Capay Valley
Conservation
and
Restoration
Manual

A Handbook for Landowners

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Capay Valley Conservation and Restoration Manual

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For the Cache Creek Watershed Stakeholders Group
Thank you for your patience, guidance, and support.

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Introduction

Purpose Of This Manual

Do you find yourself constantly battling unwanted weeds on your land? Are you tired of watching the stream erode and send your land downstream? Don’t know what to do about that gully that just gets larger every year? The Capay Valley Conservation and Restoration Manual provides over 30 potential solutions to these and many other resource concerns in Capay Valley.

This manual is the culmination of several years of hard work by the Cache Creek Watershed Stakeholders Group, the Yolo County Resource Conservation District, and the USDA Natural Resources Conservation Service’s Woodland Field Office. Its purpose is to provide techniques to support solutions for many of the resource issues (e.g. erosion, invasive plants) experienced in the Capay Valley. Techniques range from weed control to habitat and sediment ponds to streambank stabilization.

In the manual, techniques are referred to as ‘practices’. Take note that these practices, by themselves, are not the solutions to the resource issues. Only after thorough research and careful planning should these practices be employed. Think of each practice as a tool in your new conservation and restoration toolbox. You need to know what you are doing and why you are doing it before you take the tool out of the toolbox. First, identify the symptom (e.g. an eroding streambank, gully, or a field of starthistle). Second, figure out the source of the symptom (i.e. the problem). Third, plan how to address the problem. Finally, choose the “tool” or “tools” that best fix the problem. Remember, don’t treat the symptom without first addressing the problem. This will save you time, money, and effort.

The manual has been created in a format that is easy to use, update, and share. In most cases, the essential techniques for each practice have been condensed and refined so as to fit on one page, front and back. The information contained on the practice pages is intended to be succinct, yet informative enough to be useful. If you find that you are not comfortable with taking on a project based on the practice pages, refer to one of the reference documents listed at the bottom of the front page of each practice for more detailed information. Most of the reference documents are available in the special watershed section at the Esparto Library. The Yolo County RCD (530.662.2037 ext. 5) and the USDA Natural Resource Conservation Service (Woodland Field Office 530.662.2037 ext. 3) can provide technical assistance at no cost to landowners and also offer cost-share programs to help pay for implementing conservation and restoration projects (See the Cost-Share Programs section in this manual).

This manual is a working document. It is meant to be put to use. It is also designed to be relevant and useful to the Capay Valley community. The manual is purposely not bound so that pages can be added as the community identifies new needs and seeks out new solutions to resource issues. Suggestions, comments, and additions should be directed to the Stakeholders Group and the Watershed Coordinator (See Comments page at the end of this manual).

As a final note, there are several resource concerns that are not directly addressed in this manual. These concerns include flooding, soil quality (e.g. compaction, salinity, alkalinity, etc.), crop predation by wildlife, typical agricultural operations, and others. It is possible that techniques to deal with these concerns will be added to this manual in the future. We understand that there are several important techniques or issues that are only mentioned briefly in this manual. These include irrigation management techniques, comprehensive pesticide information, Integrated Pest Management (IPM) techniques, and soil fertility management. We encourage you to contact the agencies and read the materials referenced throughout the manual to learn more about these techniques or issues.
Introduction

How to Use This Manual

The manual does not need to be read from cover to cover to be useful. The introductory sections on the Physical Setting and History of Capay Valley, Basic Watershed Processes, and the Permits and Regulations Overview provide useful information on how watersheds function, some of the unique features of Capay Valley, and the laws and regulations that may be affected by potential work. Knowledge of watershed function and form can aid in understanding the processes affecting your property.

With that information you can identify the causes of a problem on your property and decide what needs to be done to rectify it. The Resource Concerns and Solutions Table provides a means for choosing the appropriate tool for the situation. If your resource concern is not listed, refer directly to the practices. The practices are divided into three categories based on topography and land use: Upland and Rangeland Practices, Lowland and Agricultural Land Practices, and Riparian Practices. These are not mutually exclusive categories - some practices are applicable to situations that occur in all three categories. Riparian (or streamside) practices are applicable in upland as well as lowland areas. A list of the practices can be found on page 18.

First, search the list under the category most similar to the topography and land use where the resource concern exists. The appropriate practice may be obvious from the title, or you may need to read about each practice to find one that fits your project’s needs. Each practice contains five sections. On the front page you will find a description of the practice (section 1) and a description of the conditions or situations where the practice can be effectively implemented (section 2). The third section lists the materials and equipment required to implement the project. The last section on the frontside of each practice page is a list of the documents referenced in writing the practice. The backside of each practice page is dedicated to describing how to implement the practice. In some cases the implementation section has been extended to a total of three pages to allow for a more detailed discussion of the practice.

Additional useful information can be found at the end of the manual. These resources include native plant lists, a listing of local plant material suppliers, erosion control products and irrigation system suppliers, contacts for technical assistance, detailed information on permits and regulations, a description of USDA-NRCS and other cost share programs, a glossary of terms used in the manual, and a list of useful reference materials.
Capay Valley

Physical Setting

The Capay Valley of today is a small valley hosting productive agriculture in its fertile bottomlands, and range and wildlands on the slopes bordering its eastern and western flanks. A defining characteristic is the presence of Cache Creek, which runs generally southward along the valley’s eastern edge. The creek drains the mountains from the northwest, hosting wildlife, delivering water to the valley, and alternately eroding and depositing sediments and gravel along its banks. The valley is unique in that it has never been heavily populated nor supported large agricultural parcels, giving it a quiet, rural quality that has lasted through the 20th century. This placid atmosphere belies the dynamic geology, which has determined its form, vegetation, and land uses.

Capay Valley Geology

The valley floor consists of deep, alluvial soils deposited by Cache Creek and its tributaries. These deposits make up the deep, rich soils that host the productive agriculture of Capay Valley and the Great Central Valley. The western walls of the valley are Cretaceous rocks (formed 145-65 million years ago) of the Great Valley Group. As with the rest of the region, the area now known as Capay Valley was under water for millennia.

The eastern wall of Capay Valley consists of two different ages and types of rocks. The lower slopes are younger, formed in the Pleistocene era 2 million to 10 thousand years ago. The upper 1/4 of the eastern wall of the Valley consists of older Cretaceous Great Valley Group rocks (the same as the rocks on the opposite side of the valley). At the interface on the slope there is a change in pitch caused by the thrust fault which has superimposed the older rocks over the much younger Pleistocene rocks exposed at river level.

Due to active tectonics, the floor of Capay Valley is increasingly tipping downward to the east. As a result, Cache Creek is confined mostly to the eastern side of the valley (see Figure 1). This differs from most meandering streams, which can meander across the entire valley floor. Because of the tectonically-induced confinement of the stream, the effective “floodplain” is much narrower than the whole valley floor. This unique situation impacts Valley land uses. Whereas, on a level valley floor, the water table may be at a fairly uniform depth below the surface, the inclined valley floor affects the water table accordingly.

The way in which the stream erodes land and deposits sediment is also affected by the tectonic situation. An idealized single-channel stream would be free to meander across the entire valley floor (where valley floor = floodplain). Since the Capay Valley floor is being tipped eastward, the stream’s ability to traverse the entire valley floor is severely limited. Erosion-resistant Pleistocene (Ice Age) rock is exposed on the eastern side, forcing Cache Creek to focus its erosive activity on the western banks, which are composed of the much more easily eroded alluvium (older river deposits). The effects of the 1997 New Year’s Flood made this point clear: while the stream did not significantly erode the eastern bedrock banks, approximately 30 acres of alluvium on the western bank where eroded at Guinda Park.
Capay Valley

Physical Setting cont...

Vegetation
The historic landscape of Capay Valley is much like that of the rest of the Great Central Valley, with dense riparian forests dominating the stream corridor of Cache Creek, giving way to grasslands and oak woodlands on the valley floor and uplands. These uplands have been affected most dramatically by agriculture, as native trees, shrubs and grasses were removed to provide home for food crops and improved forage. While the area of the old riparian forests has been reduced to accommodate agricultural and, to a lesser extent, urban development, significant stretches of native riparian forest remain along portions of Cache Creek. Introduced exotic “erosion control” plants such as Tamarisk and Arundo also play an increasing role in the streamside (and mid-channel bar) vegetation, displacing native trees and shrubs more valuable to wildlife, and exacerbating bank erosion by diverting stream flows. The foothill and mountainous areas flanking Capay Valley have the most intact native plant communities, although some historical impact of human activity and livestock management is evident in the dominance of non-native, annual or improved grass and forb species in the understory. While most of these relatively new plant species provide excellent forage for wildlife and livestock, there are also increasing concentrations of noxious weedy species such as Yellow starthistle, Barbed goatgrass, and Medusahead that threaten to reduce the quality of Capay Valley rangelands.

History

Human settlement and changes
Human activity in Capay Valley extends far into prehistory. Native American tribes lived in camps along Cache Creek for centuries, hunting and fishing for their livelihoods. In the early 19th century European and American explorers and trappers began to move through the southern Sacramento Valley, bringing with them diseases that took a heavy toll on the native people. Some of the Southern Wintun Indian tribe continued to live in the upper reaches of the Capay Valley, however, even after Mexican land grants appropriated most of the territory. After the turn of the Century, the remaining band of local Wintun Indians was relocated from its old village site near the town of Rumsey to a federally purchased rancheria on the other side of the valley; later (1942) some of the band moved to a new site near Brooks (which now hosts the Cache Creek Casino), while others moved to Colusa County.

Significant changes to the landscape did not likely begin until European settlement and activity in Capay Valley began in the 1840s with the Guesissosi and Rancho Canada de Capay grants. At that time, cattle grazing was the area’s principal economic activity. Land speculation, subdivision of parcels, and planting of grain, grapevines, and fruit trees began in the 1860’s. Also at that time, scattered ranches and tiny settlements developed along the primitive road leading to the quicksilver (mercury) mines in the canyon country to the west. By the 1870s several small schools were established in the Capay Valley and by 1890, a railroad line extended from Winters to Rumsey for passenger and agricultural freight traffic. By 1900, the population of the Capay Valley was numbered over 1,300. In 2002 around 2,000 people live in the valley.

Dominant crops shifted over the years from fruit orchards, to almonds, and, more recently, to walnuts as markets changed and growing conditions required. Agricultural development was fueled in no small part by water development projects such as the Rumsey Ditch Association’s eight-mile irrigation canal from Cache Creek above Rumsey to north of Guinda (1860’s), the Yolo Water and Power Company’s dam across the outlet of Clear Lake that feeds into Cache Creek (1914), and the Indian Valley Dam in 1975. During the1980s, a new trend in valley agriculture began as organic growers began intensive farming in the area, gradually building markets and expanding their acreage in a variety of crops.

