil Zone

This zone is moist during the irrigation season and would be typical of a wet meadow or perennial stream dry edge. Left unmanaged, this zone becomes inundated with Watergrass, Barnyardgrass, Sprangle top, Jointgrass, nut sedge and other undesirable weeds. Spike rush would extend into this zone.

Common name	Scientific name	Planting method
Bent grass	<i>Agrostis exarata</i>	Seed
Tufted hairgrass	<i>Deschampsia caespitosa</i>	Seed
Baltic rush	<i>Juncus balticus</i>	Transplants
Flatbladed Rush	<i>Juncus xiphioides</i>	Transplants
Alkali bulrush	<i>Scirpus americanus</i>	Transplants/Seed
Three-square bulrush	<i>Scirpus americanus</i>	Transplants
Clustered field sedge	<i>Carex praegracilis</i>	Transplants
Yerba manza	<i>Anemopsis californica</i>	Transplants

High, Moist Soil Zone

Similar to the low zone, but drier, this zone accommodates the following:

Common name	Scientific name	Planting method
Baltic rush	<i>Juncus balticus</i>	Transplants
Barbar's sedge	<i>Carex barbarae</i>	Transplants
Clustered field sedge	<i>Carex praegracilis</i>	Transplants
Molate fescue	<i>Festuca rubra var. molate</i>	Seed
Creeping wildrye	<i>Leymus triticoides</i>	Seed/Transplants
Alkali sacaton	<i>Sporobolus airoides</i>	Seed
Deergrass	<i>Muhlenbergia rigens</i>	Transplants
Salt grass	<i>Distichlis spicata</i>	Rhizomes

Dry Zone

This zone is dry during the summer. The deep rooted plants in this zone will frequently have access to summer water from the canal especially on better soils and low berms.

Common name	Scientific name	Planting method
Salt grass	<i>Distichlis spicata</i>	Transplants
Creeping wildrye	<i>Leymus triticoides</i>	Seed/Transplants
Purple needlegrass	<i>Nassella pulchra</i>	Seed
Nodding needlegrass	<i>Nassella cernua</i>	Seed
Blue wildrye	<i>Elymus glaucus</i>	Seed
Yolo slender wheatgrass	<i>Elymus trachycaulus majus</i>	Seed
California brome	<i>Bromus carinatus</i>	Seed
California barley	<i>Hordeum californicum</i>	Seed
Meadow barley	<i>Hordeum brachyantherum</i>	Seed
Three-awn	<i>Aristida hamulosa</i>	Seed
Pine bluegrass	<i>Poa secunda</i>	Seed
Idaho fescue	<i>Festuca idahoensis</i>	Seed
California oniongrass	<i>Melica californica</i>	Seed

Typical Costs for Vegetating Canal Banks (1999)
for one mile of canal, both sides (approx. 1.7 ac.)

Task	Cost/Unit in \$		Units		Total Cost in \$	
	Low	High	Low	High	Low	High
Installation Costs						
Sloping edges back	70.00	70.00	5	10 hours	350.00	700.00
Fall Seeding:						
Seed @ 25 lb./ac. over 1.7 ac.	15.00	30.00	34	42.5 pounds	510.00	1,275.00
Bed preparation (Tractor /harrow)	30.00	30.00	4	8 hours	120.00	240.00
Broadcast seed ("Bellygrinder")	10.00	10.00	2	4 hours	20.00	40.00
Harrowing in	25.00	35.00	1	2 hour	25.00	70.00
Winter/Spring planting:						
Spikerush/Sedge (1-2 pl./2')	0.20	0.40	5280	10560 plugs	1,056.00	4,224.00
Planting labor (@ 100 pl./hr.)	10.00	10.00	53	106 hours	530.00	1,060.00
Weed control:						
Fall Rodeo pre-seeding (10 oz./ac.)	150.00	150.00	0.31	0.31 gallon	46.50	46.50
Labor	25.00	25.00	1	1 hour	25.00	25.00
Spring Rodeo	140.00	140.00	.017	.0675 gallon	2.38	9.45
(spot treat after canal full)						
Labor	10.00	10.00	1	4 hours	10.00	40.00
Broadleaf spray before plugging	10.00	10.00	0	1.7 acres		17.00
Total Installation Costs					\$2,694.88	\$7,746.95
Annual Maintenance Costs						
Spot-spray w/ Rodeo (1-2X)	25.00	25.00	2	16 hours	50.00	400.00
Rodeo material	140.00	140.00	.035	.25 gallon	4.90	35.00
Mowing	25.00	25.00	3.5	3.5 hours	87.50	87.50
and/or Burning (5 people x 2 hours)	10.00	10.00	0	10 hours		100.00
and/or Hoeing crew (2-8 hrs, 0-2X)	10.00	10.00	0	16 hours		160.00
and Willow cleaning (1/3 yrs.)	50.00	50.00	0	0.6 acres		30.00
and Slump repair	200.00	500.00	0	2 slumps		1,000.00
Total Annual Maintenance Costs					\$142.40	\$1,812.50
Total Cost over 10 Years Including Maintenance					\$4,118.88	\$25,871.95
Average Annual Cost over 10 years					\$411.89	\$2,587.20

Levee Revegetation With Native Grasses (1998)

John Anderson, Hedgerow Farms & Rick Rominger, Rominger Brothers Farming

Earthen levees and dikes border thousands of miles of rivers, canals, and drainage systems throughout California's Central Valley. Vegetation management on these structures typically consists of costly spraying, disking, and burning to prevent any vegetation from establishing. Where vegetation is allowed to grow on levees and dikes, it generally becomes dominated by annual weedy species.

Native perennial grasses, sedges, and rushes as well as associated forb species have potential value for revegetating and managing levees. An established stand will keep out unwanted weeds while stabilizing banks and slopes with deep penetrating root systems. A number of levee revegetation projects have been initiated in California, but few have been reported and all are in the early stages of development.

This is a preliminary report on a ten acre revegetation project on a medium size levee (ten feet high) in Yolo County. The project is a joint effort between Rominger Brothers Farming and Hedgerow Farms. After three years, we are observing some very encouraging trends in vegetation establishment.

The Revegetation Process

The levee, located north of Woodland on County Road 99E, abuts 250 acres of rice production on one side and a large drainage canal on the other. Historic management of the levee and perimeter field berms consisted of annual disking and application of herbicides to control weeds. Typical levee weeds include Foxtail barley (*Hordeum jubatum*), Wild oats (*Avena fatua*), Ripgut brome (*Bromus diandrus*), Annual rye grass (*Lolium multiflorum*), Yellow starthistle (*Centaurea solstitialis*), Short-pod mustard (*Hirschfeldia incana*), Prickly lettuce (*Lactuca cerriola*), Indian sweetclover (*Melilotus indica*), and others.

Fortunately for us, this historic "clean farming" provided a planting site with a relatively low weed seed bank. Following spring and summer disking, we seeded the site in the fall of 1994 with a 10 ft. Truax drill run lengthwise along the levee. The slope is relatively

gentle (5 to 1), and was therefore not a problem for the tractor or drill. The soil type of the surrounding farmland, from which it is presumed the levee was constructed, consists of Sacramento clay, Capay silty clay, and a small area of Sycamore silty clay loam.

We used different seeding mixes on the upper and lower portions of the levee, reflecting the moisture gradient. The lower area, in addition to being more moist, was also subject to inundation during the flooding of 1996 and 1997. The species content and approximate seeding rates of the two mixes are listed in the accompanying tables. We sprayed 2-4 D in the springs of 1995 and 1996 to control broadleaf weeds during establishment.



Image by John Anderson

Stand of Creeping wildrye at the base of a Yolo County levee

Preliminary Results

We first evaluated the site in May of 1997, three-and-one-half years after seeding. Evaluations to date have been subjective observations without formal data collection, but vegetation trends are readily apparent. The grass establishment is excellent; all species that were seeded are present at least somewhere on the levee.

We have observed four distinct zones of establishment (see illustration). Zone 1, adjacent to the rice crop, was subject to prolonged flooding in 1995 and 1996. Zone 2, midway up the slope was subject to

short duration flooding. Zone 3 represents the upper portion of the levee. It does not flood and becomes quite dry during the summer. Finally, Zone 4 is the steeper south-facing dry slope adjacent to the slough. The lower portion of this slope experienced erosion during the high water in 1995.

Creeping wildrye, the Rio variety, was seeded at less than one pound per acre (due to low seed availability), but there are very healthy patches of it scattered in all four zones. Meadow barley dominates Zone 1, along with patches of Creeping wildrye. In the intermediate flood area (Zone 2), Blue wildrye and Yolo Slender wheatgrass are well represented. The upper xeric portion of the levee is dominated by Purple and Nodding needlegrass, both of which are already producing substantial quantities of seed. Blue wildrye is also doing well in this zone. In the eroded areas of Zone 4, plants are now establishing from the seed of adjacent upslope (Zone 3) plants.

Weeds in 1997 were sparse and consisted of isolated patches of mustard, Prickly lettuce, and Yellow starthistle (we did not use any broadleaf herbicide in that growing season). Foxtail barley, Annual ryegrass, and Ripgut brome were found along the levee road edges. The native forb spikeweed (*Hemizonia pungens*) was prevalent on the lower slopes.

Additional tasks could have been performed, including a prescribed spring burn to kill weed species germinating, a prescribed spring burn to kill weed species before seed maturation, and seeding additional desirable forbs such as *Lotus purshianus*, *Trifolium tridentatum*, *Trifolium fucatum*, *Eschscholzia californica*, and *Lupinus succulentii*.

Other native species appropriate for Zones 1 and 2 and other wet edge areas along levees are the sedges and rushes. Once established, they can keep out the unwanted aquatic edge weeds while providing bank protection and wildlife habitat. Species such as *Carex barbarae*, *C. praegracilis*, *Juncus balticus*, *J. xiphioides*, *J. effusus* and *Eleocharis macrostachya* are being used increasingly and commercial seed and transplant sources are becoming available.

In summary, native perennial grasses now dominate the site. Based on other sites we have watched over the past eight years, the long term success of this project appears to be certain.

The benefits of the revegetation, however, go beyond the successful establishment of native species. Of particular interest to the landowner and the neighboring farmers is the fact that there was no erosion during the flood events of 1997. In addition, essentially no management was performed over the 96-97 growing season and yet there are very few weeds. The levee is aesthetically pleasing to look at, pleasant to walk in, and it provides good habitat for wildlife. Furthermore, the site exhibits no evidence of increased ground squirrel activity, an important levee management concern.

The Road Ahead

The practice of using natives to restore disturbed landscapes is a relatively new art and the information needs are great. Projects such as the one described here need to be monitored for at least 8-10 years to document sustainability and vegetation changes. We need to consider the effects of different soils, slopes, hydrology, and management regimes to determine which species will persist and self-propagate over time. We also need to document the use of revegetated areas by wildlife, including ground nesting birds, rodents, reptiles, and insects in order to demonstrate the value of this approach. Equally important is the development of cost-effective management techniques that meet the functional requirements of the structure. Mowing, burning, selective herbicides, and even grazing will all be part of the program.

It is going to require considerable effort to change the current management techniques. While successful projects such as this one help promote the benefits of revegetation using natives, we need more vegetation managers in the field. Managers need training in the appropriate plants to use on a given site, the techniques to get the plants established, and methods to control weeds during the establishment period and beyond. Workshops and field days offered by the Yolo County Resource Conservation District go a long way towards filling this training need.

Suggested upper levee (xeric) seeding mix

Species	Common Name	live seeds/lb. (approx.)	Rate (lb./acre)
<i>Nassella pulchra</i>	Purple Needlegrass	50,000	8
<i>Nassella cernua</i>	Nodding Needlegrass	100,000	6
<i>Elymus glaucus</i>	Blue Wildrye	110,000	8
<i>Leymus triticoides</i>	Creeping Wildrye	99,000	<3

Suggested lower levee (mesic) seeding mix

Species	Common Name	live seeds/lb. (approx.)	Rate (lb./acre)
<i>Elymus glaucus</i>	Blue Wildrye	110,000	7
<i>Elymus trachycaulus majus</i>	Yolo Slender Wheatgrass	65,000	6
<i>Leymus triticoides</i>	Creeping Wildrye	99,000	<3
<i>Hordeum brachyantherum</i>	Meadow Barley	60,000	8

illustration by Paul Robins



Attracting Barn Owls to Farms

Chuck Ingels, UC Cooperative Extension, Sacramento, CA

The common barn owl (*Tyto alba*) is the most widely distributed land bird in the world (Bunn et al. 1982). It is often called the most *beneficial* bird in the world because of its hearty appetite for voles, gophers, mice, and rats. Several farmers have observed that gopher populations are substantially reduced when sufficient barn owl nesting sites are present on the farm. Unfortunately, little or no long-term research has been conducted to document the effect that installation of nest boxes has on rodent populations.

Barn owls usually swallow their prey whole and later regurgitate large pellets (usually one to two per day) containing undigested bones, teeth, and fur. Skulls found in these pellets can be keyed out to determine the identity of the prey species. The prey species taken most often are California meadow voles, pocket gophers, white-footed mice, and pocket mice (Ingels 1995). A recent prey study conducted near Lodi found that both pocket gophers and meadow voles were found in nearly half the pellets collected. Voles were eaten most often during the winter, whereas gophers were eaten most often during the spring and summer. Most of the gophers eaten were juveniles, and each nesting pair ate just under a gopher a day during the nesting season, in addition to the other rodents caught.

Barn owls naturally nest and roost in barns, silos, haystacks in barns, tree cavities, stream bank holes, and palm trees. Nests in haystacks are often destroyed when hay is removed and those in palm trees are problematic, since the young owls often fall to the ground during heavy winds. Barn owls will readily take up residence in nest boxes provided by farmers. Although some advise that barn owl boxes should be installed at one box per ten acres, there exists no scientific basis for this or any other ratio.

The distance a barn owl will fly to hunt depends on the availability of prey. Depending on the availability of food locally, barn owls often fly 1-2 miles or more to hunt each night, and may fly up to 3.5 miles (Colvin 1986). In a 1947 study in Davis, California, researchers determined that a single barn owl hunted over an area of only 165 acres (Evans and Emlen 1947).

