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

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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 *Nassella*s 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 califomica, 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 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.

Prescribed burn in grassland

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.
Nassella pulchra	Purple Needlegrass	TI	B	70,000	6.0	9.6
Melica californica	Onion grass	I	BR	240,000	2.0	11.0
Elymus glaucus	Blue wildrye	T	B	110,000	2.0	5.1
Leymus triticoides	Creeping wildrye	T	R	120,000	2.0	5.5
Elymus trachycaulus	Yolo Slender wheatgrass	T	B	80,000	2.0	3.7
Bromus carinatus	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.
Nassella pulchra	Purple Needlegrass	TI	B	70,000	5.0	8.0
Nassella cernua	Nodding needlegrass	I	B	185,000	3.0	10.7
Nassella lepida	Foothill Needlegrass	S	B	350,000	2.5	20.1
Hordeum californicum	California barley	S	B	140,000	2.5	8.0
Poa secunda	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.
Nassella pulchra	Purple Needlegrass	TI	B	70,000	6.0	9.6
Elymus glaucus	Blue wildrye	T	B	110,000	2.0	5.1
Leymus triticoides	Creeping wildrye	T	R	120,000	2.0	5.5
Hordeum brachyantherum	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.
Elymus glaucus	Blue wildrye	T	B	110,000	5.0	12.6
Leymus triticoides	Creeping wildrye	T	R	120,000	4.0	11.0
Elymus trachycaulus	Yolo Slender wheatgrass	T	B	80,000	3.0	5.5
Hordeum brachyantherum	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*		