While the long-standing Wintun presence in the Valley may have influenced some of the vegetation of the Valley through traditional grassland management techniques such as burning, the radical changes associated with the advent of mining, intensive agriculture and the creation of towns compelled community members to identify local concerns and attempt to codify and maintain the unique, rural characteristics of Capay Valley. Such efforts include the development of the Capay Valley General Plan in 1983, the formation of the Cache Creek Watershed Stakeholders Group in 1996, and the formation of Capay Valley Vision in 2000.

Watershed issues identified by the Stakeholders Group include upland and streambank erosion, streambank erosion, flooding, noxious weeds, mercury in the creek, and wildlife habitat. While the dams upstream on Cache Creek have improved flood protection, some flooding problems are still a part of life in the valley, especially during wet years. Erosion and streambank erosion in particular, continue to be serious problems for landowners, even during normal rainfall years.
Figure 2: Capay Valley Map
Watershed Processes

Basic Watershed Processes*

The purpose of this section is to give you a glimpse at the processes responsible for stream shape and function and to introduce you to some terms that will be used throughout this manual. A watershed is defined as an area of land that drains water, sediment, and dissolved materials to a common outlet at some point along a stream channel (Dunne, T. and Leopold, L.B., 1978). It may help you to think of watersheds as drainage basins. Watersheds occur at multiple scales, from small swales that may drain only an acre to large river systems that drain thousands of square miles. The smaller drainages are often referred to as sub-watersheds. Several sub-watersheds combine to form a larger watershed. Watershed boundaries are drawn along the ridgelines that surround the waterway of interest.

Since the watershed is based on the movement of water, it is important to review the means by which water can move through a system. Precipitation falls to the surface of the earth either as rain or snow. Some of the precipitation is intercepted and absorbed by vegetation before it reaches the soil surface. The precipitation that does reach the soil surface infiltrates into the soil by means of gravity and capillary action. Water will continue to move down through the soil until it reaches a zone of saturation known as the phreatic zone. The top of the phreatic zone defines the ground water table. The area above the phreatic zone is called the capillary fringe, where soil moisture is maintained by capillary forces. Between the capillary fringe and the soil surface is the vadose zone. The vadose zone is where plant roots thrive because the pore spaces between the soil particles contain a mixture of respiratory gases, capillary water, and soil microbes. When the rate of precipitation exceeds the infiltration capacity of the soil, excess water collects on the surface and flows downslope as runoff. Runoff may also occur just below the soil surface as subsurface flow.

A major component of the watershed is the stream corridor. The stream corridor can be thought of both temporally and spatially. The processes that formed a stream corridor are observed as many small events occurring over short amounts of time, while it is the accumulation of the effects of these events over millions of years that creates the stream corridor observed today. Spatially, the stream corridor can be considered in two dimensions: lateral and longitudinal.

Lateral components of the stream corridor include the stream channel, floodplain, and the transitional upland fringe. The stream channel is a channel that exhibits flowing water at least part of the year. The floodplain is the area adjacent to the stream channel that is occasionally flooded during high flows. The transitional upland fringe is the area that serves as the border between the floodplain and the surrounding landscape. While stream related processes helped form the transitional upland fringe in geologic times, their current form is maintained or altered to a greater extent by recent land use activities. Therefore, the following will consider the physical processes of formation and the function of the stream channel and the floodplain.
Watershed Processes

Basic Watershed Processes* continued

Stream channels are formed, maintained, and altered by the water and sediment they carry. A typical cross section of a stream channel (see Figure 3 on previous page) shows the thalweg – the deepest part of the channel, the baseflow channel – the channel created by low flows, and the scarp – the sloped streambank. The size and shape of the channel are determined by four basic factors: sediment discharge – the amount of sediment moving down the stream at a given time; sediment particle size; streamflow – the volume of water moving down the stream at a given time (also called discharge); and stream slope – the elevation drop between an upstream point and a downstream point. Channel equilibrium occurs when all four variables are in balance. The nature of the relationship is that if one of the variables changes, one or more of the other variables must increase or decrease proportionally in order to maintain equilibrium. For example, if streamflow is increased and the slope remains the same, sediment load or particle size will increase.

The stream channel is constantly changing to maintain this equilibrium. When the stream channel is out of balance the changes can be visually recognized in the form of degradation or aggradation. Degradation is the downcutting of the stream channel. Aggradation is the deposition of sediment and suspended bed material in the stream channel. In alluvial stream systems sediment and bed material is typically scoured from the outer bends of the stream and deposited as sand or gravel bars in the straight sections and on the inside of the bends. The size of the material that is scoured and where it deposits is dependent on many factors including streamflow (or discharge), gradient, channel area, and velocity. For example, if a bar is made up of large cobbles, it is safe to assume that a large streamflow event with high velocities was responsible for depositing the cobbles and it will take a similar event to mobilize the cobbles again.

There are two types of floodplains: Hydrologic and Topographic. The hydrologic floodplain is the area up to the top of the bank of the stream channel that becomes inundated when the streamflow exceeds the capacity of the baseflow channel. The topographic floodplain is the area adjacent to the stream channel that becomes inundated when the streamflow exceeds the capacity of the stream channel (See Figure 3 on previous page). Federal and state agencies refer to the extent of the floodplain in terms of the anticipated frequency of streamflows that result in inundation (i.e. 10-year, 50-year, 100-year floodplains). The floodplain provides temporary storage area for floodwaters and sediment produced by the watershed. The velocity of the water flowing down the stream is drastically reduced as it flows out onto the floodplain. The reduced velocity of the water causes the suspended sediment to settle out on the floodplain.

The longitudinal dimension looks at the stream corridor from its source in the mountains (or hills) to its terminus in a lake, ocean, settling basin, or a larger stream. In this sense it is similar to taking a watershed view of the stream. The overall longitudinal profile of the stream can be simplified by dividing it into three zones: Headwaters Zone, Transfer Zone, and Depositional Zone (see Figure 5 on the next page). The headwaters zone, often referred to as the upper watershed, is typically characterized by steep slopes and a steep stream gradient and is commonly the source of much of the sediment that moves down the stream. The transfer zone is typically characterized by gentler slopes and broadening valleys, through which the stream begins to meander. Some sediment is deposited in this zone, but often only temporarily. Most of the sediment is eventually ends up in the deposition zone, which is typically characterized by broad, nearly flat valley floors. It is important to note that erosion, transfer, and deposition occur in all zones, but the zone concept focuses on the most dominant processes in each zone.

The form of the channel typically changes as it moves through the three longitudinal zones. Channel form is commonly described by two characteristics: thread and sinuosity. Streams are referred to as either single or multiple thread streams. Single thread streams, which display one channel, are most common. Multiple thread streams typically take the form of a braided stream. Braided streams typically get their start when a central sediment bar begins to form in a channel due to reduced streamflow or an increase in sediment load. The central bar causes the water to split into two smaller channels on
Watershed Processes

Basic Watershed Processes* continued

either side of the bar. The smaller channels have a smaller cross section resulting in higher velocity flow, which erodes the banks and causes the channel to widen. The new wider channel results in a reduced velocity and the formation of a new central bar and the process continues.

Sinuosity is the term used to describe the amount of curvature of a channel. The sinuosity for a given reach is computed by dividing the channel centerline length (the distance you would travel if floating down the stream) by the length of the valley centerline (the distance a bird would travel if flying over the stream). Streams typically become more sinuous (take on a meandering form) as their gradient or slope decreases.

Vegetation in the stream corridor also plays an important role in channel forming processes and the ecological function of the stream. Native vegetation in the stream corridor, whether it be in the channel, on the banks, or on the floodplain, can be thought to have evolved according to the physical channel forming processes described above. Vegetation plays its own physical role in affecting channel formation. This role can be indirect, such as reducing surface erosion on the upper slopes, which reduces sediment load in the stream. Vegetation can also have direct impacts on channel formation, such as riparian (streamside) vegetation that slows the velocity of the water and protects the banks from erosion. Simultaneously, vegetation in the stream corridor provides food and habitat for wildlife, fish, birds, and countless other organisms.

*The Basic Watershed Processes section is based on information from Stream Corridor Restoration: Principles, Processes, and Practices.
Permits and Regulations Summary

Project Permitting Overview

Implementation of some of the practices described in this manual will require you to meet certain federal, state, and local regulations and obtain permits prior to on-the-ground work. A permit is an authorization, license, or equivalent control document issued by the federal, state or local government or other agency to implement the requirements of a regulation or law. Therefore, a permit is an agreement between the issuing agency and the applicant whereby the applicant agrees to follow the applicable codes and laws governing a project or type of land use. By issuing and keeping track of permits, local, state and federal agencies can set minimum standards for activities that ideally will protect California’s environment now and in the future. The permit process was developed to provide for orderly development, ensure compliance with applicable regulations, and minimize future adverse impact on a wetland or riparian area (i.e. streamside), clearing vegetation, disturbing ground, or conducting work near a sensitive area requires permits from numerous agencies. These actions are common to restoration projects.

Permit applicants may be individuals, watershed groups, special districts (such as RCD’s), or local, state, or federal agencies. Permitting agencies require different forms to be filled out for different types of applicants. Because the permitting process can be complicated and time consuming and there are often fees associated with permit applications, it is recommended that individuals work with their local watershed group to combine restoration projects and permit applications into a larger effort. Below is a brief summary of the permits applicable to restoration projects undertaken by individuals and watershed groups. A more detailed discussion of permits and the laws governing their issuance can be found at the end of the manual.

Local Agencies:

City/County Planning Department: Many City or County planning departments have local ordinances pertaining to streams and wetlands, and depending on the nature of the project several other permits/exceptions/approvals may be required as well.

Local Irrigation, Water or Flood Control District: Irrigation, Water or Flood Control Districts are empowered to protect water resources within their jurisdiction which may require a permit for certain projects.

State Agencies:

California Environmental Quality Review: The local or state government with the most jurisdictional responsibility for your project must review it under their requirements of the California Environmental Quality Act (CEQA). The main purpose of CEQA review is to identify and prevent potentially significant environmental impacts from proposed projects.

California Department of Fish and Game (DFG): The DFG requires a Streambed Alteration Agreement (1603 Permit) for any work that occurs in, on, over or under a waterway, from the bed of a stream to the top of the bank, any work that will divert or obstruct the natural flow of water, change the bed, channel, or bank of any stream, or use any material from the streambed. This permit is also required when removing exotic vegetation from a riparian area.