Nest Box Construction and Installation

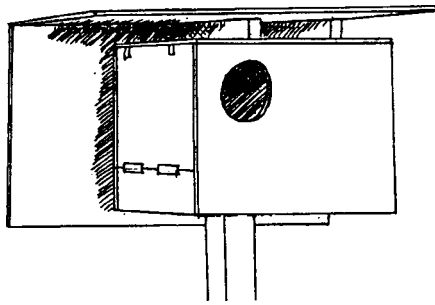
Barn owls are cavity dwellers; they do not build nests. They will readily nest in sheltered structures larger than about 1-1½ ft. in diameter. Nest boxes can be built from on-farm materials, such as barrels (see Ketner reference), beehives, and raisin sweat boxes. Nest boxes can also be constructed from plywood. Below are some design and installation suggestions and a sample plan for building and installing barn owl nest boxes:

- Build the box at least 12 in. wide by 16 in. long by 16 in. tall; even larger spaces are more conducive to the production of large broods.
- Use ½ in. plywood and use 1½ in. galvanized nails and wood glue to attach sides; alternatively, use dacrionized screws and 2 in. x 2 in. framing boards where the sides join.
- Make the entrance hole 4 in. wide and locate it near the edge of the widest side rather than in the middle.
- Provide a hinged door for removing old bedding and pellets.
- Paint the box exterior to protect the wood. Use two coats initially and repaint every few years.
- Install the box at least 12-15 ft. high, but low enough to allow easy access for cleaning.
- Provide a 1 in. thick layer of nesting material, such as wood shavings or small wood chips, to prevent eggs from rolling. In the fall of each year, remove the old nesting material and add new material.
- Provide protection from predators. One method is to wrap a 2 ft. section of thin sheet metal around the tree trunk or post. Predators are usually unable to gain access if the box is centered on top of the post or if a metal pipe is used as the post. Problem

predators, which will eat eggs or young owls, include tree squirrels, opossums, and raccoons.

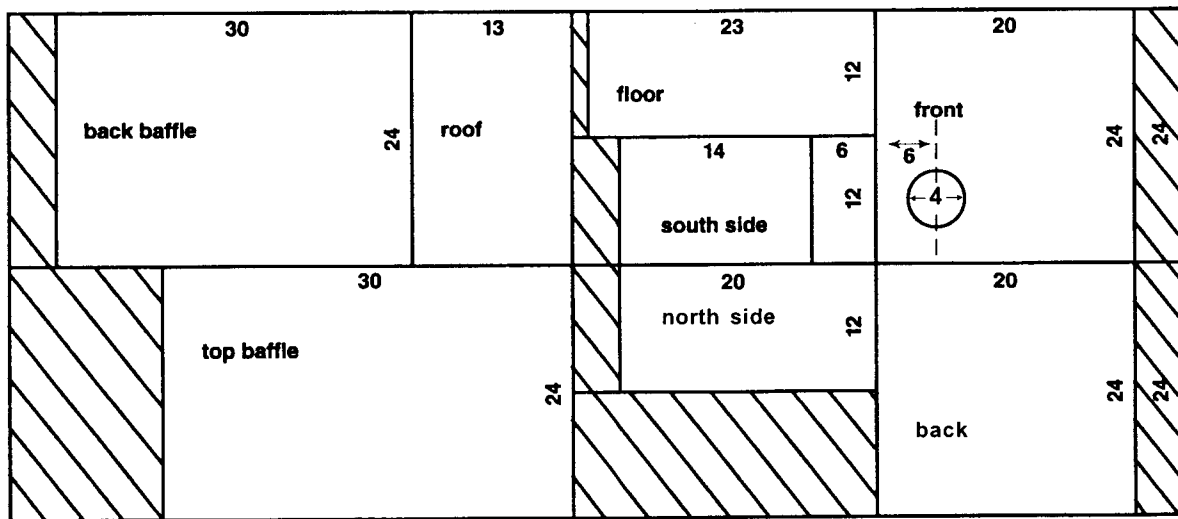
Signs that owls have inhabited the boxes include white excrement (“whitewash”) below the entrance hole, pellets on the ground below the box, and screeching and clicking sounds made by the owls—as well as the owls themselves—near the box at night. It is best to avoid disturbing the nest, especially when eggs are present, since this may cause them to abandon the nest. This period is usually about late February through March for the first brood, although eggs have been found in nests during most months of the year except late fall/early winter.

Barn owls usually begin looking for nesting sites in early January, so it may take many months before they show any interest. Also, they often use the box for nesting only, abandoning it during the summer and fall in favor of a tree or barn roost. If you have installed several boxes, it may take one or two years before they are all inhabited. Also, nest boxes may be abandoned as a result of the high mortality rate of barn owls. Fifty percent or more of all barn owls may die in their first year and collisions with vehicles are usually the main cause of death. If the box(es) have not been occupied for up to two years, try using a different box design and/or a different location.



Barn owl nest box on pole showing shade baffles and cleanout door. Note lack of “perch” in front of entrance. Barn owls do not necessarily need a perch, but Great Horned Owls can use one to prey on owlets in the box.

Diagrams provided by the Lodi District Grape Growers Association



Cutting plan for 1/2-inch CDX plywood sheet (dimensions in inches). This makes a small box. For a larger one: cut front and back 24 x 24; floor 15 x 23; roof 16 x 24.

For more information, contact:

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Potential Bird Box Nesting Species in the Sacramento Valley

Wood duck

American Kestrel

Barn Owl

Hairy woodpecker

Common flicker

Ash-throated flycatcher

Tree swallow

Violet-green swallow

Mountain chickadee

Plain titmouse

White-breasted nuthatch

Bewick's wren

House wren

Western bluebird



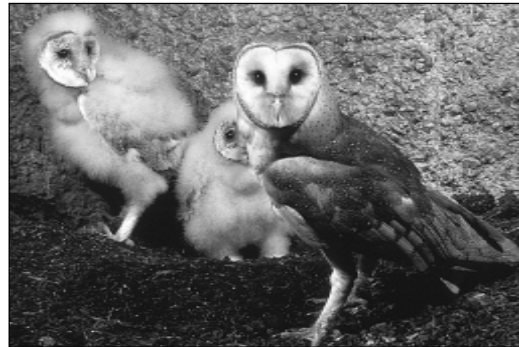
Male wood duck and box

Images © David Rosen



Western bluebird

Image © David Rosen



Barn owl with chicks

Image © David Rosen

For information and designs for bird box construction, contact your local chapter of the National Audubon Society or:

National Audubon Society
Western Regional Office
555 Audubon Place
Sacramento, CA 95825

Beneficial Insects and their Associations with Trees, Shrubs, Cover Crops, and Weeds

from "Farming With Insectary Plants" by Robert L. Bugg,
Sustainable Agriculture Research and Education Program

all photographs by Jack Kelly Clark, University of California, unless otherwise noted

Beneficial insects 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 in field and vegetable crops, because they can persist in the absence of pests, may arrive in the crop first, and may act to preempt or slow down pest outbreaks. Some important beneficial insects have special plant associations.

Bigeyed Bugs (*Geocoris* spp., *Lygaeidae*) are opportunistic predators on a wide range of insects and mites. They will also feed on nectar. They are especially important from May to mid July when they are commonly found on melon, okra, pepper, and squash plants. These predators can be abundant in stands of common knotweed (*Polygonum aviculare*) along field margins. They can also build up in cool-season cover crops, like berseem clover (*Trifolium alexandrinum*), and subterranean clovers, (*Trifolium subterraneum*), and disperse to adjoining vegetable crops when the clovers die in early summer.



Bigeyed Bug, *Geocoris punctipes*

Hoverflies (*Syrphidae*) often resemble stinging wasps or bees. Many are important predators of aphids. Adult hoverflies are principally flower visitors, feeding on nectar and pollen. The larvae are maggots, and these attack aphids. Wind shelter is very important to syrphids. Nectar is probably important as an “energy food” to sustain the hoverflies. Dietary pollen is



Hover Fly, Flower Fly

important for reproduction. Flowering buckwheat (*Fagopyrum esculentum*), commonly used as a cover crop, is attractive to syrphid flies. Among weeds common in California, adult syrphids have been shown to be attracted to corn spurry (*Spergula arvensis*). *Allograpta* spp., *Sphaerophoria* spp., and *Paragus tibialis* were observed at flowers of common knotweed. Toothpick ammi (*Ammi visnaga*) attracted *Scaeva pyrastris*, *Eupeodes volucris*, *Metasyrphus*, *Melanostoma*. In summer, we observed *Allograpta obliqua*, *Sphaerophoria* spp., and *Paragus tibialis*. Among plants suitable for windbreaks or hedgerows, syrphids are heavily drawn to such native plants as California lilacs (*Ceanothus* spp.), coyote brush (*Baccharis pilularis*), holly-leaved cherry (*Prunus ilicifolia*), and wild buckwheats (*Eriogonum* spp.). The soapbark tree (*Quillaja saponaria*) was shown to attract *Scaeva pyrastris*, *Metasyrphus* spp., and *Melanostoma* spp.

Lady Beetles (*Coccinellidae*) are important predators of aphids and other soft-bodied insects. Convergent lady beetle (*Hippodamia convergens*) is important in field, vegetable, and orchard crops; ash-gray lady beetle (*Olla v-nigrum*) is mainly important in tree crops. In the late spring, aphids usually disappear from Californian grasslands and most crops, so, out of desperation, the convergent lady beetle feeds on pollen and nectar. This species is extremely abundant on flowering soapbark tree from mid June through late June. Nectar and pollen are important in building up fat reserves in the beetles. Convergent lady beetles will seek bunchgrasses and form great masses of beetles that may remain dormant through the summer and early winter. If bunchgrasses are not available on agricultural field margins, convergent lady beetles may fly to mountains. Lady beetles can be retained and kept active in the agroecosystem by providing cover crops that harbor aphids or other alternate prey. A mixture of hairy vetch (*Vicia villosa*), and rye (*Secale cereale*) works well in the cool season, and hemp

sesbania, (*Sesbania exaltata*) may prove useful during the summer. Shrubs and trees can also harbor aphids that sustain lady beetles. Black locust (*Robinia pseudoacacea*), saltbush (*Atriplex* spp.), and California coffee berry, (*Rhamnus californica*) appear promising in this regard.

Minute Pirate Bug (*Orius tristicolor*, Anthocoridae). These tiny bugs are important predators of corn earworm. They mainly attack the eggs of these and other moths. They are common in the silks of corn, and can also build up on flowering cover crops, shrubs, and weeds. Particularly potent sources are hairy vetch and ‘Lana’ vetch, toothpick ammi, buckwheat, and wild buckwheats.



Minute Pirate Bug, *Orius tristicolor*

Green Lacewings (Chrysopidae) are predatory in the larval stages, and for some species in the adult stage. In other species, adults feed only on nectar, pollen, and honeydew. Comanche lacewing (*Chrysoperla comanche*) is extremely abundant on flowering soapbark trees from mid June through mid July, and on and bottle trees (*Brachychiton populneum*) from mid June into October.

Brown Lacewings (Hemerobiidae) are predatory in the adult and larval stages, and have been shown to be important predators of artichoke plume moth in California. Adults also feed on nectar, pollen, and honeydew, and are extremely abundant on flowering soapbark tree late at night, during June, and at bottle tree flowers from June into October.

Parasitic Wasps (Braconidae, Chalcidoidea, and Ichneumonidae) are important in biological control of insect pests, and may rely on honeydew or pollen and nectar in the adult stages. In Massachusetts, flowering sweet fennel (*Foeniculum vulgare* var. dulce) planted in an organic market garden attracted



Ichneumonid wasp, *Hyposoter exiguae*, attacking a beet armyworm larva

forty-eight species of Ichneumonidae. Fennel is probably also important for parasitic wasps in California, as it has been shown for common knotweed and toothpick ammi. Twenty species of Ichneumonidae were observed taking

extrafloral nectar from faba bean (*Vicia faba*) from late September through late October. For unknown reasons, few ichneumonids visit buckwheat or wild buckwheats.

Predatory Wasps include both social (Vespididae) and solitary species (Eumenidae and Sphecidae). The Vespidae include paper wasps and yellowjackets, which attack many species of caterpillars. Eumenidae also prey mainly on caterpillars. Solitary wasps of the Sphecidae, as a group, attack wide ranges of insects, including caterpillars, crickets, and weevils. All these wasps require nesting sites. Many solitary species are digger wasps that nest in sandy areas. Some social wasps also nest in the ground, others under eaves of buildings or in trees. Social and solitary wasps rely heavily on nectar, and commonly visit flowers and extrafloral nectaries.

In Massachusetts, sweet fennel planted amid an organic market garden flowered throughout the 12 weeks of sampling. Hymenoptera collected from sweet fennel at two sites included four species of Sphecidae (solitary wasps) and four of Vespidae (social wasps). Flowering spearmint (*Mentha spicata*) attracted six species of Sphecidae, two of Eumenidae, and two of Vespidae. Cover crops



Adult western yellowjacket, *Vespula pensylvanica*

that attract many predatory wasps include buckwheat, cowpea (*Vigna unguiculata* ssp. *unguiculata*), and white and yellow sweetclovers (*Melilotus alba* and *M. officinalis*). In Massachusetts, eighteen types of wasps were obtained from buckwheat, and eleven from annual white sweetclover. In Georgia, buckwheat attracted nine types of Sphecidae, two types of Eumenidae, and one type of Vespidae, whereas extrafloral nectar of cowpea attracted ten types of Sphecidae, six of Vespidae, and four of Pompilidae.

Tachinid Flies (Tachinidae) include numerous species that parasitize stink bugs, squash bugs, and the caterpillar stages of various moths and butterflies. Many of these flies are reliant on nectar and pollen during the adult stage. Seven types of tachinid were collected from



Tachinid fly

toothpick ammi. Buckwheat, wild buckwheat, California coffeeberry, coyote brush, other *Baccharis* spp., Toyon (*Heteromeles arbutifolia*), and white sweetclover are also heavily visited.

Softwinged Flower Beetle (*Collops vittatus*) is a brightly colored insect, with wing covers striped with bright red and metallic blue-green. Adults feed on many pests, and are commonly found running rapidly over the foliage of vegetable crops, searching for eggs of moths. Larvae are pink and crawl about on the soil surface, feeding on other insects. Adults are often encountered feeding at the extrafloral nectaries of cowpeas or sunflower, or at the flowers of toothpick ammi.



Damsel bug, *Nabis* sp.



Assassin bug, *Zelus* sp.

ADDITIONAL BENEFICIAL INSECTS

Damsel bug (*Nabis americanoferus*). These widely-distributed predators feed on many mite and insect pests in most vegetable and field crops, but rarely inhabit trees. Nymphs resemble adults except that they lack wings. Damsel bugs often appear in the field later than other predators and are more common later in the summer.

Assassin bug (*Zelus renardii*). Assassin bugs have long, often spiny, bodies with long legs and antennae. They are found in almost any crop or landscape situation and they prey on many insect species, including caterpillars, lygus bugs, aphids and some beneficial species. Their eggs are barrel-shaped and laid in groups.

Carabid or Ground beetles. These soil-dwelling beetles are believed to be important predators in both field, vegetable, and tree crop situations. They are usually black, shiny, and flattened with a prominent thorax that is narrower than the abdomen. They have long legs and run quickly. Their antennae are long and not clubbed like those of most plant-damaging darkling beetles.

Western predatory mite (*Galendromus (Metasieulus) occidentalis*). This predatory mite is common in spidermite-infested fields and orchards in the warmer valleys of California. This mite is commercially available, but many fields have sufficient native populations when left unsprayed. They can be distinguished from two spotted mites by the absence of the two spots on its sides. Their eggs are oval, as opposed to the spherical eggs of the spidermite.

Phytoseiulus persimilis. This rapidly-moving predatory mite is red and is common in spidermite-infested fields, especially along the coast. They are commercially available, but many fields have sufficient native populations if left unsprayed. Originally imported, this mite has become naturalized in California.

Use of Bats to Enhance Insect Pest Control in the Central Valley

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Claudia Funari, Research Assistant, UCCE Yolo County

Bat Houses for the Central Valley

Bats are the most important predator of night-flying insects and consume vast numbers of pests. A single little brown bat can catch 600 mosquitoes in an hour, and a typical colony of 150 big brown bats in the midwest eats 38,000 cucumber beetles, 16,000 June bugs, 19,000 stink bugs and 50,000 leafhoppers as well as thousands of moths in a season. The twenty million Mexican Free-tail bats from Bracken Cave, Texas, eat 25 tons of insects nightly.

Bats are mammals and belong to the group Chiroptera, which means “hand-wing,” as their wings resemble extended arms with fingers and thumbs. They are not rodents, and are closer related to primates than they are to mice. They mate in the fall and generally have one ‘pup’ the following spring. If food is scarce, bats may re-absorb the embryo and fail to reproduce until the following year. Many bats live for thirty years or more.

Most of the bats in the Sacramento Valley migrate south or to the coast for the winter, where food is more abundant. Others may hibernate in caves where they remain dormant during the winter months. Bats often return to their original roosting sites in the spring when the weather begins to warm and insects become more abundant.

Bats are frequently associated with people and are often found in man-made structures. They prefer places that are warm, dry, and protected from disturbance, such as old water towers and in expansion joints under bridges. They have even been found roosting in burlap sacks on several farms in Yolo County.

Bat numbers have declined dramatically in recent years due to habitat loss and human disturbance of roosts. To encourage the activity of bats, the following information provides guidelines on how to build and install bat houses to attract a colony of bats to your property.

Bat House Construction and Installation

Many people have had success in attracting bats to certain areas by erecting bat houses. The species of bats most likely to inhabit bat houses in the Central Valley include: Pallid bats, Big Brown bats, Mexican free-tails, Little Brown bats, and Pipistrelles. The following information describes how to build a structure that meets the needs of bats, and where to place the houses.



Pipistrellus hesperus, western pipistrelle.

image © Merlin D. Tuttle, Bat Conservation International

DESIGN AND MATERIALS

Exterior plywood is the best material to use to make the house, and staples and bolts must be galvanized or of exterior grade. Bat houses need to be at least 32” tall, 14” wide, and have a 3-6” landing pad extended below the opening. Houses should have 1-4 roosting chambers, spaced at 3/4 of an inch. The landing pad and the inside of the roosting chambers should be roughened or have some sort of durable plastic screening for the bats to grab hold. Make sure the house interior has no sharp points (from nails or plastic screening), as bats can tear their wings on them.

Vents should be placed on the houses to avoid overheating and stuffiness, and both front and side vents should be used. Side vents should be 6" tall by 1/2" wide, while front vents should be horizontal, also 1/2" wide and as long as the box is wide.

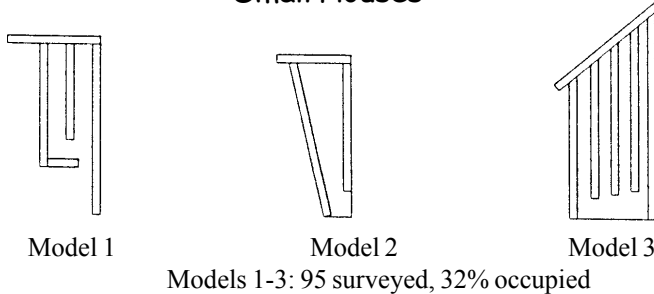
WEATHERPROOFING AND TREATMENT

All seams must be caulked, because bats don't like leaky houses. Remember, this house is going to be up for years, so make it last! Treating the houses with bat guano diluted with water helps make the house smell and feel a little more weathered, which the bats like. You can also produce this same effect by putting the house out during winter, before the bats return for the spring.

OTHER TYPES OF BAT HOUSES

One of the easiest and cheapest ways to install bat houses on buildings is simply to attach sheets of plywood to the barn or house with 3/4" spacers between the sheet and wall. Taller rather than wider pieces of plywood allow for greater temperature variation. Don't forget a landing pad and some mesh for the bats to hang on to.

Small Houses

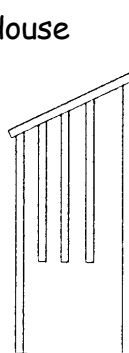


Medium House

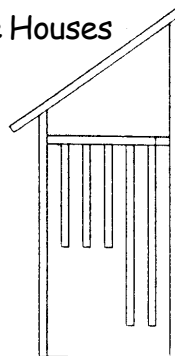


Model 4
12 surveyed
58% occupied

Large Houses



Model 5
69 surveyed
46% occupied



Model 6
51 surveyed
71% occupied

EFFECT OF SOLAR RADIATION

Temperatures in the Sacramento Valley are **HOT** and can deter bats from your bat house. Use thick wood (at least 1/2" thick) for insulation of the house. We suggest putting houses up inside barns or on the north or west facing side of a building. Combined with the thick insulated wood, this protects bats from extreme temperature fluctuations.

Houses should be tall enough (at least 2') to allow for temperature variation within the house. If there is temperature variation in the house, bats can move around to adjust to the temperatures during the day.

LOCATION

The following factors need to be taken into account:

- Any place that already has bats is best.
- Any place near water as they need to drink every night, usually right after they emerge at dusk. The suggested distance from water is a quarter of a mile.
- Bats prefer agricultural areas over urban areas, mainly because of the diversity of habitat and the abundance of insects.
- Houses should be placed near areas with any sort of protected cover, like a grove a trees for instance. The most dangerous times for bats are at dusk and at dawn when both nighttime and daytime predators are hunting. A place of cover to immediately duck into after they emerge gives the bats needed protection from predators.
- Houses should be placed 20-25' from the nearest tree; this gives them flying space when they emerge, and protects them from any tree climbing or perching predators.
- Finally, do not place boxes near Barn Owl boxes! This is a common mistake. While barn owls do help out by eating rodents, they also eat bats. Place your house a fair distance from your Barn Owl box, and don't face them towards each other.

BAT HOUSE PLACEMENT

- Bat houses in barns and on the north and west sides of buildings have had the greatest rate of occupancy.
- To protect the houses from predators they should be at least ten feet off the ground
- DO NOT mount onto a metal building. The houses will get far too hot for bats.
- Houses should not be lit by bright lights.
- Do not tilt bat houses. Some people say tilting houses helps bat pups hang on. But in lean years, mothers actually need to kick their babies out of their houses because they don't have the resources to feed their pups. So let nature take its course.
- Put houses up before bats return in spring. Usually the winter is best. This way houses smell weathered and old.

MOUNTING BAT HOUSES

Mount houses on the north or west facing side of the house, directly under the eaves. Screw or nail both top and bottom of house to the existing structure (barn, shed, etc.) for best results. Use no larger than 2 1/2" screws. If points extend into box, the bats might catch and rip their wings.

Bat House Maintenance

Bat houses don't require much maintenance. After a couple years you might think of re-caulking or putting on another coat of paint. This insures that the houses are sealed and protected from the weather while the bats are living in them.

Look out for wasp nets. Wasps and bats can live together in bat houses. However, if the wasp nests take up too much space, the bats will probably look elsewhere for housing. To avoid this, try wiping the nest out of your bat box in the winter months when both bats and wasps are absent.

Time Until First Occupancy

Most bat houses used by bats are occupied in the first or second season. If you don't see occupancy after the second year, move the house to another location. Bat houses that have not had activity for five

years have less than a one percent chance of being occupied in successive years.

Checking for Occupancy

You might want to look into your house every so often and see who's there. The best way to check for occupancy is to observe the houses at dusk on a warm evening to see whether bats emerge. You can also look for droppings on the ground (guano) that are similar in size and appearance to rat droppings.

Health Concerns

Contrary to popular belief, bats are not blind, do not become entangled in human hair, and seldom transmit diseases of other animals and humans. Less than 1/2 of the one percent of our colonial bats contract rabies, and when they do, they develop a type of paralysis, fall to the ground and quickly die. There has never been an epidemic outbreak of rabies in bats. If you do see a bat on the ground, treat it with the respect that you would give any wild animal and leave it alone. By leaving it alone, you remove the risk of contracting any diseases.

Bat droppings do not pose any greater health threat than bird or cat droppings. Inhalation of dust associated with animal feces of any kind should be avoided.

Removing Bat Colonies

Sometimes bats inhabit areas where they are not wanted. To remove bats, watch to see where the bats emerge at dusk. Then place a piece of fiberglass window screen over the exit hole so that the material hangs at least a foot down. This serves as a one way valve so that the bats can crawl out, but they can't get back in. Avoid sealing areas where bats occur during late spring and early summer when flightless young are often in the roosts.

If you are serious about experimenting with bat house design or would just like help or be involved in a nation-wide research project devoted to collecting information on bat houses, contact Bat Conservation International, P.O. Box 162603, Austin, Texas, 78716, or call 512.327.9721.

If you would like more information on how to construct bat houses, call BCI or Yolo County Farm Advisor, Rachael Freeman Long at the UC Cooperative Extension, 530.666.8143.

Who Might I Find In My Bat House?

from *Bat House Builders Handbook*, Merlin Tuttle and Donna L. Hensley

images © Merlin D. Tuttle, Bat Conservation International

Bats of California that Will Roost in Bat Houses:

Little Brown Bat, *Myotis lucifugus*

This is the most common bat in Canada and the northern two-thirds of the United States. This is one of the species most likely to occupy bat houses. They can be found almost everywhere in the Central Valley. They are extremely heat-tolerant with body temperatures recorded up to 129°F (54°C). They roost in woody areas, buildings, rock crevices, tree hollows and bat houses and will also roost with Big Brown Bats. They tend to eat mosquitos, moths, and other night-flying and aquatic insects.

Big Brown Bat, *Eptesicus fuscus*

This bat is attracted to caves, abandoned mines, and buildings. They are less likely to tolerate high temperatures, but they do tolerate very low temperatures. It has been found that their body temperature can reach sub-freezing degrees. Therefore, they do not migrate and can be found overwintering in bat houses. They prefer beetles and tend to hunt around areas with trees.



Eptesicus fuscus, big brown bat, in flight with beetle.



Pallid Bat, *Antrozous pallidus*

This is one of the more interesting-looking bat species. Their ears are about half as long as their heads and bodies combined! You can bet these bats have a marvelous sense of hearing! They are ground feeders and tend to eat larger prey such as grasshoppers, beetles, and even scorpions. This species doesn't migrate, but just hibernates in the same area deep within rock crevices. These bats are attracted to buildings, bat boxes, rock crevices, and spaces under bridges. They are one of the few bats that like the aridity of the central valley.

Mexican Free-Tailed Bat, *Tadarida brasiliensis*

This bat is named "free-tail" because its tail projects past the membrane that connects its legs and tail. Thus the tail is "free" of the membrane. This is another species most likely to occupy bat houses. It is the most colonial of all species. One of the largest roosts, at Bracken Cave in Texas, holds up to 20 million bats. This bat overwinters in Mexican and Central American caves and migrates back to the central valley in the spring. These bats eat an enormous amount of moths and mosquitos.

Using Transplants to Establish Native Grasses, Sedges, and Rushes (Plug Planting)

John H. Anderson, Hedgerow Farms

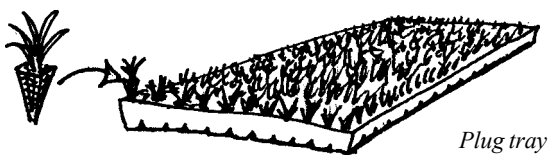
illustrations by Paul Robins

Reasons for Using Transplants

There are several benefits to using transplants to establish native grasses, sedges or rushes. One of these is rapid establishment, which could be an important consideration in some restoration projects. For some species, sufficient seed of locally adapted biotypes may not be available in large enough quantities to broadcast. In this case, greenhouse grown transplants provide a much more efficient use of available seed and weed control can be optimized during the first season. Mechanical or chemical means can be used in advance of planting to provide a “clean slate” for young plugs and minimize weed competition. Another advantage is that with advanced maturity of transplants, many will produce seed the first season and begin the process of filling in non-vegetated areas.

Transplant Types

Thanks to the vegetable transplant industry, techniques to economically reproduce large quantities of high quality transplants have been developed. Small transplants grown in flats of 200 plants (1-1/4 in. x 1-1/4 in. x 2-1/2 in. cells) are easy to grow and plant. If planting is done correctly, survivorship is excellent. Transplants grown in larger stubby cells are excellent, but the plants are more costly and planting them requires more labor. In most cases where there is adequate soil moisture at the time of planting, the larger size transplants are not necessary.



Ordering Transplants

Most cool season grass transplants require 6-10 weeks of growing time before they are ready to plant. Once plants are ready, they can be stored in a cool

environment for 4-8 weeks before planting. Order in September or early October to be ready for a December or January planting.