State Water Resources Control Board (SWRCB): The SWRCB Division of Water Rights requires a Water Rights Permit when there is intention to take water from a stream for storage or for direct use on nonriparian land.

California Regional Water Quality Control Boards (RWQCB): The RWQCB for the region requires a Federal Clean Water Act (CWA) Section 401 Water Quality Certification for every federal permit or license for any activity which may result in a discharge into any waters in the United States. Activities include flood control channelization, channel clearing, and placement of fill. Federal CWA Section 401 requires that every applicant for a U.S. Army Corps of Engineers CWA Section 401 permit or Rivers and Harbors Act Section 10 permit must request state certification from the RWQCB that the proposed activity will not violate State and Federal water quality standards.

Federal Agencies:

National Environmental Policy Act (NEPA): NEPA’s basic policy is to assure that all branches of the federal government give proper consideration to the environment prior to undertaking any major federal action that significantly affects the environment. In order to reach a decision, NEPA requires a prescribed process, including public involvement, scientific analysis and potential mitigations. NEPA compliance is mandated when the Natural Resource Conservation Service (NRCS) provides financial assistance.
Permits and Regulations Summary

Project Permitting Overview cont...

U.S. Army Corps of Engineers (ACOE): The ACOE requires a Federal Clean Water Act (CWA) Section 404 Permit when work involves the intentional or unintentional placement of fill or discharge of dredged materials into any “waters of the United States.” This includes sedimentation from erosion.

U.S. Fish and Wildlife Service (USFWS): The USFWS requires an Incidental Take Permit if a project may result in “incidental take” of a listed species. The permit allows a non-Federal landowner to proceed with an activity that is legal in all other respects, but that results in “incidental taking” of a listed species. Take is defined under the federal Endangered Species Act as any activity that would harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect any threatened or endangered species. A Habitat Conservation Plan (HCP) must accompany an application for an incidental take permit.

12 Practical Tips for Getting Your Project Approved

1. **Consult Early.** Consultation with permitting and regulatory agencies should begin as early as possible in planning your project. This way potential concerns can be addressed and potential problems identified.

2. **Carefully Select and Design Your Site.** Evaluate several alternative sites and designs before making your choice.

3. **Have Written Descriptions and Site Plans Available.** You may need to provide a written description as well as a map and site plan of your project at your first meeting with each agency.

4. **Learn the Rules.** Take time to study the protocols and regulations of those agencies that must approve your project. Study all applicable federal, state, and local agency permitting requirements.

5. **Know the Players.** Become familiar with the regulators and how they function.

6. **Approach the Process with a Positive, Non-Adversarial Attitude.** It is generally counterproductive to resist the permit process as you are going through it. Indeed the squeaky wheel gets the grease. But be polite.

7. **Reduce Adverse Environmental Impacts.** Design your project to eliminate or reduce as many potential environmental impacts as possible. Consider environmentally superior alternatives. Incorporate suggestions you learned during early consultation.

8. **Involve the Public.** Meet with members of your community to get their ideas and views of your proposed project. Avoid surprises.

9. **Pay Attention to Details.** Follow all the rules. Respond promptly to requests for information. Do not cut corners.

10. **Be Willing to Negotiate.** The permit process has been established because of the public concern for protecting the waterways, and this is the prime responsibility of the agency reviewer. The reviewers are sensitive to the concerns of individuals and property rights and are willing to consider alternative project designs to meet the needs of the property owner and still protect natural resources.

11. **When in Doubt, Ask.** If you are not sure whether your project needs a permit, ask. Going ahead without all proper permits or without following conditions of approval will very likely cost you time and money.

12. **Get Everything in Writing.** Request each agency you contact put everything in writing. This will help prevent any misunderstandings.
# Resource Concerns and Solutions Table

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Conservation and Restoration Practices

Introduction

The practices in this manual are divided into three categories based on topography and land use: Upland and Rangeland Practices, Lowland and Agricultural Land Practices, and Riparian Area Practices. The purpose is to make it easier for you to find a practice appropriate to the land type and land use of your property. This does not mean that the solution to your resource concern can’t be found in one of the other categories. For example, some practices such as Gully Repair, Native Perennial Grass Establishment, and Riparian Buffers can apply to situations in all three categories. The practice or practices you choose to employ should be carefully chosen to fit with your land management goals and to provide the most appropriate solution to your resource problem.

For solutions to be truly effective they need to be planned with the larger system in mind. Before installing a practice consider how it will affect your neighbors’ land. For practices in the stream corridor be aware that what you do can affect the balance of the stream system, causing changes both upstream and downstream. These changes can be both detrimental and beneficial to the health of the watershed and your relationship with your neighbor. For example, stabilizing the streambank along your property may cause your downstream neighbor’s streambank to begin to erode. It is important to communicate your intended actions with those who may be affected. In many cases you will find that others are dealing with the same problems as you are, and that you can save time, money and other resources by collaborating on solutions. This straightforward, no-nonsense approach that takes into account how your resource problems and solutions fit into the larger scheme of things, encourages communication and collaboration among neighbors, and results in successful projects that meet everyone’s needs is known as the “watershed approach.”

One of the most effective ways to take a watershed approach to your resource concerns is to participate in a local watershed group. Local watershed groups provide an opportunity for landowners to come together to develop locally appropriate solutions to common resource concerns. Through active participation in the watershed group, landowners can create what is often called a “watershed plan.” A watershed plan describes the current condition of the watershed, defines the group’s goals for watershed quality, and outlines the tasks required to meet those goals. The value of taking part in the watershed planning effort is that it demonstrates to potential project funders and the regulatory and permitting agencies that your activities, as an individual or as a group, have been planned to maximize benefits and reduce the potential for conflicts or harm to the environment. The Cache Creek Watershed Stakeholders Group has identified watershed health in Capay Valley as its highest priority. For more information or to become involved with the Stakeholders Group contact the Yolo County RCD Watershed Coordinator at (530) 662-2037 ext. 121 or howard@yolorcd.org, or photocopy and fill-out the comments page at the end of the manual and mail it to the Yolo County RCD.
# List of Conservation and Restoration Practices

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Introduction

The Upland and Rangeland Practices category focuses on the resource concerns and types of land use common to the hills and mountains that border Capay Valley to the east and west. Livestock grazing is the most common use of the upland areas surrounding Capay Valley, so some of the practices offer advice on grazing management and land management efforts to improve the quality and quantity of feed and water for livestock and wildlife. The goal is healthy rangelands and healthy livestock. The remaining practices address the problem of erosion. In some cases erosion is a necessary natural process, but often human activities on the land (e.g. roads, home sites, ponds, livestock management) can result in accelerated erosion rates. Erosion can often impair or endanger human use of the land (e.g. landslides, road washouts) as well as be detrimental to the health of the environment.
Notes:
Invasive Grass/Weed Control

Description and Benefits of Invasive Grass/Weed Control
Weed control involves the containment, reduction, and/or elimination of certain plant species that are invasive and problematic in a rangeland system. Weed control methods include mechanical removal, chemical applications, cultural practices, grazing, prescribed burning, biological control, revegetation with native species, and integrating various combinations of these methods. Weed control can lead to increases in native plant species, forage quality for wildlife and livestock, wildlife populations, plant diversity, and soil water availability. It can also decrease allergens, restore normal fire regimes into an area, and help prevent degradation of rivers and streams. Due to the variability among control methods and their effectiveness on different weed species, any weed control program requires consultation with the County Agricultural Commissioner, University of California Cooperative Extension Specialist, and/or local Pest Control Advisor.

Conditions Where Invasive Grass/Weed Control Applies
Although not all weed control techniques are practical at all locations, most methods can be applied in rangeland systems.

- Hand-pulling (and hand cutting), grubbing, and hoeing can be applied anywhere a person can access and are good options for controlling new (incipient), small infestations, or previously controlled weed infestations where plant density is low.
- Grazing (if the weed is palatable) can be done just about anywhere.
- Mowing is effective in areas accessible by mowing machinery, typically flat or gently sloping areas, and where soil erosion (i.e. stream banks) and desirable plant species vulnerable to soil compaction/large equipment are NOT a concern.
- Chemical herbicides can be applied anywhere authorized by the specific herbicide label and is one of the most efficient weed control methods. Many herbicides are registered for rangelands, and even some for use near water. Herbicides are a good tool to utilize on large weed infestations, such as yellow starthistle and/or with the particularly problematic species perennial pepperweed. Once a weed infestation is reduced, other methods can be integrated without significant loss of efficiency.
- Prescribed burning can be done in most situations depending on the slope of the terrain and experience of the burn crew.

Materials Needed

**Hand pulling, grubbing, and hoeing:** leather gloves, grubbing hoe, mattock (head with both axe and hoe), shovel, bags (to collect plants if containing seed).

**Mowers:** different types include the sickle-bar mower, rotary mower, flail and reel mower.

**Hand cutting tools:** hand sickles, scythes, machetes, brush/weed cutter.

**Chemical:** 
- Chemical: herbicide, adjuvant (surfactant or spreader), water, dye, soap, paper towels, absorptive material for spills (kitty litter), graduated cylinder or measuring cup, eye protection, tyvex jumpsuit, rubber gloves and shoes, long sleeve shirt and long pants, permits from Ag Commissioner’s office if necessary, herbicide label, location of nearest hospital, notepad to record amount of herbicide used and rate for county records.

**Application Equipment:** back pack sprayer (for spot applications), boom (for wider spray coverage); ATV, spray tank, and boom (for large area application); airplane/helicopter with tank and boom (extremely large scale applications), label containing name of chemical being used and applicator contact information.

Prescribed burning can be an effective tool for controlling weeds.
Invasive Grass/Weed Control

Implementation

Developing a Weed Management Plan
Frequently there are multiple ways to control a particular weed species. Often integrating several different control methods is more effective than just using one tool repeatedly. This makes careful planning of your weed control activities very important. In general the following 8 items should be addressed in strategizing a weed control plan:

1. What is the goal of the site?
2. What weeds are present?
3. Prioritize your weeds.
4. What control methods are available for each priority weed species?
5. Develop a control plan or timeline for implementation of control methods.
6. Implement control plan and monitor results.
7. Did you achieve your goal? If not, why?
8. Make changes to the control plan and try again modifying goals if necessary.

Below there are several tips on how to organize your weed control activities. Appendix A at the end of this manual contains two worksheets to help you prioritize weed control activities and develop your weed control plan. Much of the information provided has been adapted from the Nature Conservancy’s Wildland Invasive Species program website: http://tncweeds.ucdavis.edu/index.html. The Nature Conservancy’s Adaptive Management Tools are a great source of planning documents to use for large weed control activities and can be found at: http://tncweeds.ucdavis.edu/products.html

Weed Identification (What Weeds Are Present?)
Use a reference text like Weeds of the West by the Western Society of Weed Science or The Grower’s Weed Identification Handbook by UC Cooperative Extension to identify your weed species. Take a sample to the County Agricultural Commissioner’s office. They can tell you the best way to control the species and how problematic it is in the State. The California Department of Food and Agriculture has a useful website for identifying noxious weeds in the state: http://www.cdfa.ca.gov/phpps/ipc/encycloweedia/encycloweedia_hp.htm

How to prioritize weed species to control
Prevention is the key to good weed control. If a weed is on your neighbor’s property and is a known problem – keep it off of yours. If a weed is just starting to invade your property, and is a known problem- control it first. This will save you time and money later. Focus weed control techniques initially on the perimeter of source populations and progress toward the heart or center of the weed population. This will contain the spread of the weed while control measures are being taken. The more impact a weed can have on the overall ecological functioning of an area the more important it is to remove it early. Thus, species that are know to alter water flow, sedimentation, and other processes are high priorities. Do not waste time on species that you don’t have the tools to control; especially if there are other problem species you could focus your control efforts on more successfully. See Appendix A for worksheets on setting weed control priorities.

What Weed Control Methods Are Available?
There are many ways to research the best available control methods for a particular weed species. Investigate control methods by talking to the County Agricultural Commissioner’s office. You can also look up useful control techniques for many weeds on the web at http://tncweeds.ucdavis.edu/esadocs.html. Call your local Farm Advisor or UC Cooperative Extension (UCCE) Weed Specialist. They may be researching the most effective weed control methods.

- Joseph DiTomaso, UCCE Non-Crop Weed Ecologist, (530) 754-8715, ditomaso@vegmail.ucdavis.edu
- Morgan Doran, UCCE Farm Advisor, (707) 435-2459, mpdoran@ucdavis.edu
- Tom Lanini, UCCE Weed Ecologist, (530) 752-4476, wtlanini@ucdavis.edu
- Rachael Long, UCCE Farm Advisor, (530) 666-8734, rflong@ucdavis.edu

Mechanical control:
Plants that resprout from underground roots and structures, like perennial pepperweed will not be controlled using this method unless the entire root system can also be removed. Shallow rooted species, like barbed goatgrass and medusahead can be controlled by hand pulling. Yellow starthistle can also be controlled this way as long as the root crown can be removed and the soil is moist. Plants should be able to be pulled out with part of the root attached to be effectively controlled. This should be done after flowering but prior to seed maturation and dispersal for maximum efficacy. Plants can be bagged (recommended if seed has been produced) and removed from the site, piled for decomposition or burning, or left in place. Certain species resprout readily if the soil is moist and should be repositioned or removed from the site.
Invasive Grass/Weed Control

Implementation cont...

Mowing or grazing:
Mowing and/or grazing can help reduce seed production, but timing and growth stage of the plant are critical. Repeated mowing or grazing when the plant is just about to flower can be very effective at reducing seed production in annual plants and depleting underground storage carbohydrates of perennial plants. Mow or graze the weed below the lowest growing branch (2-4 inches). If plants resprout, mow or graze again post flowering but before seed maturation or dispersal. Repeat to avoid seed production. May result in low branching pattern. This is very effective if competitive grasses are mixed in with the weeds forcing the weeds to branch higher and resulting in a more effective kill using mowing or grazing. Thatch can be hayed, burned, removed from the site, or left on site to act as a mulch. If thatch contains seeds or propagules of the weed, leave on site to avoid spreading the weed to non-invaded areas.

Chemical control:
Contact your local County Agricultural Commissioner for details on spraying herbicides: Yolo County Agricultural Commissioner, 70 Cottonwood St., Woodland, CA 95696, (530) 666-8140.

Weed Control Examples
The following weed control information should not be used as a recommendation for use on your site. It is a discussion of successful treatments used for addressing these weeds. A licensed Pest Control Advisor (PCA) should be consulted to determine the best control methods to use at your site.

Yellow Starthistle
Yellow starthistle is a broadleaf, summer annual from Southern Europe. It has invaded millions of acres in California. It is often found along roadsides and in pastures. Yellow Starthistle is extremely competitive for soil moisture and an abundant seed producer (large plants can produce over 100,000 seeds) some of which lay dormant in the soil for up to 3-5 years. Although this plant presents a problem in rangeland systems where its propensity for spread and competitive ability creates large scale problems, it can effectively be managed using integrated weed control methods. Transline® (clopyralid) herbicide can be applied in late winter-early spring (January – April) to control Yellow Starthistle seedlings and rosettes. It is considered the most effective herbicide for Yellow Starthistle control. Transline® is a selective herbicide that does not injure grasses or many broadleaf species. Application rates are 4-10 oz product/acre (costing about $14-$35/acre). If applied when
Invasive Grass/Weed Control

Implementation cont...

Yellow Starthistle is in the seedling or rosette stage, no surfactant is needed. Mowing prior to this application may improve herbicide coverage. Roundup® (glyphosate) can be applied when Yellow Starthistle is bolting or early flowering at rates of 1.5-2.5 qt product/acre (costing about $20-$35/acre) in a broadcast spray or a 1% solution for spot treatments. This is a non-selective herbicide so care should be taken when applying around desirable plant species. Surfactants should be used with late season (bolting-flowering) treatments. Mowing can be used later in the season when Yellow Starthistle is in the bolting/early flowering stage. It is best employed after initial control work has decreased the population (year 2 or 3, once control has begun). This treatment can be effective or very ineffective in that it is heavily timing and growth form dependent. Mowing must be done at the early flowering stage (late spring-summer when 2-5% of the spiny heads are flowering) and on plants that have a high branching pattern. If the blade doesn’t cut below the first branches, the plant will regrow with multiple branches and multiple seed heads! Mowing too early can stimulate this and mowing too late can spread viable seed. Integrated methods can be very effective at yellow starthistle control. Burning tends to stimulate seeds to germinate. If a prescribed burn is performed, follow up treatments will be needed. One suggested reduction plan involves burning in year 1, and using Transline in year 2 and 3. This exhausts the seed bank and reduces starthistle cover so further control can be done easily by mowing or hand pulling.

Perennial Pepperweed

Perennial Pepperweed is creeping broadleaf perennial plant from southeastern Europe and southwestern Asia. This is an extremely problematic weed in that it competes for light, is an abundant seed producer, and produces underground storage roots that make this species very difficult to control (40% of plant is underground). Prevention and maintaining high density stands of desirable vegetation are the best forms of control for this plant. Once established, no control option alone will be 100% effective. When using chemical control methods, getting thorough coverage and deposition on the lower leaves is important. Telar® (chlorsulfuron) applied to Perennial Pepperweed with a surfactant offers good control at the flower bud to early flowering stage. Use rates include 1.5 - 2oz product/acre (costing about $45-$60/acre) with 25% nonionic surfactant. Follow-up treatments will be needed in subsequent years. Telar® cannot be used near water and soil residual activity may inhibit other species recovering. It is selective and will not injure many native grass species if used at lower rates. Roundup® (glyphosate) applied at 4 qts product/acre (costing about $55/acre) provides good control of top growth only. Mechanical methods including hand pulling, burning, and mowing alone are not effective at controlling Perennia Pepperweed. Integrated methods include a combination of mowing and herbicide treatments. Mowing at the bolting - flower bud stage followed by treatment with Roundup® on the regrowth can be effective at controlling Perennial Pepperweed. This is a good technique if the infestation is located near an aquatic area. This method also leads to the most recovery of other species in the area. The Bufferlands located near the Sacramento Regional County Sanitation District (SRCSD) has had good success using Garlon® (tricyclopyr) at a rate of 1.5 qts/acre (if Garlon® 4 = about $46/acre) after repeated mowing (3x) at the bolting stage.

Johnsongrass

Johnsongrass is a perennial grass from the Mediterranean region. It was introduced as a forage crop and rapidly develops colonies and that smother other species. It can be found commonly along moist roadside ditches and is considered one of the ten most noxious weeds in the world. Johnsongrass reproduces by seed and underground stems (rhizomes). It is best to treat seedlings if possible or mature plants in the flowering stage. Grass selective herbicides can be used to control Johnsongrass but may injure desirable grass species. They may be used successfully to control grass weeds and preserve native forb species. One thing that can be used is a selective method of applying a non-selective herbicide: wicking or careful spot spraying. Roundup® (glyphosate) is very effective at controlling Johnsongrass if applied broadcast at 1.5-2.5 qt product/acre (costing about $20-$35/acre) or a 1% solution for spot treatments. This should be applied while Johnsongrass is flowering but prior to seed set. Mechanical methods can be used to grub out small infestations while the soil is moist.

Annual Ryegrass

Annual Ryegrass also called Italian Ryegrass is a winter annual grass brought in for forage and lawn mixtures from Europe. It is very competitive, reseeds readily, and creates large monocultures. Annual Ryegrass is difficult to remove from a native grass planting. Annual Ryegrass germinates in the fall following the first rains, sends up flowering stalks in the late winter/early spring, and goes to seed in the early summer. Control methods focus on preventing seed production and protecting desirable species. A 1% solution of Roundup® (glyphosate) can be used to spot treat Annual Ryegrass with good success. Preemergent herbicides may be used to control seedlings once desirable species are established. Karmex® (diuron) applied as a preemergent at 2-6 lbs/acre (about $10-$35/acre) controls Annual Ryegrass and does not injure established species. Mechanical methods such as mowing can be used when plants are flowering and prior to seed maturation for good control (may need to mow more than one time).
Native Perennial Grass Establishment

Description and Benefits of Native Perennial Grasses

The focus of this practice is on the establishment of stands of native perennial grass in rangeland or otherwise large acreage settings. For the use of native perennial grasses in cropland and roadside settings see the Farm Edge Native Grass Establishment practice in this manual. Over the past 150 years California has seen a shift in its grassland vegetation from a mixture of perennial grasses and annual grasses/forbs to a system dominated by annual grasses/forbs (many of them introduced and invasive). Armed with rapid growth and prolific seed production, annual grasses effectively compete with slow-growing, long-lived native perennial grasses for light and soil water. For this reason reestablishing native perennial grasses requires careful human management of the land, as well as patience. This practice will cover the general guidelines to follow for reestablishing perennial grasses on Yolo County’s grasslands and oak woodlands. Native perennial grasses provide many benefits, including deep rooting, which allows for deeper water penetration into the soil in the winter. This in turn can help reduce soil compaction. Many perennial grasses remain green longer than annuals and can provide good forage for grazing animals.