Site Preparation

GROUND TREATMENT

Plug transplants can be put in almost any type of soil as long as it is moist. The roots of healthy transplants penetrate the surrounding soil in just a few days. In weedy areas where there can be a heavy layer of thatch that contains weed seed, fire is recommended to remove the thatch. Fall burns just after the first germination usually kill all early germinating weeds. Mowing and raking may be an option for smaller areas.

WEED CONTROL PRIOR TO PLANTING

In weedy sites, it is ideal to practice one year of vigorous weed control to reduce the weed seed bank. If that is not possible, weeds should be controlled just prior to planting in the fall or winter. The most effective controls are broad-spectrum herbicide applications, two days to two weeks prior to planting. If weed growth begins early in the fall and scheduled planting is in January, an additional earlier application may be required. Propane weed flammers can be used in place of herbicides, but weeds must be small at the time of flaming.



Individual plug tube

Planting Time

In the Sacramento/San Joaquin Valley and adjacent foothills, assuming there is no irrigation available, planting should be done in December, January, or early February. In very wet springs as in the El Niño year of 1998, planting could be as late as March. If there is reliable irrigation available, planting can begin earlier and go into mid-April, depending on the plant species being used. There must be good

ground moisture at the time of planting and in weeds sites, maximum weed germination is desirable before planting. The more weeds have germinated and killed early on, the fewer the weeds to control later.

Planting Techniques

A hole is made with a dibble stick that easily penetrates the ground and makes a hole similar to the size and shape of the plug. A plant is placed in the hole and the top is sealed by pinching it with fingers or compacting it with a blunt stick. The most effective method for planting is to work in teams of three: a hole-puncher, a planter who also carries the plants, and a follow-up sealer. Depending on the site, a good team of three can plant 300-500 plants per hour.

Transplants respond well to nitrogen fertilizers that are applied just prior to planting or while plugs are still in the containers.

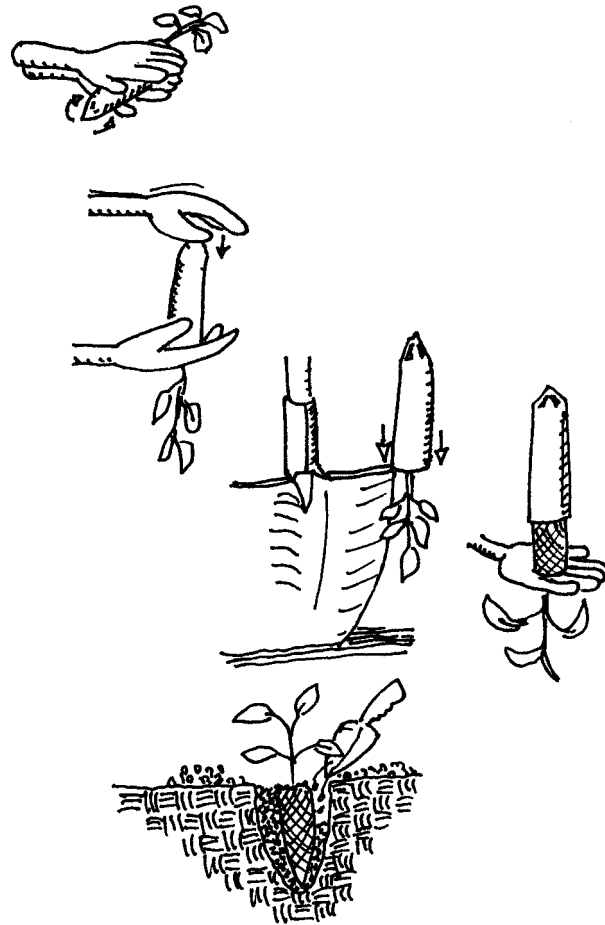
Planting Density

Low density plantings would include 1-3 plants per square yard (4,840-14,520 plants per acre). This density may not be the desired end result density, but it provides seed-producing plants rapidly. Under proper management (fire, grazing, mowing), those species that are best adapted to the site will reseed and have good seedling survival. As additional plants are added to the population, a self-evolution of the local ecosystem can theoretically occur.

High density plantings would include 9-27 plants per square yard (43,560-130,684) plants per acre. High density planting should be used where rapid and complete cover is desired by the end of the first year. These are generally small or highly visible projects.

Follow-up Management

Post planting management basically involves the control of weeds. Some pre-emergent herbicides can be used immediately following planting. Be sure to follow label recommendations. In low density plantings, management strategies should encourage reseeding from the established plugs. Along with weed control, this might include some soil disturbance to provide a seed bed for the newly-dropped seed.



Planting technique

Propagation of Trees and Shrubs by Stem-Cutting

Tom Griggs, Restoration Ecologist, The Nature Conservancy

Willows, Cottonwood, Mulefat, and Coyotebrush respond well to this type of propagation.

Uses

- Nesting and foraging habitat for songbirds
- Roosts for raptors
- Windbreaks for waterfowl roosting areas
- Visual screens to hide vehicles on roads

Site Selection

The planting area should have a shallow water table and the appropriate soil texture and profile to suit the tree. Willows and cottonwoods *must* grow their roots into permanently moist soil, otherwise they cannot survive. All cottonwoods and willows usually grow into the surface of the soil water table, from one to ten feet below the soil surface. Seepage from canals and ditches will also provide a year-round moist soil zone. All prefer a loamy soil texture for optimum growth. Only Valley willow (*Salix goodingii*) appears to thrive on heavy clay soils.

Site Preparation

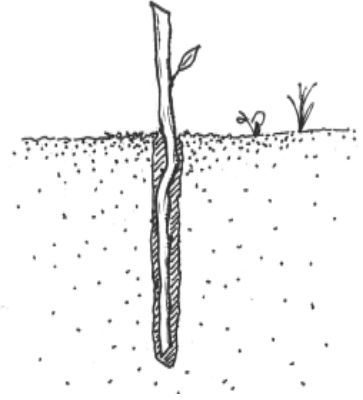
The planting spot should be recently tilled soil with no weeds. Tillage of the soil will benefit the early growth of the cutting by facilitating root growth. A post-hole soil auger on the PTO of a tractor can deep-till scores of planting holes per hour. The depth of the hole should be to the upper edge of the water table. Alternatively, a planting trench can be easily created by dragging a ripping-shank through the soil.

Collection

Cut *first-year* stems of 3/4 inch diameter. Length should be between 3-6 feet. Keep cuttings moist at all times in a plastic bag or in a bucket with water. It is important to both cut and plant your cuttings before bud swelling, as the wood's rooting hormones are diverted for flowering after bud break, diminishing your chances for plant rooting and establishment.

Planting

Cuttings should be soaked in a bucket of water overnight before planting. Water need only cover the cut bases. When planting, at least 2-3 feet of the cutting should be buried in the soil. A hole can



be prepared with a ram rod or auger, but in very soft, moist soil, the cutting can be shoved directly into the soil. Trim the above-ground portion back to 1'. Make certain that the cutting is upright (buds pointing upward), as an upside down cutting will not sprout. Compact the soil around the cutting to remove air pockets in the soil. Rooting hormone (Indole acetic acid or indole butyric acid = brand names: Rootone, Dip-n-gro, Hormex) may increase the amount of roots initially produced by the cutting, which in turn will result in a vigorous sapling sooner.

Irrigation

The first goal of irrigation should be to keep the rooting zone damp. The most frequent cause of mortality during the first season is drying of the cutting before a sufficient root system has developed. The upper end of the cutting will lose water on warm, dry days in the spring. This desiccation can overwhelm an underdeveloped root system, resulting in death of the entire cutting.

A second goal of irrigation is to grow the root systems down to the water table. This may involve a deep-irrigation schedule to entice the roots to grow down to deeper water tables.

At the opposite extreme, too much water, as in ponding for days, will cause the cutting to rot.

Weeds

During the first season weeds should be controlled. Cottonwood and willows do not tolerate shading by weeds. A dense stand of weeds will also impede root growth of the cutting. By the second year, roots of the saplings should be deeper than the roots of the weeds.

Deer and Rodents

Deer will browse all the leaves off a sapling, slowing its growth. Commercially available deer-repellents are effective, if applied early and regularly. One solution is to plant more cuttings than the local deer herd can eat.

Meadow voles (*Microtus* spp.) may eat the bark at the base of the cutting, thereby girdling and killing it. Voles can be controlled by removing weeds and other cover from around the cutting. Raptor roosts can also help control the smaller rodents.

Beavers can be a major problem. Hundreds of cuttings have been known to disappear overnight as a result of beavers. Only physical protection (fencing) can help.

First and Second Year Maintenance Strategies

The first season maintenance should focus on frequent irrigations and weed control. By mid-summer irrigations should be less frequent and deep to promote a deep-growing root system.

If the sapling's roots have not connected with the soil water table, then a second season's irrigation may be necessary. Infrequent, long duration irrigations should be applied. Water stress symptoms are yellowing of older leaves followed by drooping of the tree.

How to Grow California Oaks

Douglas D. McCreary, Natural Resource Specialist, UC Cooperative Extension

Native oaks are a vital and important component of the vegetation of California. They grow in a wide variety of habitats and help provide a distinctive character to the landscape. Not only are they beautiful to look at, but they also provide food and shelter for many wildlife species, they stabilize soil, and they help counteract the “greenhouse effect” by taking up carbon dioxide and producing oxygen.

It is estimated that one or more species of oaks grow on over 20 percent of the state’s 100 million acres of land. Unfortunately, there are also reports that some native oaks may not be regenerating very well in some locations. Poor natural regeneration raises concerns about the long term fate of these species. To assist Mother Nature in establishing new oak trees, efforts are underway to plant acorns and small seedlings. Such regeneration efforts will ensure that our magnificent oaks, which have graced California valleys and foothills for thousands of years, will be around for future generations to enjoy.

The following guidelines provide successful techniques for growing oak trees. While there are many ways to get an oak tree started, the procedures described have proved successful for a variety of species and environments.

Acorns or Seedlings?

Oak trees can be started by either directly planting acorns or transplanting small seedlings. However, since relatively few native oak seedlings are produced in the state, it may be difficult to purchase them. Those that are produced are generally grown in containers and should be no more than one year old before transplanting since they quickly outgrow small pots. Even with the largest containers, it is important that seedlings be transplanted within a couple of years since oaks tend to produce massive root systems and can easily become “pot-bound.”

Some bareroot oak seedlings are also available. Recently the California Department of Forestry Nursery at Magalia began growing, and making

available to the public, several species of oaks. The supply of both container and bareroot oak seedlings should increase in future years as techniques for rearing them are developed and perfected, and more people express an interest in planting native oaks.

The choice of whether to plant acorns or seedlings depends on many factors, including availability and conditions at the planting site. Generally, acorns are easier to plant, but the survival of seedlings may be greater if they are planted correctly at the right time of the year. Another influencing factor is the type of predators present on the planting site. If there are high populations of acorn-eating rodents (ground squirrels or deer mice), it may be easier to plant seedlings than to try to protect the acorns.

Maintain Local Seed Sources

Since most tree species have adapted to the specific environments where they grow, it is important to only plant a given oak species in areas where it naturally occurs or where it may have grown in the past. Even within a species, you must be careful to only plant acorns or seedlings that come from a parent tree growing in the same general environment. If you took an acorn from a blue oak tree growing on the coast and planted it in the foothills of the Sierra Nevada, for instance, it would probably grow poorly or die, even though blue oaks grow in both locations. Since coastal trees are genetically adapted to more temperate, moister conditions, they would be subject to injury from the colder, drier conditions of the interior. If you collect acorns yourself, you can be sure where they come from, and know that they are also handled and stored properly. If you buy from a nursery, make sure you find out the location and the elevation of the acorns collected, and insist on seed sources from as near your planting site as possible.

Collecting Acorns

Acorns can be collected either directly from the trees or from the ground beneath. However, the healthiest acorns are generally those picked from the

trees. Those that fall to the ground often dry out and are damaged--especially if they lie exposed for more than a few days during hot and dry weather. If you collect acorns from the ground, leave behind those that are very small, cracked or feel light and hollow. Acorns collected directly from trees can be handpicked or knocked to the ground using long poles or pieces of plastic pipe. It's easy to pick them up if you place tarps under the trees first.

The best time to collect acorns is in the late summer and early fall, when they are just starting to turn from green to brown and some are starting to fall to the ground. It's probably too early to collect them if they are all dark green and it is difficult to remove their caps (the cup covering the rounded end). Wait a couple of weeks and check them again.

Storing Acorns

Prior to storage the caps on all acorns should be taken off. They should come off easily when twisted. Acorns collected directly from the trees should be put in zip-lock bags and immediately placed in a refrigerator. Refrigeration slows the metabolic activity and helps prevent them from heating up or drying out--both of which can be damaging. A recent study indicated that storing acorns in a refrigerator for a month or so before planting resulted in faster and more complete germination than planting acorns immediately.

Acorns picked up off the ground should be soaked for a day before they are placed in cold storage. Those that float should be discarded. "Floaters" are generally acorns that have been damaged by insects or have dried out while they were on the ground. "Sinkers" should be saved. Remove the acorns from the water and place them in plastic bags in the refrigerator. Check them occasionally for molds. If molds do develop, take the acorns out and rinse them, and then put them back in the refrigerator.

Another problem that can develop in cold storage is premature germination. Blue oak acorns are especially prone to this. The white tip emerging from the pointed end of the acorn is actually the start of the new root system. Once these roots have grown for a few weeks, they can start to go bad and turn dark brown or grey and mushy. Therefore, if you see the acorns starting to germinate in storage, you should plant them as soon as possible.

Acorn and Seedling Planting

Acorns can be planted from early November (after the first rains have soaked the soil) until early March. It is generally better, however, to plant the acorns early in the season since the earlier they are placed in the ground (after one month cold storage interval), the earlier they start to grow. Early planting also reduces the problems associated with premature germination.

Plant the acorns one-half to one inch below the soil surface. Dig a hole using a hand trowel, hoe, or shovel. It's best to dig the hole several inches deeper than the acorn is actually planted, and then partially fill the hole back up with loose soil. This gives the new root a chance to get a good start in soft, easy-to-penetrate soil. If the acorns have germinated, try not to break the root tip, and position it so that the root is pointing down. Even if the tip of the root has begun to turn brown, the acorns are still okay as long as some of the root is white and fleshy. Place ungerminated acorns on their sides in the hole and cover with soil.