Conditions Where Native Perennial Grass Establishment Applies

Native perennial grasses can be reestablished in any grassland or oak woodland, regardless of current land management. Actively grazed rangelands can provide an ideal opportunity for native perennial grass establishment, although changes will most likely need to be made in grazing management. The techniques outlined in this practice will apply more specifically to rangeland areas in Western Yolo County, such as the foothills of the coastal range, the Dunnigan Hills, and the Capay Valley. See Farm Edge Native Grass Establishment for techniques more appropriate for level pasturelands and previously farmed land.

Materials Needed

Site preparation/weed control:
- Tractor or ATV equipped with a spray tank and boom.
- Broad spectrum herbicide (e.g. glyphosate)
- Prescribed Burn Equipment: including fire resistant jumpsuit, drip torch or other ignition device, backpack sprayer, burn plan and permits, shovels, polaskis, McCleods, assistance from CDF or an experienced crew.

Seeding:
- Tractor equipped with a No-till seed drill; or a seed broadcaster and harrow.
- Native perennial grass seed.

Maintenance:
- Tractor or ATV equipped with a spray tank and boom.
- Selective herbicides (e.g. Transline) and broad spectrum herbicides (e.g. glyphosate)
- Prescribed Burn Equipment
- Also see materials needed for Invasive Plant/Weed Control.

References

Native Perennial Grass Establishment

Implementation

Like other practices that involve native perennial grass establishment, it is best to think of this practice as having three phases: site preparation/weed control, seeding, and maintenance. Reestablishing native perennial grasses on your land is a long term commitment that will require careful planning and diligent maintenance to be successful. Timing is also critical during all phases.

Site preparation/weed control: The first step is selecting a site. Site attributes such as soil type and quality, existing vegetation, slope, aspect, average precipitation, accessibility, current/future use, and size should all be considered. By assessing these site attributes you will determine how your project will proceed. The environmental attributes, from soil quality to precipitation, are key for determining the various appropriate native perennial species for the site. Work with your seed supplier to determine the appropriate mix of species and application rates.

Once you have selected a site and determined that it can sustain native perennial grasses you must prepare the site for seeding. The emphasis on site preparation is thatch and weed seed reduction. For the purposes of establishing native perennial grasses, any non-native annual grass or herbaceous broadleaf plant is considered a weed. There are three primary techniques for weed control in rangeland settings: grazing, prescribed burning, and herbicides. Existing vegetation will determine the preferred weed control management. If annual grasses dominate the site, the following strategy should be employed: Heavy grazing in the spring just prior to setting of seed, a prescribed burn in late summer/early fall and an application of glyphosate to combat the first flush of weeds following the first rain (if necessary) should provide the best environment for seeding.

Seeding: October and November are typically the optimal months for planting. Keep track of the weather patterns and plan to plant so that the seed will not sit on the ground too long before a good, germinating rain. Ideally, a small rain event in September or early October will promote the germination of remaining weed seeds and glyphosate can be applied prior to or shortly after the native perennials have been seeded. Seeding should be done using a no-till range drill designed to handle fluffy seeds, such as the Truax drill, which was designed for prairie restoration in the Mid-West. Native perennial grass seeds germinate slower than annuals, typically 2-4 weeks (depending on temperature) following the first germinating rain.

Maintenance: Maintenance intensity will diminish as the native perennials become established, but the first 2-5 years are crucial. As with site preparation, maintenance focusses on weed control with the goal of reducing competition. Now that the native perennial grasses have been planted, herbicide use must be more selective. Once again, grazing or mowing the site in the spring following planting can reduce seed production of annuals. If broadleaf annuals, such as Yellow starthistle, are the dominant weeds found emerging in the spring, a selective broadleaf herbicide can be applied. A wick application of glyphosate using an ATV or tractor mounted wick applicator in the spring is another option. A pre-emergence herbicide can be applied in the fall prior to the first rain event. Burning the site the first spring following planting is not recommended, but prescribed burns can be one of the most cost effective methods for weed control. Burning, along with grazing and mowing are the preferred techniques for long term maintenance. Burns should be conducted in the late spring (in general) and not more that once every two to three years. The Nature Conservancy and the California Department of Forestry (CDF) are good resources for more specific prescribed burn information (See Fire Management for more information).
Stock Pond Habitat Enhancement

Description and Benefits of Stock Pond Habitat Enhancement

Stock ponds are ponds that have been constructed in rangeland settings to provide a water source for livestock. This practice will describe enhancements that can be made to existing stock ponds, which will result in improved water quality for the livestock and the creation of wildlife habitat. Studies have demonstrated that cattle health and weight gain are improved when they are provided with clean water. Enhancing stock ponds to benefit livestock involves fencing off the pond and providing a trough that draws water from the pond by the use of a pump or gravity (referred to as an “off pond watering system”). Enhancing stock ponds to benefit wildlife also includes fencing off the pond, but with a “wildlife friendly” fence (see other side for more details). Additionally, the fenced off area is planted with native plants. The vegetation provides food, nesting habitat, and cover for insects, birds, and other animals.

Conditions Where Stock Pond Habitat Enhancement Applies

Enhancement of stock ponds can be undertaken for ponds of any size and water holding capacity. Full implementation (i.e. fencing, off pond watering system, planting of trees, shrubs, grasses, forbs, rushes and sedges) of this practice is best suited to stock ponds that hold water all year. Smaller ponds and ponds that are dry for up to half of the year are still suitable for partial implementation (i.e. fencing, off pond watering system, limited planting of grasses, forbs, rushes and sedges). In either case, fencing off the pond and providing for an off pond watering system will give the rancher the most benefit to his/her operation. The extent of the plantings is determined by the conditions of the site, the ability to provide supplemental irrigation, and the desire of the rancher to devote some time to regular maintenance.

Materials Needed

- Small Tractor or ATV: for preparation and maintenance of the fenced area; needs the ability to attach a discing implement, mower, and herbicide spray boom.
- Hand Tools: shovels, rakes, hoes, dibble sticks, sledge hammer, 5 gal. bucket, fence wire tool.
- Drip Irrigation System
- Off Pond Watering System: pump (solar or gravity pumps work best), storage tank, trough, pvc, solar panel.
- Fencing: posts, barbed wire, smooth (wildlife friendly) wire.
- Native Plants: trees, shrubs, forbs, grasses, sedges and rushes.

References


Stock Pond Habitat Enhancement

Implementation

There are three main components to stock pond habitat enhancement - fencing, off pond watering system, and native plantings. Careful planning should be done prior to breaking ground. Work with your local NRCS and/or RCD office to determine the cost effectiveness of your plan and the additional benefits you can expect to see. NRCS and RCD staff can also provide technical assistance in planning your project and may be able to match you with a cost-share program that will make your project more affordable.

Fencing: Install a 5-wire fence around the pond. The size of the fenced area depends on the extent of the plantings you want to undertake as well as the location of other fences and the topographical limitations of the area. If keeping the cattle out of the pond and providing them with a watering trough is your primary goal, the fenced area need not be much larger than the pond. If you intend to improve the wildlife habitat around the pond, the fence should allow for at least a 20 foot buffer around the pond. Use a smooth wire, instead of the normal barbed wire, for the top and bottom wires of the fence to allow for safe movement of wildlife in and out of the pond area. A gate in the fence will simplify your maintenance and recreational access to the pond as well as allow for future “flash grazing” as a vegetation management tool.

Off Pond Watering System: These systems can vary widely depending on the site and the number of cattle and the number of fields that will use the system. In fact, the systems are too varied and too complicated to adequately explain here. If you are unfamiliar with such systems working with your local NRCS engineer can save you a lot of time and money. Their technical assistance is at no cost to you and they may be able to match you with a cost-share program. Two general examples of off pond watering systems are as follows: 1) The use of a solar pump to pump water to a storage tank on a small rise, which gravity feeds the water to one or more troughs in one or more fields; 2) A more simple approach is to use a siphon pump to pull water from the pond and gravity feed it directly to the trough.

Native Plantings: Planting native vegetation to provide habitat for wildlife will require several years of maintenance to the area while the plants become established. It will also require considerable work to prepare (i.e. weed control) the site for planting. See Hedgerows and Riparian Buffers for details on establishing native plants. However, some simple and inexpensive planting options do exist. These low/no maintenance options may be preferable for the busy rancher. Basically, consider planting just at the waters edge using sedges and rushes. These can be purchased as “plugs” and planted in the winter or early spring. If you have rushes or sedges growing along the streams on your land you can dig some of these up, separate them and plant them at the pond. Additionally, live cuttings of willow and cottonwood can be planted at the waters edge. See Live Staking and Pole Planting for details on how to harvest, handle and plant these live cuttings. None of these plantings will require supplemental watering or future maintenance (just keep the livestock from trampling or eating them), although you may need to install cages around the live cuttings to discourage browsing by herbivores.

Figure 6: Keeping livestock out of watering ponds improves water quality and livestock health.
Rangeland Management

Description and Benefits of Grazing Management

This special practice on grazing management will describe several methods for managing rangelands used for grazing livestock. This practice differs from others in this manual as the information is presented in a series of articles. Topics include: Grazing Ecology, Grazing Management Systems, Prescribed Grazing, Range Development and Improvements, and Brush Management. The purpose of this practice is to introduce livestock managers to a variety of methods they can use to improve forage quality and quantity, resulting in healthier livestock.

Grazing Ecology

Introduction

Ranching is really a grass farming business. Everything depends on the conversion of solar energy into forage. This forage, or plant matter, is then harvested by the grazers and converted into livestock matter. Understanding how grass grows and how grazing affects annual or perennial grasses is extremely important for anyone in the livestock business.

Plant Growth and the Grazing Interaction

Plants go through three basic stages (or phases) of growth. Phase 1 occurs in the beginning of the growing season, or after a plant has been severely grazed (i.e. more than 80% of its leaf area is gone). When this occurs plants compensate by mobilizing energy from their roots and putting it into new leaf growth. The growth rate in this phase is very slow, but the leaves are of high quality. Despite this high quality, the overall biomass of the plant is low, so the quantity of the forage is low. In the Capay Valley, and throughout annual rangelands, this phase occurs during the months of November through February, when producers are feeding high quantities of hay. At this time crude protein is high, but energy (cellulose) is low, resulting in the need for supplementation of energy (cellulose).