Planting seedlings requires a little more care due to the greater risk of transplant shock and root injury. Seedlings should be planted between December and February, when the soil is wet but not frozen. When planting container seedlings, try to keep the soil from falling off the roots. Place the seedlings in the ground such that the top of the soil from the container is even with the ground line. It is especially important not to plant the seedlings so shallow that the potting mix sticks up in the air, since this can cause the seedlings to desiccate due to moisture "wicking out". If you are planting bareroot seedlings, be sure not to "J-root" them (planting in too shallow a hole so the root bends up). Also, tamp the soil down in the planting hole to remove air pockets. If possible, water the transplants when they are planted. This settles the soil, insures there is adequate moisture, and helps eliminate air pockets.

Recent studies have indicated that auguring deep holes (2-3 feet) below planting spots and backfilling with broken-up soil can promote deep root development and stimulate vigorous growth. This is especially beneficial if you are planting in hard, compacted ground. Deep root development provides seedlings with greater access to moisture, thus reducing the ill effects of summer drought. Placing a fertilizer tablet a few inches below and to the side of the bottom of the root can also help ensure

that the developing seedling will have plenty of nutrients for its initial growth.

The site where you choose to plant acorns or seedlings may also be critical for their success. Choose a sunny spot that has loose, well-drained soil and is fairly free of weeds. Also, avoid areas where there are lots of pocket gopher mounds or ground squirrel activity. If you feel that the acorns may be threatened by rodents such as squirrels or mice, plant them a little deeper--about two inches below the surface. If they are planted deeper, it might be harder for these animals to dig them up. If they are planted too deep, however, they may rot in the soil and fail to germinate.

Planting Layout

The number of acorns or seedlings to plant in a given area depends on how many oaks you eventually want to grow there. Unfortunately, it is very difficult to predict how many trees will be produced from plantings, since many uncertain factors, including weather, animals, and competing vegetation can influence the outcome. When laying out the planting area, consider spacing seedlings or acorns in a natural manner, rather than in straight rows, using surrounding oak trees as a model. On open rangeland, it is recommended that trees be established in small clumps or clusters, with the goal of about 40 planting spots per acre. This comes out to an average of one cluster every 30-40 feet. Within each cluster, plant 3-4 seedlings. In restoration projects in riparian zones, a greater density is usually desirable, so have the clusters closer together, at about 15-20 feet apart.

Seedling Maintenance and Protection

Another critical factor affecting young oak seedlings is competing vegetation. Adjacent plants--especially grasses--can use up so much of the available soil moisture that little is left for the seedlings. It is therefore recommended that a 2-3 foot radius around the planting spots be cleared of other vegetation. This can be done by hand weeding, hoeing, scalping, or by spraying a contact herbicide. However, with any of these methods, be sure to check back in spring and early summer to remove any additional weeds that may have come up.

Another way of reducing weeds near seedlings is to place some type of mulch around the planting spots.

Bark chips, straw, compost, mulching paper, or even black plastic can be used. Mulches have an added benefit in that they also help conserve moisture by reducing evaporation from the soil surface. In areas where water is accessible, several deep irrigations (2 gallons per seedling) during the late spring and early summer can also help ensure that the seedlings are not damaged by drought.

Since acorns are an important food source for many different animals, there is always a risk that some will be dug up and eaten. As the seedlings start to grow in the spring, there also exists the chance that livestock, rabbits, grasshoppers, or other animals will eat their tender young shoots. The risk of such injury to both acorns and seedlings can be reduced by placing protective cages around the planting spots. One type of cage that has worked well in research plots consists of an 18x18 inch aluminum screen that is formed into a 5-inch diameter cylinder and stapled to a 1x2x24 inch wooden stake. The cylinder is folded closed at the top. The stake is driven into the ground so that the screen cage covers the spot where the acorn or seedlings are planted. This cage will keep out rodents, insects, and browsing animals. Another cage consists of a screen cylinder placed around a 1-quart yogurt or cottage cheese container that is open at both ends. Place the quart container in the soil so that the top is at the soil surface. This protective cage will not only prevent stem damage, but will also help keep out burrowing animals such as gophers which often can damage roots.

When the seedlings grow to the top of the screen cages, open the cages up so the seedlings can continue to grow. You're now well on your way to establishing an oak tree!

*For more information on planting oaks of California, contact your local University of California Cooperative Extension Farm Advisor's Office, or check the website for the Integrated Hardwood Range Management Program at danr.ucop.edu/ihrmp/. For distribution range maps, see poster: *Oaks of California*, by Good Nature Publishing Co., 1904 Third Avenue, Suite 415, Seattle, Washington, 98101 or visit www.goodnaturepublishing.com, or see text: *Oaks of California* by Bruce M. Pavlik, Pamela C. Muick, Sharon G. Johnson, and Marjorie Popper (1991), Cachuma Press.*

HOW TO GROW CALIFORNIA OAKS

Latin name	Common Name	Elev Range (ft)	Elev Range (ft) South	Associations	Habitat types
<i>Quercus agrifolia</i>	Coast Live Oak	3000	to 5000	Forms pure stands; also grows with interior live oak and coast live oak	Common on valley floors or not-too-dry fertile slopes
<i>Quercus berberidifolia</i>	Scrub Oak	1000-5000			Dry slopes, chaparral
<i>Quercus chrysolepis</i>	Canyon Live Oak	300-5000		Found with mixed conifer, chaparral, and woodland species; tanoak, Douglas-fir, Pacific madrone, coast live oak	Most widely distributed oak in CA.; sheltered north slopes and steep canyons
<i>Quercus cornelium-mulleri</i>	Muller Oak	3000-6000			slopes, granitic soils, chaparral, pinyon woodland
<i>Quercus douglassii</i>	Blue Oak	500-2000	to 5000	Grades into open Valley oak stands at low elevations, blends into denser Live oak stands at higher elevations, foothill pine common	Hot, dry sites with rocky soils, 12-40 in. deep; can't compete with live oak on better sites
<i>Quercus dumosa</i>	Nuttall's Scrub Oak	<700 rare			Generally sandy soil near the coast, sandstone, chaparral, coastal-sage scrub
<i>Quercus durata</i>	Leather Oak	500-5000			Chaparral
<i>Quercus engelmannii</i>	Engelmann Oak	<4000		In pure stands & with Coast live oak	Warm, dry fans and foothills
<i>Quercus garryana</i>	Oregon White Oak	500-3000		Douglas fir, mixed evergreen forest, Pacific madrone & tanoak	Cool humid sites near coast to hot, dry sites inland
<i>Quercus john-tuckeri</i>	Tucker Oak	3000-6500			slopes on desert borders, chaparral, pinyon/juniper woodland
<i>Quercus kelloggii</i>	California Black Oak	200-6000		Most common with tanoak, madrone, mixed conifer forest species; also with coast live oak, interior live oak, and blue oak	More common on forest sites; found on moister hardwood rangelands; well-drained soils. Slopes, valleys, woodland, coniferous forests
<i>Quercus lobata</i>	Valley Oak	500-800	to 5600	Blue & Oregon white oak, sometimes Interior live oak.	Uncommon. Prefers fertile, well-drained bottomland soils, streambeds, and lower foothills. Slopes, valleys, savannah
<i>Quercus palmeri</i>	Palmer Oak	2300-4300			Rocky slopes and flats
<i>Quercus parvula</i>	Island Scrub Oak	<3300			Canyons, slopes, chaparral, woodland
<i>Quercus sadleriana</i>	Deer Oak	2000-7200			Open rocky slopes, ridges, coniferous forests
<i>Quercus tomentella</i>	Island Oak	<2000			Uncommon: canyons, slopes, woodlands
<i>Quercus turbinella</i>	Desert Scrub Oak	4000-6500			Pinyon/Juniper woodland
<i>Quercus vaccinifolia</i>	Huckleberry Oak	3000-9000			Steep slopes, ridges, coniferous forests, subalpine
<i>Quercus wislizenii</i>	Interior Live Oak	,2000	>6200	In pure stands or mixed with blue and/or coast live oak, and valley oaks in So. California	Wide range, from valleys to foothills; moister areas than blue oak

Information in this table is summarized from the resources mentioned at the end of this article and from the *Jepson Manual of Higher Plants of California* by James C. Hickman.

Effective Herbicides for Use in the Establishment of Native Grasses

Bryan Young, Sacramento County Bufferlands Program

Weed control is one of the single most important factors in establishing a native grass system. When applied appropriately, herbicides can be an extremely valuable and cost-effective tool in the battle against exotic weeds. In fact, many native grass professionals have deemed the use of herbicides fundamental in the process of native grass establishment. The following

provides summarized information on several herbicides that have been successfully used in the establishment of native grass projects. Keep in mind that much more information is available on the product label and material safety data sheets. This information is provided by your chemical distributor and must be read by the applicator before using the product.

ACTIVE INGREDIENT	REGISTERED PRODUCT NAMES*	GENERAL DESCRIPTION	DESCRIPTION OF USE FOR NATIVE GRASS PROJECTS	APPROX. CHEMICAL COST PER ACRE (1999)
Glyphosate	RoundUp® RoundUp Ultra® RoundUp Pro®	A postemergent systemic herbicide with no residual soil activity. Controls a broad spectrum of weeds by inhibiting metabolism and protein synthesis. This product will damage or kill native grasses.	<ul style="list-style-type: none"> • Glyphosate is an excellent tool for depleting weed seed banks. • Low rates of glyphosate can be used to kill off early flushes of cool season weeds. • In order to keep an area chemically fallowed year round, slightly higher rates are often needed to control warm season weeds. • Seeding native grass into area immediately after treatment is not a problem. In fact, seeded areas can be treated with glyphosate up to the point of native grass seedling emergence. • If drift damage to natives can be avoided or tolerated, glyphosate can be used for spot treatment of difficult weeds. <p>Glyphosate activity and control spectrum can be enhanced and broadened by mixing with an activator containing ammonium sulfate or through tank mixing** with a variety of other herbicides.</p>	\$7 - \$45

ACTIVE INGREDIENT	REGISTERED PRODUCT NAMES	GENERAL DESCRIPTION	DESCRIPTION OF USE FOR NATIVE GRASS PROJECTS	APPROX. CHEMICAL COST PER ACRE (1999)
Octanoic acid ester of Bromoxynil	Buctril®	A selective postemergent herbicide that controls many broadleaf weeds in their early growth stages by blocking photosynthesis.	<ul style="list-style-type: none"> • Can be used for early season treatment of broadleaf weeds, after grass seedlings have reached the three leaf stage. Other broadleaf selective herbicides would likely injury grass seedlings at this stage. Note: This herbicide used alone is only effective on broadleaf weeds in early stages of growth. • This chemical can be tank mixed** with other herbicides to increase weed control spectrum. 	\$20- \$40
MCPA	Rhonox®	A selective postemergent herbicide that controls a broad spectrum of broadleaf weeds.	<ul style="list-style-type: none"> • Can be used for early season treatment of broadleaf weeds, after grass seedlings have reached the three leaf stage. Other broadleaf selective herbicides would likely injure grass seedlings during this stage. Note: This herbicide used alone is only effective on broadleaf weeds in early stages of growth. • This chemical can be tank mixed** with other herbicides to increase weed control spectrum. 	\$2 - \$15
Triclopyr	Garlon 4® Remedy®	A selective postemergent herbicide that controls broadleaf weeds at a variety of plant growth stages.	<ul style="list-style-type: none"> • Used to control a variety of broadleaf weeds through late spring. Great caution should be taken when using this product for later season applications, as this product will volatilize in temperatures over 80° F. Volatilized chemical can easily drift and damage non-target plants • Triclopyr provides excellent control of perennial pepperweed when applied in spring. 	\$25 - \$100
2,4-D	Weedar 64® Amine 4® Garlon 3A®	A selective postemergent herbicide that controls broadleaf weeds at a variety of growth stages.	<ul style="list-style-type: none"> • Used to control a variety of broadleaf weeds throughout the year at a low cost per acre but, it is not as effective as triclopyr in cooler temperatures. • This chemical can be tank mixed** with other herbicides to increase weed control spectrum. 	\$6 - \$25

EFFECTIVE HERBICIDES FOR USE IN THE ESTABLISHMENT OF NATIVE GRASSES

ACTIVE INGREDIENT	REGISTERED PRODUCT NAMES	GENERAL DESCRIPTION	DESCRIPTION OF USE FOR NATIVE GRASS PROJECTS	APPROX. CHEMICAL COST PER ACRE (1999)
Dicamba	Banvel®	A selective postemergent herbicide that controls many broadleaf weeds by affecting root growth.	<ul style="list-style-type: none"> • Often used in a tank mix with 2,4-D or Buctril to broaden the scope of broadleaf weeds controlled by the herbicide application. • This product provides very effective later growth stage control of broadleaf weeds such as star thistle and sweet clover. 	\$35 - \$140
Clopyralid	Transline®	A specialty herbicide used for selective postemergent control of broadleaf weeds.	<ul style="list-style-type: none"> • This product provides excellent postemergent control of yellow star thistle. 	\$12 - \$65
Oxyflourfen	Goal®	Supplemental labeling, California only. A selective herbicide that controls susceptible weeds by inhibiting metabolism and protein synthesis. Control is both pre and postemergent.	<ul style="list-style-type: none"> • Used to control a variety of broadleaf weeds through pre and postemergent action. • Preemergent control is targeted for broadleaf weeds, but may have some effect on grass seedling recruitment. • Provides excellent postemergent control of cheeseweed (<i>Malva spp.</i>). 	\$30 - \$120
Fluazifop	Poast® Fusilade®	A selective postemergent herbicide for the control of annual and perennial grass weeds.	<ul style="list-style-type: none"> • Used to control grass weeds in well-established grass and fine fescues. Use of this herbicide will likely result in observable damage to native grass. Well-established grasses will survive this damage. Finer bladed grasses will incur less damage. • Used for effective spot control of Johnson grass. 	\$8 - \$90
Chlorsulfuron	Telar®	An herbicide that can be applied for preemergent or postemergent control of many annual, biennial, and perennial grass and broadleaf weeds. Action is through interference with plant cell division.	<ul style="list-style-type: none"> • Used for postemergent control of many broadleaf weeds. Very good for control of perennial Pepperweed. Use caution when applying around desirable woody vegetation as drift can cause damage or death. • Used for preemergent and early postemergent control of annual rye grass. 	\$10 - \$70

ACTIVE INGREDIENT	REGISTERED PRODUCT NAMES	GENERAL DESCRIPTION	DESCRIPTION OF USE FOR NATIVE GRASS PROJECTS	APPROX. CHEMICAL COST PER ACRE (1999)
Diuron	Karmex®	An herbicide that can be applied prior to the emergence of weeds for control of susceptible weeds for an extended period of time or post-emergence for control of susceptible weeds when environmental conditions are favorable. This herbicide blocks photosynthesis in susceptible weeds.	<ul style="list-style-type: none"> Used for pre-emergent broad-spectrum control where seedling recruitment is less important than pre-emergent weed control. 	\$25 - \$75

*These are general guidelines for herbicide use in the establishment of native grasses. They are intended to help you in making decisions. The information provided and the use of trade names does not constitute a specific recommendation of the products listed. Always follow label recommendations and comply with federal, state, and local authorities regarding restrictions on pesticide use and the latest reentry intervals.