Plants in Phase 2 have enough leaf area to produce energy through photosynthesis to support growth and development of roots. This is the most rapid time of growth and is usually between the months of February and April for Capay Valley. However, this rapid growth is dependent not only on moisture but also on temperature. If temperatures are too low for growth to occur, then no amount of rain will help growth. In Phase 2 there is usually enough energy and protein to meet the nutritional needs of livestock. Basically, there is a high quantity of high quality feed.

During Phase 3 plant growth begins to slow, because of shading and senescence. Plants begin their cycle into seed production and dormancy. As plants begin to mature, the plant material becomes high in lignin content which decreases digestibility. Crude protein levels drop and supplementation becomes necessary.

From this we can deduce that keeping a plant in the Phase 2 for the longest time possible will not only meet the nutritional requirements of the livestock, but also reduce your supplementation bill. How do you do this? Never graze a plant into Phase 1 (regrowth is too slow) and don’t allow the plant to reach Phase 3 until the final days of the growing season.

Figure 7: Plant growth phases.
Rangeland Management

Grazing Ecology cont...

Annuals and perennial plants need time to recover and re-grow from a grazing event. Annuals tend to take less time to recover, but also start growing (Phase 1) later and reach Phase 3 sooner than perennial plants.

Overgrazing

Many have thought that overgrazing is a function of too many animal numbers on too little area. Although this can happen, it is more a function of time. The reason is that it takes time for grass to recover from a grazing event. Livestock, like most animals (even humans), have preferences for what they eat, which are described in terms of palatability. Some grasses are more palatable to livestock than others. Differences in preference have been measured between cattle, sheep, goats, and many other types of animals. These preferences change over time due to many factors. One that is very clear is the difference between Phase 1 and 2 (vegetative) Yellow Starthistle and Phase 3 Yellow Starthistle that has gone to seed and has spines on it. The first is high in protein and energy value, and the latter is a physical deterrent that many animals won’t eat. Thus palatability and preference change with time.

For this reason we sometimes need to ignore palatability in favor of a more holistic approach. Just because our children don’t want to eat their veggies doesn’t mean we let them run and eat candy all day. This is the same with overgrazing. You will lose all of your good feed if the grazing pressure on that good feed never releases to allow growth and development. The grasses and forbs you don’t want then must be grazed to reduce their advantage over the good feed that will be grazed by your livestock. You must even the playing field so that what you want has a chance. It also must be said, however, that in doing so you may sacrifice some performance from your livestock. However, if you don’t allow this to happen your rangeland will become infested with plants that will in the long run lower your performance anyway (Medusahead, Ripgut Brome, Yellow Starthistle, etc.). By using grazing systems and stocking rates (see Grazing Systems) you can insure that your rangeland gets the amount of rest that is necessary for growth and development. Grazing your rangelands moderately will help you achieve your goals by keeping plants in Phase 2; however, you must realize that at different times of the year it may take longer to recover from grazing. In the winter recovery is slow, while in the spring it is rather quick. Movements of the herd must reflect the physiological development of the plants, not calendar dates that are set. Thus keeping an open-ended plan and constantly using adaptive management will help you make decisions based on environmental conditions. Constant monitoring is necessary to make these decisions.

Wrap Up

Keeping your rangelands in good condition and health takes time and active management. By understanding the nature of your rangelands you will begin to develop a plan that helps you work with nature rather against it. Knowing how grass grows and what it needs to recover from defoliation will help keep your rangelands in a productive and healthy state.

Prescribed Grazing

Introduction

Prescribed grazing is the controlled harvest of vegetation with grazing or browsing animals, managed with the intent to achieve a specified objective. These objectives are developed by the landowner during the planning process. At a minimum, prescribed grazing would include enough information for the landowner to know the proper amount of harvest to maintain enough cover to protect soil and maintain or improve the quality and quantity of desired vegetation. Balancing the available forage with the number of grazing and browsing animals is key to effective grazing management. Proper grazing management can increase production and protect the natural resources that rangelands provide.

Annual Grasslands

California annual grasslands should be managed to insure proper residual dry matter (RDM) for the next growing season. Annual forage responds to conditions that influence plant germination and establishment in the fall. Although fall weather has the greatest impact on annual plant growth, the water holding capacity of the soil and RDM also influences growth. How to recognize RDM levels is described below. High levels of RDM tend to favor plants such as Ripgut Brome, Wild Oats, Medusahead, and Barbed Goat Grass. Low levels of RDM tend to favor plants including Silver Hairgrass, Yellow Starthistle, Filaree, Turkey Mullen, Tarweeds, Vinegar Weed, Clover and Bur Clover. Management of annual grasses should focus on moderate levels of RDM. Landowners should test these guidelines and develop their own levels to meet their specific site and condition requirements.
Rangeland Management

Prescribed Grazing cont...

Perennial Grasslands
California perennial grasses are found within many range sites and need to be managed in a different way if restoring perennial grasses to the ranch is a management objective. Native perennial grasses developed over millennia with natural wildlife herd movements. Herds tend to concentrate on a specific site and move frequently due to predator pressures. These types of high intensity short duration grazing systems favor longer-lived, deeper-rooted perennial grass systems. Perennial grass systems tend to have higher infiltration rates, better soil quality characteristics, and longer “green” periods due to their extensive root systems that reach depths of over 3 feet.

Managing your ranch for both annual grasses and perennial grasses can benefit production in many ways. Annual grasses produce high amounts of digestible protein in a short amount of time. Using proper management can utilize these “green” periods while they occur. Perennial grasses can extend this “green” period by a few months. The need for supplemental inputs may be reduced by this extension of “green” forage.

RDM measurements: Measurements are taken in the late summer to early fall.

Visual determination
- **Light Grazing** – leaves little or no patchy appearance. Plant matter averages 3 or more inches in height and small objects (golf ball) are masked. RDM is over 800 pounds per acre.
- **Moderate Grazing** – leaves an average of 2 inches of unused plant matter and has a patchy appearance with little bare soil. Small objects are hidden at 20 feet away or more. RDM is 400 to 700 pounds per acre.
- **Heavy Grazing** – leaves less than 2 inches of unused plant matter. Small objects and areas of bare soil are visible from 20 feet. RDM is less than 400 pounds per acre.

Weight determination
Ten samples should be made over a range site. Randomly pick a spot to measure and place the frame on the ground. Clip at approximately ½ inch off the ground. Put all clipped material and litter or shattered plant material into a sack and weigh with the gram scale (be sure to measure and subtract the weight of the sack). Grams per square foot multiplied by 96 gives you pounds per acre. Example: 9 grams per square foot X 96 = 864 pounds per acre. Stocking rates can be figured from this data to reach guideline levels.

Perennial measurements
- **Photo Points** – A photo point of the perennial stand you wish to manage should be taken each year in late spring when the annual grasses and forbs have gone dormant but the perennials are still green. This will allow you to see the perennials in the photo. A photo point can be a pole in a fence line, a tree, or other permanent structure. Taking the photo properly along with documenting exposure, shutter speed, and the type of film is important.
- **Plant Recognition** – Using plant ID guides can help. However, if you cannot identify the key perennial plant you wish to manage contact your local Resource Conservation District or U.C. Extension Office.
- **Utilization** – The concern here is the amount of photosynthetically active material (green blades) remaining for the plant to recover from grazing. Generally, less than 40 percent defoliation will not inhibit plant growth. However, one must give the plant time to grow before the dormant season. Perennials should not be grazed between early March and late May. This will allow the defoliated plants to grow and produce seed. Watch these areas over time to see the trend of the system.

For more information on annual or perennial rangeland and the monitoring aspects please contact your local Resource Conservation District or U.C. Livestock Advisor.

Websites to visit for more information
California Rangelands Research & Information Center - [http://agronomy.ucdavis.edu/calrng/range1.htm](http://agronomy.ucdavis.edu/calrng/range1.htm)
Rangeland Management

Grazing Systems

Introduction
Grazing Systems are an essential part of any sustainable ranch. There are many types of grazing systems that can be used to benefit the land, and the landowner. This article will outline some of the basic and more widely used grazing systems. Your ranch operation, your landscape, and your ranch infrastructure will determine which grazing system is right for you. If one system is not showing the results that you would like to see, another may need to be implemented. Your neighbor’s grazing system may not work for your ranching operation so be flexible, innovative, and thorough. Each grazing unit (field) can also have different grazing systems or stocking methods to get desired results, as would be the case if a field has a specific weed that would need consistent defoliation to keep it in check (e.g. Yellow Starthistle). Grazing systems help you balance the supply of forage with the demand for that forage. When this is done the system will help you:

- Maintain or accelerate improvement in vegetation and facilitate proper use of the forage on all grazing units.
- Improve efficiency of grazing through uniform use of all grazing units.
- Stabilize the supply of forage throughout the grazing season.
- Enhance forage quality to meet livestock and wildlife needs.
- Improve the functioning of the ecological processes.
- Improve watershed protection.
- Enhance wildlife habitat.

Grazing Systems
There are several types of grazing systems that can be developed to fit the specific management objectives of the specific piece of land. The four basic types of grazing systems are:

1. Deferred rotation grazing: This system consists of a multipasture, multiherd system that maintains or improves forage productivity. Stock density is moderate, and the length of the grazing period is longer than the deferment period. One field is deferred at all times while the other fields are being grazed. The number of livestock is balanced with the available forage in all grazing units.

2. Rest rotation grazing: This system consists of multipasture, multiherd or multipasture, single herd grazing. Stock densities are moderate to heavy depending on the number of livestock herds. Rest periods are longer than grazing periods and grazing periods are set so that no grazing unit is grazed the same time of the year during the cycle of the system.

3. High intensity – low frequency grazing (HILF): This system consists of multipasture – single herd systems. The length of the grazing period is moderate to short, with long rest periods. Dates of moving livestock are set by the utilization of forage.

4. Short duration grazing: This system is similar to the HILF system except that the lengths of the graze and rest periods are shorter.

Stocking Methods
Along with grazing systems a rancher must also pick a type of stocking method (see Appendix C). If grazing systems determine where and when you are grazing a unit of land, stocking methods are how you are grazing that unit. There are three major stocking methods:

1. Allocation stocking methods.
2. Nutritional optimization stocking methods.
3. Seasonal stocking methods.
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Grazing Systems cont...

Allocation stocking methods are based on allocating the forage resource to the livestock. There are four basic allocation stocking methods that are used extensively throughout the U.S.

1. Continuous set stocking method – This method places the same numbers of animals on one grazing unit for the whole grazing period. This stocking method has been equated with poor grazing management. However, it is an appropriate method under the right forage growth circumstances and when managed to provide the proper forage allowance to the livestock being fed. Unfortunately this is not always practiced.

2. Continuous variable stocking method – This method adjusts the land area or livestock number as forage availability changes throughout the grazing period.

3. Set rotational stocking method – This method is useful on pastures where forage growth rates vary little or physiological maturity is going to occur regardless of forage height and growth rate. A recovery period is used to allow the plant to gain leaf area and build food reserves. Care is advised with this method because of its lack of flexibility between growth cycles.

4. Variable rotational stocking method – This method adjusts the recovery period to the variable growth rate of the forage species. The grazing period is set for this method, although in practice problems often arise when too much or too little forage is set aside for the next rotation. The grazing period for this method is usually under 7 days and depends on the class of livestock.

Nutrition optimization stocking methods are used to selectively feed livestock. These methods can be used in conjunction with continuous or rotational stocking methods.

1. Creep grazing allows young stock to graze forage that other livestock cannot get to. This is used with meat type animals to get higher weaning weights. It can also be used to place lactating cows ahead of heifers and dry cows when on rotational pasture.

2. Strip grazing tries to maximize utilization of standing forage by limiting the amount of fresh forage at any one time. This tends to increase forage intake because the herd responds to fresh forage by grazing as soon as it becomes available to them. Forage allocation is usually broken down into units small enough to be grazed off in one to four hours.

3. Frontal grazing is a form of continuous variable stocking. As available forage disappears, more area is opened up for grazing. This system is most useful when incorporating a new field into the area being grazed when forage production is low. By slowly rationing the new field piece by piece one reduces trampling and rejection losses.

Seasonal stocking methods seek to time access to fields to lengthen the grazing season or avoid harming the pasture area. This type of method can be used to varying degrees either in continuous or rotational stocked pastures.

1. Deferred stocking method can be used to stockpile forages or to keep livestock out of pasture areas needing seasonal protection for a variety of reasons. One reason to use this method would be to delay stocking of a pasture because it is too wet. When soils are wet they can be compacted severely by livestock. This method can be used to protect riparian areas for grazing at critical times, or to protect ground nesting bird habitat.

2. Sequence stocking method takes advantage of the seasonality of forage production. It integrates forages with differing seasonal availability into a diverse group of pastures. This system tries to reduce stored feed production and consumption to an absolute minimum.

Wrap Up
Grazing systems and stocking methods can help you manage your ranch more efficiently. A few things you will need to do to start managing your ranch using these systems and methods are listed below:

- Ranch Map: Get a good ranch map of your property. Aerial or Topographical maps can be of great help when designing your grazing system. Some things you may want to include on your map are: property lines, fence lines, roads, watering areas (ponds, wells, windmills, solar), soils, buildings, corrals, springs, troughs, pumps, salt/feeding areas, range sites, wildlife/recreation potentials.

- Record Keeping: Keep up-to-date records of herd movements, supplementation program, veterinarian tasks, pregnancy rates, weight gains, etc. Keep records on each field as well; # of animal units on the field, in and out dates, # of grazing days, # of rest days, and any monitoring data for that field (i.e. stubble heights, lbs. of residual dry matter, range health, and wildlife).

- Annual Inventory: If you are in the livestock business, run it like a business. Take an annual inventory of all the items you use on your ranch, and their value. This should include machinery, livestock, buildings, feed and supplies, and real estate. Keep records of all receipts and expenses. Ranchers that make it have multiple file
Rangeland Management

Grazing Systems cont...

- Make sure your operation will “pencil out” when you do your annual inventory, or when you invest in new projects. A ranch planning consultant may be needed to analyze and summarize these records. They are in a better position to make a “cold” appraisal without prejudice.
- Grazing Plan: Write down what you intend to do but always keep an open ended plan that can allow for adaptive management. Document when changes are needed, and why. This will help you discover the weakest links in your operation.
- Goals and Objectives: Take time to develop your goals not only for the operation but for your standard of living. What is it you want out of this lifestyle? What will the land need to produce for you to maintain that lifestyle? Is it feasible with the size of your property and your operation?

Which One Is Right For You?
Grazing systems and stocking methods will vary depending on whether you are a small landowner leasing out your land with no internal fences or a large landowner that runs a cow-calf operation with a few stockers. How will you choose? Lay out your goals and objectives, look at your operation, then meet with a range specialist, plan your graze, and graze your plan. It will take time to find those weak links and fix them.

Range Development and Improvements

Introduction
There are many range improvements that you may want to make on your property. This is a list of several improvements you may want to consider when developing a ranch plan or conservation plan. Many of these items can be cost shared by the USDA - Natural Resource Conservation Service (NRCS) under their programs. However, care should be used when putting money into your ranch. Evaluation of your weak links in your operation will go a long ways when deciding where to put your money. For example, it would be unadvisable to put a cross fence in when water development is your weak link in getting good distribution on the property.

Fencing
Fencing is a major part of ranch infrastructure and can determine what type of grazing system you may employ. Since some grazing systems are not possible without the help of fencing, getting an understanding of the fences on your property and how they relate to grazing systems is important. Herd movement, watering and feeding facilities, and the size of the field are all considerations when deciding to erect a fence. There are two major types of fence: conventional and electric.

There are two main types of conventional fences. One is made from barbed or smooth wire and can be strung with three or more strands as you determine as necessary. The other is typically called a sheep fence, which usually consists of woven wire fence up to 30" and two barbed or smooth wires on the top. These types of fences are usually used either as a boundary fence or as a cross fence. Standard heights for these fences are over 42". A “Wildlife Friendly” fence helps wildlife move more freely about their territory without injury. They are made with 5 strands of wire, 3 barbed in the middle, and 2 smooth wires, one on top and the other on bottom. The bottom wire is at least 12" off the ground to allow fawns to move under the fence without injury. When crossing waterways or flood channels, a self-cleaning floodgate should be used so that debris doesn’t build up along the fence and cause a dam to form and take down the fence.

Electric fences consist of anywhere from one to three or more wires. Single wire fences are usually cross fences used to reduce the size of a paddock in order to concentrate livestock in the field or keep them out of a specific field, as with creep grazing (see Grazing Systems). Since there is no ground wire the field needs to be able to carry a current, which means that one-wire systems won’t be effective in dry range. For more permanent fences two or three wire electric fences are recommended. They have a ground wire that will help provide the shock when the ground is too dry to conduct electricity. Voltage and a power source are important to consider when running an electric fence. Livestock should be trained to an electric fence before release into a field bounded by an electric fence.
Rangeland Management

Range Development and Improvements cont...

Water Developments:

Natural Water Supplies:
Lakes, ponds, and streams: These are usually the most reliable and require the lowest maintenance of all water supplies. In Capay Valley streams are generally not good water sources (unless you have access and rights to Cache Creek). Natural lakes and ponds rarely exist in the Capay Valley. Human-made reservoirs are discussed below.

Springs and seeps can provide a dependable source of water with little expense. However, sites are often limiting. When developing a spring care should be taken to exclude cattle from the spring itself and water should be piped to a nearby trough. This will keep the water clean and free of unwanted pathogens. The spring should also be able to overflow into its natural channel so that excess water can still feed the natural spring vegetation. A wildlife guzzler can also be installed for other wildlife.

Human-Made Stockwater Developments:
Wells are usually the most dependable water source; however, they are often the most expensive. Horizontal wells provide good water without the need for a pumping system. Vertical wells will need some type of pumping system. Although windmills are functional here in Capay Valley, solar units are recommended due to the reliability of the unit. When using a solar unit, utilizing a tank can help increase reliability and storage without the cost and maintenance of a battery system.

Reservoir development is limiting because of cost and limited sites. Reservoirs in the Capay Valley need engineered spillways for proper functioning without erosion. Contact the USDA-NRCS if you would like to put in a reservoir. NRCS staff can make recommendations even if there is no cost-sharing available. Reservoirs should be fenced and water should be piped by pump or siphon to an area that will cause the least amount of environmental damage.

Rain traps are another way of harvesting rainwater into catchment basins. They consist of a sloping, slightly concave, watertight collecting area and a closed reservoir for storing the collected water. Sites should be between 5 and 10% slope so that rainwater will collect in the lower corner where it can be piped to the reservoir, and then off to a trough or guzzler.

Storage and Watering Facilities:
Storage facilities may consist of metal, fiberglass, cement, or masonry tanks or cisterns, or even surplus railroad cars. Permanent tops or floating covers should be installed to prevent evaporation. There are many types of troughs and tanks that can work successfully on range. They should be located on level, solid ground and anchored securely via concrete or railroad ties. Troughs should not be higher than 20 to 24 inches for cattle or more than 12 to 16 inches for sheep. Placement of troughs along fence lines allows watering from both fields and uses only one trough. A concrete pad or rock should be installed around the trough for at least 6 feet. Providing an overflow pipe that runs at least 20 feet out to daylight should be installed so that the ground around the trough doesn’t become saturated.

Range Fertilization
When thinking about fertilizing rangeland a soil test should be done first to find deficiencies. The major types of fertilizers help solve deficiencies in Nitrogen, Phosphorus, Potassium, and Sulfur. Organic fertilizers can also be used to solve small deficiencies, and increase organic matter. Which nutrient is deficient will determine when and with what implement you

Vertical well with a solar pump and trough
Rangeland Management

Range Development and Improvements cont...

will need to apply the fertilizer. Although fertilizer can increase production on the property, that production is usually short lived. Organic fertilizers tend to leach nutrients more slowly than other fertilizers and help build soil organic matter. However, proper range management can help keep that production higher once fertilizers have been added.

Rodent Control

High rodent populations are commonly associated with poor range conditions. Ground squirrels are widespread and can consume large amounts of plant matter. Ground squirrels directly compete with livestock during the winter forage period. Natural control of rodent populations should be encouraged whenever possible. Natural enemies include coyote, bobcat, fox, weasel, badger, striped skunk, hawks, owls, eagles, rattlesnakes, and gopher snakes. A strong, virile population of rodent eaters, except for coyote, should be maintained. Artificial control can be effective for rodent control. The principal methods are 1) poisoning, 2) trapping, 3) shooting, and 4) exclusion. Rodenticides are applied as baits, foliage spray, or as a fumigant. However, these rodenticides are poisonous to humans and nontarget animals, and are closely regulated and must be carefully handled. Do not use around areas where you are trying to use natural controls so as not to injure non-targeted animals.

Brush Control

Many ranches within Capay Valley have brush encroaching on the rangelands. This has taken place over years of active fire suppression. These old continuous stands of brush provide little habitat for wildlife and also reduce forage for livestock performance. Brush plants use three to five times more water than native grasses for each pound of leaf growth. There are many ways to reduce the amount of brush on your properties. The four major control methods are: mechanical, chemical, prescribed burning, and prescribed grazing.