**Unless specifically directed against in the label, mixing different herbicides in a tank is a common and legal practice used to maximize herbicide application efficiency. Before mixing herbicides in a tank, test mixtures for compatibility in a glass jar. Incompatible mixtures could lead to equipment damage or an ineffective treatment. Compatibility charts are available from pesticide manufacturers and distributors. Some special safety and reentry restrictions apply when using a mixed tank. This information must be obtained before applying any tank mixes.

Common Herbicides and their Effectiveness on Certain Weeds (UC Cooperative Extension)**

	Preemergence								
	Casoron	<i>Karmex*</i>	Devrinol	Solicam	Surflan	<i>Goal</i>	Simazine	Treflan	Prowl
Annual Broadleaves									
Cheeseweed (Malva)	C	P	P	P	P	C	P	N	N
Chickweed	C	C	C	P	C	N	C	C	C
Clover	P	P	P	N	N	P	C	N	N
Fiddleneck	C	C	C	P	C	C	C	C	C
Filaree	P	C	C	P	N	C	N	N	N
Flax-leaved Fleabane	C	N	N	N	N	N	C	N	N
Goosefoot	C	C	C	C	C	C	C	C	C
Groundsel	C	N	P	P	N	C	C	N	N
Henbit	C	C	N	P	C	C	C	C	C
Horseweed (Marestail)	P	N	N	N	N	N	C	N	N
Knotweed	C	C	C	P	C	P	C	C	C
Lambsquarter	C	C	C	P	C	C	C	C	C
Mustard	C	C	P	P	N	C	C	N	N
Nightshade	C	C	N	C	P	C	C	N	P
Pigweed	P	C	P	P	C	C	C	C	C
Prickly lettuce	C	C	C	C	N	C	C	N	N
Puncturevine	C	P	N	C	C	C	P	P	P
Purslane	C	C	C	C	C	C	C	C	C
Shepherdspurse	C	C	N	P	N	C	C	N	N
Sowthistle	C	C	C	C	N	C	C	N	N
Spurge	C	P	N	C	C	C	P	C	C
Wild radish	C	C	N	N	N	C	P	N	N
Annual Grasses									
Annual Bluegrass	C	C	C	C	C	P	C	C	C
Barnyardgrass	P	C	C	C	C	P	C	C	C
Crabgrass	P	C	C	C	C	N	P	C	C
Ryegrass	N	C	C	C	C	N	N	C	C
Wild barley	C	C	C	C	C	P	C	C	C
Wild oats	NA	P	C	C	P	P	C	P	C
Fescues	P	C	C	C	C	C	C	C	C
Perennials									
Field bindweed	P	N	N	N	P	N	N	P	P
Bermudagrass	P	N	N	P	P	N	N	P	P
Dallisgrass	N	N	N	N	P	N	N	N	N
Johnsongrass	N	N	N	C	N	N	N	N	P

C=Controlled

P=Partial control

N=Not controlled

* Herbicides in bold, italic text are those that are approved for use on roadsides and rights-of-way.

**The information provided and the use of trade names does not constitute a specific recommendation of the products listed. Always follow label recommendations and comply with federal, state, and local authorities regarding restriction on pesticide use and the latest reentry intervals.

	Postemergence						
	Roundup	MSMA	Gramoxone	2,4-D	Poast	Fusilade	Prism
Annual Broadleaves							
Cheeseweed (Malva)	P	N	P	P	N	N	N
Chickweed	C	C	C	P	N	N	N
Clover	P	N	P	P	N	N	N
Fiddleneck	C	N	P	P	N	N	N
Filaree	P	N	P	P	N	N	N
Flax-leaved Fleabane	C	N	P	C	N	N	N
Goosefoot	N	N	P	C	N	N	N
Groundsel	C	N	C	C	N	N	N
Henbit	C	C	C	P	N	N	N
Horseweed (Marestail)	C	N	P	C	N	N	N
Knotweed	C	N	P	P	N	N	N
Lambsquarter	N	N	N	C	N	N	N
Mustard	P	N	C	C	N	N	N
Nightshade	C	P	C	C	N	N	N
Pigweed	C	N	C	C	N	N	N
Prickly lettuce	C	N	P	C	N	N	N
Puncturevine	C	N	C	C	N	N	N
Purslane	C	N	C	C	N	N	N
Shepherdspurse	C	N	C	C	N	N	N
Sowthistle	C	N	P	C	N	N	N
Spurge	C	P	P	P	N	N	N
Wild radish	C	N	C	C	N	N	N
Annual Grasses							
Annual Bluegrass	C	N	P	N	N	N	C
Barnyardgrass	C	P	P	N	C	C	C
Crabgrass	C	C	C	N	C	C	C
Ryegrass	C	N	P	N	C	C	C
Wild barley	C	N	P	N	C	C	C
Wild oats	C	N	P	N	C	C	C
Fescues	P	N	C	N	N	N	N
Perennials							
Field bindweed	P	N	N	P	N	N	N
Bermudagrass	C	N	N	N	P	P	P
Dallisgrass	P	C	N	N	C	C	C
Johnsongrass	C	C	N	N	C	C	C

C=Controlled

P=Partial control

N=Not controlled

*Herbicides in bold, italic text are those that are approved for use on roadsides and rights-of-way.

**The information provided and the use of trade names does not constitute a specific recommendation of the products listed. Always follow label recommendations and comply with federal, state, and local authorities regarding restriction on pesticide use and the latest reentry intervals.

Yolo County RCD Weed Hit List

Grass Weeds

Jointed goatgrass	<i>Aegilops cylindrica</i>
Barbed goatgrass	<i>Aegilops triuncialis</i>
Rip-gut brome	<i>Bromus diandrus</i>
Jubata grass	<i>Cortaderia jubata</i>
Pampas grass	<i>Cortaderia selloana</i>
Watergrass	<i>Echinochloa crus-galli</i>
Medusahead	<i>Elymus caput - medusae</i>
Johnsongrass	<i>Sorghum halepense</i>

Broadleaf Weeds

Yellow starthistle	<i>Centaurea solstitialis</i>
Purple starthistle	<i>Centaurea calcitrapa</i>
Iberian starthistle	<i>Centaurea iberica</i>
Rush skeletonweed	<i>Chondrilla juncea</i>
Canada Thistle	<i>Cirsium arvense</i>
Poison hemlock	<i>Conium maculatum</i>
Field bindweed	<i>Convolvulus arvensis</i>
Italian thistle	<i>Cordus pycnocephalus</i>
Dodder	<i>Cuscuta pentagona</i>
Klamath weed/St. Johnswort	<i>Hypericum perforatum</i>
Pepperweed/Whitetop	<i>Lepidium latifolium</i>
Common knotweed	<i>Polygonum aviculare</i>
Russian thistle	<i>Salsola tregus</i>
Milk Thistle	<i>Silybum marianum</i>
Puncture vine	<i>Tribulus terrestris</i>
Cocklebur	<i>Xanthium strumarium</i>

Riparian Weeds

Tree of Heaven	<i>Ailanthus altissima</i>
Giant reed	<i>Arundo donax</i>
Purple loosestrife	<i>Lythrum salicaria</i>
Himelaya blackberry	<i>Rubus discolor</i>
Tamarisk	<i>Tamarix parviflora</i>

Acquatic Weeds

Water hyacinth	<i>Eichhornia crassipes</i>
Hydrilla	<i>Hydrilla verticillata</i>
Giant Salvinia	<i>Salvinia molesta</i>

The Yolo County RCD is forming a **Weed Management Area (WMA)** with the Yolo County Agricultural Commissioner's Office and other concerned entities. WMA's are local organizations that bring together land-owners and managers (private, city, county, state, and federal) in a county, multi-county, or other geographical area for the purpose of coordinating and combining action and expertise in combating common invasive weed species.

To become involved in the local WMA, call the RCD. For information about WMAs, see the California WMA website at www.cdffa.ca.gov/wma. To form your own WMA, call Steve Schoenig at the California Department of Food and Agriculture, at 916.654.9768 or e-mail him at sschoenig@cdffa.ca.gov.

This list of weeds does not necessarily correspond with the Agricultural Commissioner's lists or classifications of weeds. It was generated by the Yolo County Weed Management Area. All of the weeds listed are extremely hearty invaders in our valley landscape. In many cases it is not enough to just remove them; their growth areas need to be replanted with desirable species. Plan ahead, as you may have to work at eradication for a couple of years in order to significantly reduce the weed seed population on your site. Contact UC Cooperative Extension for appropriate use of weed eradication chemicals or the RCD and NRCS on planning, planting, and maintaining native plants.

Cost Share Programs for Resource Conservation and Wildlife Habitat Development

Paul Robins, Yolo County RCD

Detailed information on the programs discussed below can be found in the document “Cost Share and Assistance Programs for Individual California Landowners and Indian Tribes,” produced by University of California Cooperative Extension. It can be downloaded from their website at www.ceres.ca.gov/foreststeward/funding.

U.S. Department of Agriculture Farm Service Agency (FSA) & Natural Resources Conservation Service (NRCS)

CONSERVATION RESERVE PROGRAM (CRP)

The concept behind the CRP is to get highly erodible or otherwise sensitive lands out of production in order to reduce problems such as soil erosion and sedimentation that impact water quality and wildlife habitat. This has been expanded to include riparian and hedgerow projects as well. Farmers who choose to participate in CRP sign up for a minimum of ten years and develop a conservation plan that takes certain acres out of production. In return, the farmer receives annual rental payments on the land from the government up to \$50,000 per person per year. Participating farmers can also apply for 50% cost share on implementation of conservation practices agreed to in the conservation plan. After the initial ten years have passed, CRP contracts can be renewed for an additional five years. There is currently a continuous signup for special projects such as riparian buffer strips, windbreaks, and wildlife habitat plantings. Contact your local Natural Resources Conservation Service (NRCS) field office for more information.

STEWARDSHIP INCENTIVE PROGRAM (SIP)

This program is administered mostly by the California Department of Forestry in tandem with the FSA. Through the SIP, landowners can apply for up to 75% cost share reimbursement performing a broad range of resource management activities on their land such as: a management plan, tree planting (including hedgerows), tree thinning or pruning, fuels management, erosion control, riparian/wetland

restoration, and fish and wildlife habitat improvements on farmland. A property must contain 20 to 1,000 acres of forestland (10% tree cover minimum) to qualify. For more information, call the Stewardship Helpline at 800.738.8733.

ENVIRONMENTAL QUALITY INCENTIVES PROGRAM (EQIP)

This program replaces the ACP (Agricultural Conservation Program) and shifts cost-sharing focus from single-year practice implementation to 5-10 year whole farm conservation plans. Farmers interested in developing a wildlife habitat and conservation plan on their property can receive up to 75% cost-share, \$10,000 maximum per year (\$50,000 maximum per contract) on a plan developed in cooperation with NRCS and approved by the FSA County Committee. The District's highest funding priorities are irrigated crop- and farmland. Practices approved for EQIP include irrigation improvements, permanent vegetation establishment, stream improvements, covercrops, fencing, and dams and pond development. For more information, contact your local NRCS field office.

WETLAND RESERVE PROGRAM (WRP)

The WRP is an easement and/or habitat restoration program focused on restoring existing or converted wetlands to those lands' original wetland hydrology and vegetation. Dependent upon when funds are allocated, sign-ups typically take place in late spring or early summer. The NRCS cooperates with the US Fish and Wildlife Service (USFWS) to determine the eligibility of the land as well as help the farmer develop a plan for restoring the wetland. The farmer receives a cash payment for three different types of agreements on his or her land: 1) a permanent conservation easement with 100% cost-share for planning and implementation costs; 2) a 30-year conservation easement with 75% cost-share; or 3) a 10-year (minimum) non-easement restoration agreement with 50% cost share for the development and implementation of the plan. Lands eligible for WRP enrollment include riparian corridors and uplands adjacent to wetlands. For more information, contact your local NRCS office.

EMERGENCY CONSERVATION PROGRAM (ECP)

This program provides technical and financial assistance to individual landowners for emergency restoration measures for new problems caused by a natural disaster. Eligible work includes removing debris from land and roadways, grading and filling gullies, reestablishing permanent plant cover, and restoring fences, dams, ponds, irrigation and drainage systems, pipelines and other facilities. For more information, contact a local Farm Services Agency office.

EMERGENCY WATERSHED PROGRAM (EWP)

This program provides technical and financial assistance for emergency restoration measures for new conservation problems caused by a natural disaster. In contrast to the above-mentioned ECP, EWP support is not geared to individual landowners but rather landowner *groups*. Eligible work includes removing debris from land and roadways, grading and filling gullies, reestablishing permanent plant cover, and restoring fences, dams, ponds, irrigation and drainage systems, pipelines and other facilities. For more information, contact your local NRCS field office.

US Fish and Wildlife Service (USFWS)

PARTNERS FOR FISH & WILDLIFE (PFW)

This program provides technical and financial support to the landowner interested in *restoring* wildlife habitat on his or her property. USFWS will guide an interested landowner through the process of determining the possibilities of the piece of land and developing a plan for developing habitat. Depending on the project, landowners can apply for cost share on up to 50% of the cost for implementing the plan. The Fish & Wildlife Service's emphasis in this program is on restoring habitats that protect special status species and that will be self-sustaining in the long run. Candidate projects include creating shallow water areas, revegetating with native plants, and erecting fence along riparian areas to exclude livestock. Interested landowners can call program coordinator Debra Schlafmann at 916.414.6456 or visit the USFWS informational website at www.ceres.ca.gov/wetlands/introduction/partners.

Wildlife Conservation Board (WCB)

INLAND WETLAND CONSERVATION PROGRAM (IWCP)

The objectives of the IWCP include the enhancement of wetlands and other wildlife habitat on private land. The WCB has set this program up so that the interested landowner works together with a "local sponsor" (a local agency or non-profit organization—an RCD is one example) to develop and maintain a wetland project. The WCB can offer up to 50% cost share through the local sponsor for the project implementation. The WCB can also buy conservation easements on property that landowners would like to maintain as wetland wildlife habitat. The program is funded by the State Habitat Conservation Fund, which is established for availability through 2020. For more information, call the WCB Wetlands Program Manager, Peter Perrine at 916.445.1109.

CALIFORNIA RIPARIAN HABITAT CONSERVATION PROGRAM (CRHCP)

This is a statewide program created in 1991 to support efforts towards protection and restoration of riparian habitat. Landowners interested in receiving program support must work with a local non-profit organization or agency such as the RCD. The WCB will support a project with the requirement that the applicant and other partners provide at least 25% matching contribution, whether in funds or in-kind. Criteria for project selection include: 1) inclusion in a larger watershed planning effort; 2) benefit to many species, especially "listed" species; 3) physical link to other habitat in good condition. The WCB requests that landowners sign an agreement to maintain a project for at least ten years after construction. For more information, contact program coordinator Scott Clemmons at 916.447.1072.

California Waterfowl Association (CWA) & California Department of Fish and Game (CDFG)

CWA has an active program for wetland restoration and enhancement on both private and public lands through the North American Wetlands Conservation Act (NAWCA). This is a complement to their Wood Duck Box and Brood Pond programs. The overall purpose of the programs is to create spring and summer wetlands to support breeding waterfowl within agricultural areas in the Sacramento Valley. Interested landowners should contact Dave Patterson of CWA at 916.648.1406.

Ducks Unlimited (DU)

DU continues to have support available through their Valley CARE program which works with private landowners to create wildlife habitat on farms. Monies are also available for land improvements to allow winter flooding for habitat within the Central Valley Project Improvement Act (CVPIA) area through (b)22 monies. Cost share funds are also available from private donations. Contact Don Connelley or Peter Schmidt at 916.852.2000.

California Department of Forestry & Fire Protection (CDF)

VEGETATION MANAGEMENT PROGRAM (VMP)

The goal of this program is to provide incentives for using fire as a tool to control unwanted brush and other vegetation that create wildfire hazards. Benefits include minimizing future wildfire suppression, maximizing watershed values, and improving the grazing and hunting capacity of the land. CDF will cover the liability, plan for, and conduct a prescribed burn on private land. The landowner pays 10% or more of the estimated cost, depending on land management objectives. Participants develop a management plan for the property with consideration of follow-up treatments to enhance the effects of the burn. Joint projects with neighboring landowners are encouraged. For more information, contact program manager Ken Nehoda at 916.653.2380.

California Department of Fish & Game (CDFG)

PRIVATE LANDS WILDLIFE HABITAT ENHANCEMENT & MANAGEMENT PROGRAM (PLM)

The PLM seeks to enhance and safeguard much-needed habitat for California wildlife and, at the same time, improve profits for ranchers and farmers, forestland owners, and managers. Through this program, a landowner is enabled to offer fishing and hunting opportunities that start before or extend beyond traditional seasons; modify regulated bag limits; issue tags or permits directly to individuals he lets on his land; set and collect whatever access and service fees desired; and eliminate payment of additional fees normally required for hunting. The program also helps develop non-hunting activities like bird watching, photography, camping, and hiking. To participate, a

landowner must complete a habitat assessment; develop and receive approval for a management plan and pay the license fee; and must also make a five-year commitment to the program and maintain records of progress in improving habitat. For more information, contact Allison Torres at 916.653.9393.

An index of these and many other programs is included on the following pages. The index was generated by Jeanne Wirka and Judy Boshoven of the National Audubon Society.

Program	Source	Services	Eligible projects	Eligible applicants	Contact
Bay-Delta Ecosystem Restoration Program	CALFED	Grants	Projects that restore ecosystem health and improve water management	Agencies Individuals Nonprofits in Bay-Delta watershed	Cindy Darling (916) 657-2666 calfed.ca.gov/ecosystem_rest
Bring Back the Natives	National Fish and Wildlife Foundation	Grants	Restoration of aquatic species to historic ranges	Nonprofits Public agencies Individuals Partnerships encouraged	Pamela McClelland NFWF (202) 857-0166
California Riparian Habitat Conservation Program	CA Dept. of Fish and Game/Wildlife Conservation Board	Grants Acquisition	Bank stabilization and revegetation Convert floodplain crops to riparian vegetation Restore natural stream function Fish habitat Acquisition	Public agencies Nonprofits RCDs	Scott Clemons (restoration) (916) 445-1072 psclemmons@ucdavis.edu Local DFG contact for acquisition
Conservation Reserve Program	Farm Service Agency	Rental program Cost share	Commodity Credit Corp. makes rental payments: provides cost share for approved practices including reveg., filter strips, wildlife habitat	Farmers	Larry Plumb (916) 498-5300 www.fsa.usda.gov/pas/prgfact
Conserving California Landscapes	Packard Foundation	Acquisition Grants PRIs	Land acquisition/grants focusing on central coast, Central Valley, or Sierra Nevada. Innovative approaches/capacity-building/policy		Jeanne Sedgwick (650) 948-7658 www.packard.org
Ecosystem Restoration Program	US Army Corps of Engineers	Corps develops and constructs project; Cost-share	New program "Ecosystem restoration"	Public entities able to enter coop. agreement; Nonprofits that can commit to operation, maintenance, etc	Alicia Kirchner (916) 557-6767

Program	Source	Services	Eligible projects	Eligible applicants	Contact
Emergency Conservation Program	NRCS	Technical Assistance	Restoration, repair after natural disaster	Landowners	Local NRCS office or Helen Flach, (530)792-5600 Helen.Flach@ca.usda.gov
Environmental Education Program	CA Dept. of Education	Mini-grants State-priority grants Others	Curricular or programmatic development for Environmental Ed. grades K-12	Public agencies Nonprofits Universities Non-commercial broadcasters	Bill Andrews (916)657-5374
Environmental Education Program	USEPA	Mini-grants (<\$5,000) Grants (\$5,000-\$25,000)	Projects that increase public awareness and knowledge of environmental issues	Public agencies Nonprofits Universities Non-commercial broadcasters	Stacy Benfer (415) 744-1161, benfer.stacey@epamail.epa.gov or www.epa.gov/environed/ solntoic
Environmental Enhancement and Mitigation Program	CA Resources Agency	Grants	Highway landscaping Urban forestry Acquisition Restoration Roadside recreation	Public agencies Nonprofits	Bill Borden (916)653-5656
Environmental Grant Program	Patagonia	Mini-grants	Local habitat projects that build public involvement and support	Must have 501(c)3 tax-exempt status	Jil Zilligen (805)643-8616
Environmental License Plate Fund	CA Resources Agency	Grants Easements	Land acquisition or easements for environmental protection Protection/restoration of habitat Endangered species	Public agencies Nonprofits	Harold Warass (916)653-5656 or Don Wallace (916)653-9709
Emergency Watershed Program	Natural Resources Conservation Service	Technical & Financial support	Emergency restoration for new problems caused by natural disasters	Landowner groups	Local NRCS office or Helen Flach (530)792-5600 Helen.Flach@ca.usda.gov

Program	Source	Services	Eligible projects	Eligible applicants	Contact
Environmental Quality Incentives Program (EQIP)	Natural Resources Conservation Service	Technical Assistance Cost share	Voluntary conservation measures	Agricultural producers	Local NRCS officer or Helen Flach (530) 792-5600 Helen.Flach@ca.usda.gov
Farmland Protection Program	Natural Resources Conservation Service	Easements	To acquire conservation easements on cropland to limit non-ag uses	State and local farmland protection programs	Local NRCS officer or Helen Flach (530) 792-5600 Helen.Flach@ca.usda.gov
Habitat Conservation Fund	CA Dept. of Parks and Recreation	Grants	Habitat for deer, lion, imperiled species Aquatic habitat for anadromous fish Riparian habitat	Cities Counties Districts	Odel King (916) 653-8758
Inland Fisheries Program	CA Dept. of Fish and Game	Grants	Salmon restoration Steelhead restoration Fish habitat	Public agencies Nonprofits	Mary Brawner (916) 654-5628
Inland Wetlands Conservation Program	CA Dept. of Fish and Game/ Wildlife Conservation Board	Grants	Projects that protect or enhance wetland habitat ponds, waterfowl feeding/nesting habitat. Multiple-objective projects (flood control + habitat)	Local governments Nonprofits RCD	Marilyn Cundiff (916) 445-1093
LEGACI Program	Great Valley Center	Grants	Landuse, economic development growth, agriculture conservation, investment	Community groups Nonprofits Local government	Great Valley Center (209) 522-5116 www.greatvalley.org
National Coastal Wetlands Conservation Act	US Fish and Wildlife Service	Grants	Acquisition Restoration Enhancement	Agencies Individuals Nonprofits	US Fish and Wildlife Service (503) 231-6128
Native Plant Conservation Program	National Fish and Wildlife Foundation	Grants	Projects that protect, enhance, and/or restore natural plant communities; also education, inventory, and assessment	Nonprofits Public agencies Private interests Partnerships encouraged	Pamela McClelland NFWF (202) 857-0166

Program	Source	Services	Eligible projects	Eligible applicants	Contact
Nonpoint Source Implementation	State Water Resources Control Board EPA319	Grants	Projects that reduce NPS pollution Demonstration projects Tech transfer Training Public education Technical assistance Ordinance development	Local Regional Water Quality Control Boards	
North American Wetlands Conservation Act Program	California Waterfowl Association/ CA Dept. of Fish and Game	Cost share	Farmland restoration that create spring and summer wetlands for breeding waterfowl.	Landowners	Dave Patterson (916)648-1406
Pacific States Conservation Program Partners in Flight Nongame Bird Conservation	National Fish and Wildlife Foundation	Grants for demo projects	Protect or improve habitat Engage private landowners Leverage other funding Riparian habitat Watershed projects Outreach	Nonprofits Public agencies Private interests Partnerships encouraged	Gregg Elliott PRBO (415) 868-2882 elliott@nfwf.org
Partners for Fish and Wildlife	US Fish and Wildlife Service	Technical assistance Cost-share	Help landowners improve quantity and quality of habitat	Landowners	Dan Strait, USFWS (916)414-6456 Daniel_Strait@mail.fws.gov
Private Lands Wildlife Enhancement and Management Program (PLM)	CA Dept. of Fish and Game	Fishing/ hunting incentives	Enhance habitat Improve profits for private landowners by allowing changes to hunting restrictions.	Private landowners	Allison Torres (916) 653-9393
Project modifications for improvement to the environment	US Army Corps of Engineers		Restore environmental resources degraded by previous Corps project	Public entities Large nonprofits	Alicia Kirchner (916)557-6767

Program	Source	Services	Eligible projects	Eligible applicants	Contact
Pulling Together Initiative	National Fish and Wildlife Foundation	Grants	Prevent, manage and eradicate noxious invasive weeds by forming local weed management area partnerships	Landowners	Gary Kania and Gabriela Chavarria (202) 857-0166
Stewardship Incentive Program	California Dept. of Forestry and Fire Protection (CDF) and FSA	Technical assistance Cost-share	Stewardship projects that enhance fish and wildlife habitat, riparian zones and wetlands, soil and water resources, rangeland and timber.	Landowners owning between 20 - 1000 acres	David Soho (408) 335-9148 or (800) 738-8733
Transportation Enhancement Activities Program (TEA)	CalTrans	Grants Matching funds	Projects related to, or in the area served by, any active or completed transportation project that involves Federal transportation funds.	Local governments Nonprofits may not apply directly but can partner with public agency	Marsha Mason CalTrans TEA Office (916) 654-5275
Urban Streams Restoration Program	CA Dept. of Water Resources	Grants	Stream restoration Monitoring Clean-up	Cities Counties Districts Nonprofits	Sara Denzler (916) 327-1664 sdenzler@water.ca.gov
Vegetation Management Program	California Department of Forestry (CDF)	Liability coverage Planning Cost share	Control unwanted brush and other vegetation	Landowners	Ken Nahoda (916) 653-2380
War on Weeds	CA Interagency Noxious Weed Coordinating Committee	Mini-grants	Cooperative weed projects Research Education	Public agencies Nonprofits Landowners	Steve Schoenig ssschoenig@cdfa.ca.gov
Water Quality Management Planning	State Water Resources Control Board EPA319	Grants	Water-quality planning Not research	Cities Counties Districts	Paul Lillebo (916) 657-1031 lillp@dwq.swrcd.ca.gov

Program	Source	Services	Eligible projects	Eligible applicants	Contact
Watershed Assistance Grants	River Network	Grants	Strategic planning Org. development Watershed meetings		Kathy Luscher (503) 241-3506x16 dluscher@rivernetnetwork.org or www.rivernetnetwork.org/wag
Wetland Reserv Program	Natural Resources Conservation Service	Easements Cost-share	Restore wetlands for migratory birds Improve water quality Aid in flood water retention Increase open space	Landowners	Local NRCS officer or Helen Flach (530) 792-5600 Helen.Flach@ca.usda.gov
Wildlife Habitat Incentives Program (WHIP)	Natural Resources Conservation Service	Cost share	Technical/financial assistance for habitat improvement measures	Participants who “agree to prepare and implement a wildlife habitat development plan”	Local NRCS officer or Helen Flach (530) 792-5600 Helen.Flach@ca.usda.gov

Cost-Sharing Options for Conservation Plans

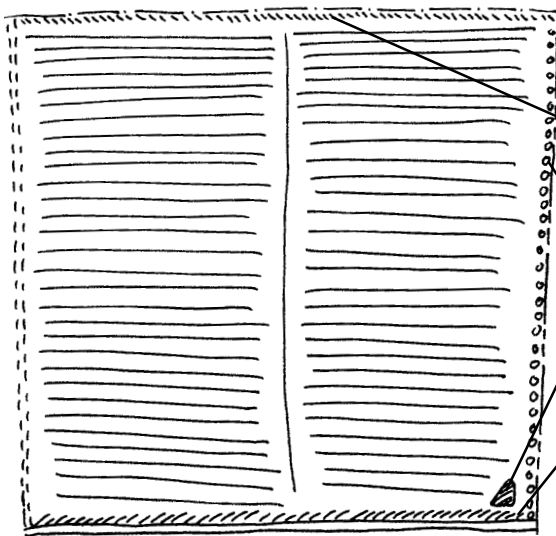
Paul Robins, Yolo County RCD

The following three pages feature hypothetical farms and conservation plan options for funding support from the organizations and agencies outlined in the previous section. These are meant to illustrate what a plan might look like in dollars and cents and how much help one could realistically expect in executing one. The examples are all based on information from February 1998.

Conservation Project Cost and Funding Example #1

Joe Flat Farms

160 acres of leveled row crop ground sloping east and south with irrigation canal on north border, county road on south border, and access road and head ditch on west border:



Potential projects on Joe's farm include:

- $\frac{1}{2}$ mile of canal bank stabilization with permanent vegetation (\$1800 + \$250/yr. maintenance costs)
- $\frac{1}{2}$ mile of insectary hedgerow (\$3,700 initial cost + \$300/yr. maintenance for 3-5 years)
- 1 acre-foot tailwater pond (\$6,600 installed [with return system, add \$11,500] + \$250/yr. maintenance)
- $\frac{1}{2}$ mile of permanent roadside vegetation (\$1500 + \$260/yr. maintenance for about 3 years)

Without any help, Joe will spend over \$25,000 installing these projects and over \$1,000/year maintaining them over 3-5 years. However, he can receive cost share support on all of the above projects if he enlists help from the programs below:

The **Environmental Quality Incentives Program (EQIP)** would reimburse him for up to 75% of the costs of all of the above practices, namely \$1,350 for the canal work; \$2,775 for the hedgerow planting; \$10,000 for the tailwater return pond; and \$1,125 for the roadside grass planting. This would reduce his ini-

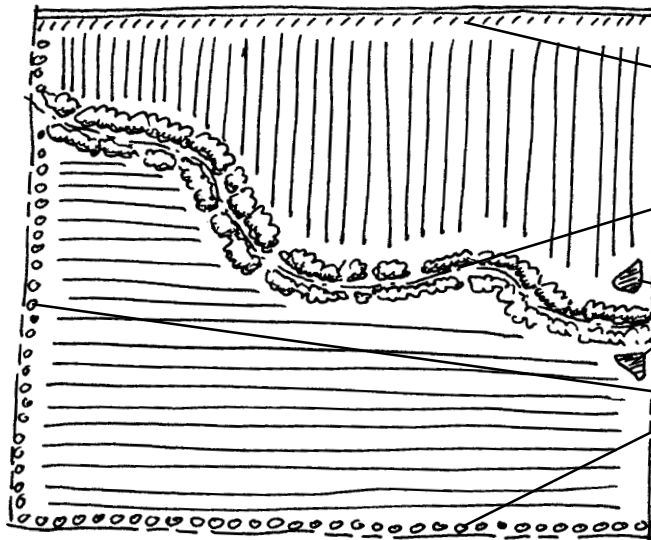
tial costs by \$15,250 to \$9,850. If he were to install a pond without a return system, his total costs would be closer to \$3,400. Although the cost of a return system is initially high, he can count on a water savings benefit with irrigated crops of \$2,000/season, meaning that it would more than pay for itself within six years.

The **Stewardship Incentives Program (SIP)** could give him up to 75% support for the hedgerow planting, but not in addition to the support he would receive if he enrolls the hedgerow in the above EQIP program.

Conservation Project Cost and Funding Example #2

Beeswax Farms

160 acres, 20 of which is taken up by a creek bisecting the property. The rest of the acreage is leveled for row and field crops. The property is bordered on the north by a county road:



Potential projects on this farm include:

- $\frac{1}{2}$ mile of permanent roadside vegetation (\$1500 + \$260/yr. maintenance for about 3 years)
- $\sim\frac{1}{2}$ mile of creek channel improvement and riparian buffer strip (\$14,000 + \$570/yr. maintenance costs for 3-5 years)
- 1 acre-foot tailwater ponds (\$6,600 each installed [with return system, add \$11,500] + \$250/yr. maintenance)
- 2 x $\frac{1}{2}$ mile strips of insectary hedgerow (\$7,400 initial cost + \$600/yr. maintenance for 3-5 years)

Beeswax Farms can expect to spend almost \$60,000 installing all of these projects if they undertake them without cost-share support. However, they can expect to substantially reduce their costs with help according to the examples below:

Combination 1:

EQIP, as on Joe Flat's farm, will reimburse Beeswax Farms up to 75% (with a \$10,000 limit per practice) for all of these practices, paying \$1,125 for the grassed roadside; \$10,000 for the creek work; \$20,000 for the two ponds, and \$5,550 for the two hedgerows, contributing a total of \$36,675 to the farm's efforts.

The balance of the creek project cost can be met by signing up with the US Fish & Wildlife Service's **Partners For Wildlife (PFW)** program and/or the California Wildlife Conservation Board's **California Riparian Habitat Conservation Program (CRHCP)**, saving them an additional \$4,000 of installation cost. The CRHCP can also cover maintenance costs, saving Beeswax farms an additional \$2,850 over five years.

Combination 2:

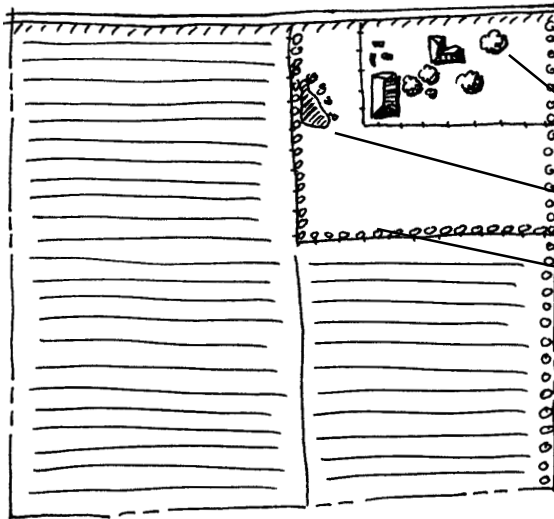
Beeswax Farms could opt to enroll the ground they lose in widening the creek channel in the **Conservation Reserve Program (CRP)** in order to receive federal rental payments (\$50/acre on Class II soil) in addition to cost-sharing for the work done. CRP would cover only 50% of the cost, or \$7,000. Coordination with PFW or CRHCP could pay the balance of the project cost, however.

They could sign up the rest of their practices in EQIP for the same sort of cost-share support as described in Combination 1.

Conservation Project Cost and Funding Example #3

Hobby Farms

40 acres, a portion of which is leased out for agriculture, ten acres of which is in pasture, house and barn, and fallow. The property faces a county road on its north side:



Potential projects on this farm include:

- $\frac{1}{4}$ mile of permanent roadside vegetation (\$750 + \$150/yr. maintenance for about 3 years)
- Wildlife pond (\$6,600 installed + \$250/yr. maintenance)
- 2 x $\frac{1}{4}$ mile strips of insectary hedgerow (\$3,700 initial cost + \$300/yr. maintenance for 3-5 years)

The Hobby family can expect to spend over \$11,000 installing all of these projects if they undertake them without cost-share support. However, they can expect to substantially reduce their costs with help according to the examples below:

Combination 1:

If they can coordinate with their tenant farmer for an additional conservation project, they could sign up for **EQIP** support (it requires at least five distinct projects). A simple one for the farmer to undertake is covercropping, which would cost roughly \$100/acre for seeds and cultural practices, \$75/acre of which the program would reimburse. That would mean a cost of \$750 to the Hobbys. If they qualify, however, EQIP would pay for \$8,250 towards the roadside, two hedgerows, and pond projects.

An additional \$1,650 could potentially be saved by enrolling the pond in a **PFW** program or the Wildlife Conservation Board's **Inland Wetland Conservation Program (IHCP)**. The limitation for eligibility for these programs is that the ground must have historically been wetland before conversion to farming. By linking the pond with the hedgerow, however, the pond's habitat value is enhanced and could receive special consideration.

Combination 2:

Funding can be pursued for the above projects (with the exception of the roadside vegetation) on an individual basis without EQIP support. As under EQIP, the California Department of Forestry's **Stewardship Incentives Program (SIP)** will support 75% of the cost of the hedgerows.

The pond could be funded in combination by the PFW and IHCP programs mentioned above. Both programs provide a maximum of 50% cost share; successful applicants could potentially cover almost 100% of their costs. Another alternative for pond funding would be through the CRP, which would pay the government's rental rate on the ponded land and cover 50% of the construction and planting costs. CRP funding could be combined with PFW and IHCP funding for better cost coverage.

Vendors & Contractors

An incomplete list of service providers in the Northern California area

NURSERIES/SEED SUPPLIERS

All Seasons Wholesale Nursery
Ron Motz
P.O. Box 2128
Elk Grove, CA 95759
916.686.2583

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
Francis Burke
2815 Road 40A
P.O. Box 85
Rumsey, CA 95679
530.796.3521

CCC Napa Native Plant Nursery
P.O. Box 7199
Napa, CA 94588
707.253.7783

CA Dept of Forestry & Fire Protection
L.A. Moran Reforestation Center
P.O. Box 1590
Davis, CA 95617
530.753.2441

Central Coast Wilds
114 Liberty Street
Santa Cruz, CA 95060
831.459.0656
www.centralcoastwilds.com

Circuit Rider Productions
9619 Old Redwood Highway
Windsor, CA 95492
707.838.6641

Comstock Seed
917 Highway 88
Gardnerville, NV 89410
775.746.3681
Fax: 775.746.1701

Conservaseed
P.O. Box 455
Rio Vista, CA 94571
916.775.1676

Cornflower Farms
Ann & Jeff Chandler
P.O. Box 896
Elk Grove, CA 95759
916.689.1015
Fax 916.689.1968

Clyde Robin Seed Co.
P.O. Box 2366
Castro Valley, CA 94546
510.785.0425
Fax 510.785.6463
www.clyderobin.com

Elkhorn Native Plant Nursery
P.O. Box 270
Moss Landing, CA 95069
831.763.1207

Environmental Seed Producers
P.O. Box 2709
Lompoc, CA 93438
805.735.8888
www.espseeds.com
e-mail: esp@espseeds.com

Pacific Coast Seed
6144 Industrial Way
Building A
Livermore, CA 94550
925..373.4417
800.339.8245

TS & L Seed Co.
37331 Hwy. 16
P.O. Box 359
Woodland, CA 95776
530.666.1239
Fax 530.666.2910

Freshwater Farms
5851 Myrtle Avenue
Eureka, CA 95503
800.200.8969
www.freshwaterfarms.com

Peaceful Valley Farm Supply
110 Springhill Boulevard
P.O. Box 2209
Grass Valley, CA 95945
530.272.4769
www.groworganic.com

Valley Transplants
23000 Bruella Road
Acampo, CA 96220
209.368.6093
Fax 209.745.1115

Harmony Farm Supply
P.O. Box 460
Graton, CA 95444
707.823.9125
www.harmonyfarm.com

Rana Creek Ranch
35351 E. Carmel Valley Road
Carmel Valley, CA 93924
831.659.3811
Fax 831.659.4851
www.ranacreek.com

Yerba Buena Nursery
19500 Skyline Blvd.
Woodside, CA 94062
650.851.1668
www.yerbabuenanursery.com

Hedgerow Farms
21740 County Road 88
Winters, CA 95694
530.662.4570

S & S Seed
P.O. Box 1275
Carpinteria, CA 93014-1275
805.684.0436
Fax 805.684.2798

You Bet Farms
15595 You Bet Road
Grass Valley, CA 95945
530.292.9450

Kamprath Seeds
205 Stockton Street
Manteca, CA 95337
800.325.4621

Sierra Valley Farms
P.O. Box 79
Beckworth, CA 96129
530.832.0114

Larner Seeds
P.O. Box 407
Bolinas, CA 94924
415.868.9407
Fax 415.868.2592

Specialty Gardens
P.O. Box 567451
Modesto, CA 95357
209.527.5889

Native Here Nursery
101 Golf Course Drive
Tilden Park, CA 94708
510.549.0211

Sweetland Farm & Nursery
27443 Sweetland Road
North San Juan, CA 95690
530.292.9033

CONSULTANTS/CONTRACTORS

A & L Services, Inc.
36445 County Road 31
Davis, CA 95616
530.757.2506

Balance Hydrologics
1760 Solano Avenue
Suite 209
Berkeley, CA 94707
510.527.0727

Bioengineering Associates
Evan Engber
P.O. Box 1355
Laytonville, CA 95454
707.984.8333

S.D. Carmack Dirt Moving
1540 Caroleigh Way
Yuba City, CA 95993
530.673.0313

Eco/Plan International
3028 Esplanade, Suite A
Chico, CA 95973-4924
530.345.1342

H.T. Harvey & Associates
P.O. Box 1180
Alviso, CA 94538
408.263.1814

Jones and Stokes Associates
2600 V Street, Suite 100
Sacramento, CA 95818
916.737.3000

Kelly & Associates
Environmental Science
216 F Street, #51
Davis, CA 95616
530.753.1232

Mervyn G. Clark Construction
P.O. Box 75
Sutter, CA 95982
530.755.0596

John & Cathy Reyes
P.O. Box 168
Dunnigan, CA 95937
530.724.3510

Sierra View Landscape
Riley Swift
5729 Manzanita Avenue, #2
Carmichael, CA 95608
916.344.4943
Fax 916.344.4704

The Reveg Edge
P.O. Box 609
Redwood City, CA 94064
650.325.7333
Fax 650.325.4056
www.ecoseeds.com/nature

Weigand Land Leveling, Inc.
450 Proter
Suite G
Dixon, CA 95620
707.678.9466

Wetland Research Associates
2169 E. Francisco Boulevard
Suite G
San Rafael, CA 94901
415.454.8868

Wood Bros., Inc.
P.O. Box 216
Lemoore, CA 93245.0216
559.924.7715