Mechanical:

This is the most widely used method because of regulations on burning and the effectiveness of reducing re-growth. There are many types of mechanical methods; however, the focus of this section will be mostly on blading. Blading has been the most effective form of mechanical brush control for this region because of its effectiveness on removal of the brush root crown. The removal of this root crown is essential to reduce resprouting. This method is very effective and will reduce the amount of brush for up to 5-10 years. Cost can range from $30 to $75 per acre depending on the density of the brush.

Blading should only be done on sites that are level to moderate slope, and have good soils for re-seeding. Due to the vegetative cover that older shrubs provide and the summer forage qualities of brush, a zero-brush ranch policy is generally not desired. A mosaic of old brushes for wildlife cover, and sprouting brush for food should be the objective. The most effective time of the year for mechanical brush management is late spring to early summer when soil conditions are favorable and the shrubs don’t have mature seed. If soil is disturbed it should be placed on the contour in the windrows.

Use a bulldozer (D-6, 7, or 8) with a solid, straight blade. The blade of the tractor is used at ground level to shear off small brush and pile debris in windrows. The blade is regulated to leave standing herbaceous vegetation mostly undisturbed. On the forward pass through the brush the above ground material is removed. On the second pass, usually when in reverse, the blade is lowered to knock off the shrubs’ root crowns. Brush should be piled or windrowed to provide small game habitat or for prescribed burning.

Chaining, Railing, Dragging, and Ball and Chain are all mechanical methods that will remove the above ground biomass but will not kill the plant because the root crowns are not usually damaged. They are typically used in stands of nonsprouting single-stemmed species. A major advantage of chaining, railing, and dragging is that large acreages can be treated at a lower cost per acre. Additionally, the Ball and Chain method can be done from hilltops to get slopes that are dangerous for equipment operation. However, erosion can be a problem on steeper slopes.

Chemical:

This method involves the application of selective herbicides to the soil or plants by airplane or ground equipment. Many brush species are tolerant to herbicides so results will vary. This method can also be used in conjunction with prescribed burning. After the herbicides have killed the plant you can burn the skeletons of the shrubs after the fire season. This can be an effective way to manage brush, but it is less selective than other methods and can be expensive. Contact a pest control advisor (PCA) for more information on chemical applications for brush management.
Rangeland Management

Range Development and Improvements cont...

Prescribed Burning:
Burning is a low expense and moderately effective control method that mimics the natural systems of the Capay Valley hills. If there is sufficient fuel load for a fire you should pick sites that will best improve both range health and wildlife habitat. Burning should be done with the California Department of Forestry to insure safety. A Vegetation Management Program is an agreement with CDF and private landowners to manage brush and other vegetation with the use of burning on their land. It is a cost-share program in which the landowners take on the cost of the Air Quality Burn Permits and the fire breaks, and CDF will light and take responsibility for the burn. Burns take place starting late October or early November depending on environmental conditions. This is the best time for a burn because it increases deer browse and is outside of the fire season. Although this method works well, it increases forage production for only 2-5 years before the brush takes over again. This tool should be used if the reduction of brush will result in improved wildlife habitat. It can also be used in areas too large for cost effective blading, or in areas inaccessible to equipment.

Prescribed Grazing:
Some landowners have had success controlling brush by putting high numbers of livestock in a confined area. Livestock can either browse the brush down to low levels, as with goats, or be used to knock it down by hoof action, as with cattle. Animal performance is reduced with this type of prescribed grazing, so monitoring of the herd is required along with supplementation. Using prescribed grazing can also reduce the amount of brush that one will have by allowing the grasses and forbs to compete with brush seedlings. Prescribed grazing should always be used when following any of these treatments.

Range Seeding:
Always follow any brush removal practice with a range planting program. This will help reduce soil losses to erosion and provide a seed base for areas where grass and forb species have been absent. It will also help reduce weed species that may move in to the disturbed soil areas.

Range Seeding
There are two major types of range seeding: drill and broadcast. Drill seeding uses less seed but is more expensive and time consuming. The use of a range drill (a specialized drill) can be useful on ground that doesn’t have a properly prepared seedbed. There are many annual and perennial grasses that you may want to seed depending on your goals and objectives. In the table below is a list of recommended plant species for the Capay Valley. Work with the USDA-NRCS, the Yolo County RCD, or your local seed supplier to get seeding rates. All rates are in Pure Live Seed (PLS). Check seed tags for species and percent germination and purity. If PLS drops below 80 percent, an application adjustment should be used (80 / % PLS = adjustment factor). If clover or other small seeded legumes are coated an adjustment factor of 1.5 should be used (1.5 x lbs./acre = adjusted seeding rate). September 15 to October 15 is the best time to seed annual grasses and clovers in order to take advantage of soil warmth and early rains before plant growth shuts down in winter. For perennial grasses it is best to drill the seed into the ground after enough moisture has entered the profile to allow drilling. Broadcasting of perennials can be done, but because native perennial seed is expensive, drilling is usually more economical.

<table>
<thead>
<tr>
<th>Annual Species:</th>
<th>Scientific Name:</th>
<th>Perennial Species:</th>
<th>Scientific Name:</th>
</tr>
</thead>
<tbody>
<tr>
<td>‘Blando’ brome</td>
<td>Bromus mollis</td>
<td>‘Perla’ kolegrass</td>
<td>Phalaris aquatica</td>
</tr>
<tr>
<td>Rose clover</td>
<td>Trifolium hirtum</td>
<td>‘Berber’ orchardgrass</td>
<td>Dactylis glomerata</td>
</tr>
<tr>
<td>Zorro annual fescue</td>
<td>Vulpia myuros</td>
<td>Blue wildrye 1</td>
<td>Elymus glaucus</td>
</tr>
<tr>
<td>‘Lana’ woollypod vetch</td>
<td>Vicia villosa ssp. varia</td>
<td>Purple Needlegrass 1</td>
<td>Nussella pulchra</td>
</tr>
<tr>
<td>‘Wimmera-62’ ryegrass</td>
<td>Lolium multiflorum</td>
<td>California barley 1</td>
<td>Hordeum brachyantherum californicum</td>
</tr>
<tr>
<td>Subterranean clover</td>
<td>Trifolium subterraneum</td>
<td>California oniongrass 1</td>
<td>Melica californica</td>
</tr>
<tr>
<td>Annual ryegrass</td>
<td>Lolium multiflorum</td>
<td>Idaho fescue 1</td>
<td>Festuca idahoensis</td>
</tr>
<tr>
<td>Crimson clover</td>
<td>Trifolium incarnatum</td>
<td>‘Yolo’ slender wheatgrass 1</td>
<td>Elymus trachycaulus</td>
</tr>
</tbody>
</table>

1 California Native Perennial Grass
Rangeland Management

Range Development and Improvements cont...

For annual species grazing should be moderate for the first season. Heavy short duration grazing can be used to reduce competition. When restoring perennial grass, deferment may be needed until the grass is established. However, heavy short duration grazing can also be used to reduce annual grass competition. Grazing should occur in late spring when soil moisture is lower so as not to induce compaction. This will also give the native perennials time to establish.

Any areas that have been disturbed by normal ranch operations should be re-seeded. This will help prevent soil erosion and provide food for livestock and wildlife. Using seed-rich straw can also be applied to areas that are susceptible to erosion processes. It can also be used to seed small disturbed areas. The straw provides a microclimate that is favorable to seed germination. Native perennial grass straw is available from native grass seed suppliers.

References

USDA-NRCS. 1985 Fact Sheet 22. Reseeding Grasses and Clovers on Burned Areas.
Fire Management

Description and Benefits of Fire Management
This practice will describe how prescribed burning is used as a land management tool in California. This practice is intended to introduce you to some basic information about prescribed burning, and should not be thought of as a guide to conducting your own prescribed burn. However, it will give you an idea of what is required to implement a prescribed burn—the steps you will need to take and the agencies you will need to contact. Implementing a prescribed burn is a complicated activity that involves careful planning, coordination, and experience, yet can provide multiple benefits to land owners and land managers. Some of the benefits are summarized in the list below:

- Reduces ground fuel loading in forests
- Reduces thatch buildup in grasslands
- Prepares an area for replanting
- Improves wildlife habitat
- Controls or eradicates unwanted weeds
- Improves the quality of rangeland forage
- Protects people and property from catastrophic wildland fires
- Improves conditions for reintroduction of native grasses and forbs

Conditions Where Fire Management Applies
Most ecosystem types in Yolo County, including grasslands, oak woodlands, chaparral, and mixed conifer forests, evolved with occasional low (and sometimes high) intensity wildfires as part of the natural life cycle. Most land owners and land managers are interested in reintroducing fire on their land for the following reasons: to control or eradicate unwanted weeds or grasses (such as Medusahead, Yellow Starthistle, and Barbed Goatgrass) on rangelands and grasslands; prepare rangelands and grasslands for seeding of native perennial grasses and other grasses and forbs to improve forage quality; to reduce the density of chaparral to improve rangeland forage quantity and quality and to protect against unwanted wildland fires; to induce reseeding of native plant species that require fire for proper germination and establishment; to reduce the fuel load in oak woodland, chaparral, and mixed conifer forests as a means to reduce the potential for catastrophic crown fires; to create a defensible space around homes and other structures to protect them from wildland fires; to improve habitat quantity and quality for wildlife.

Materials / Equipment Needed
Note: The actual equipment needed depends on the size and complexity of the burn.

- Personal: Fire Resistant Pants and Shirt or Coveralls, Hard Hat, Fire Resistant Shroud, Gloves, Goggles, Fire Shelter, Leather Boots, First Aid Kit.
- Heavy Equipment: Bulldozer, Fire Engines.
- Burn Plan, Burn Permit from CDF (only during fire season on CDF-responsibility lands), Air Quality Management District Permit.

References
Fire Management

Implementation

The following describes the steps you will need to take to implement a prescribed burn on your land. Note that the information contained on this page is not sufficient to adequately guide you through the process of planning, conducting and monitoring a prescribed burn. It is intended to give you a sense of what it takes and who you will need to contact in order to incorporate prescribed burning into your land management activities. It is recommended that if you are interested in conducting prescribed burns on your land that you work with the California Department of Forestry and Fire Protection (CDF), your local fire department, and/or any local program that approaches fire management on a larger scale. In some cases, CDF or your local fire department use prescribed burns for training personnel, so you may want to contact them first to see if such an opportunity exists.

The first step is to look at your land management needs and determine whether burning will help you meet those needs. You should research the effect fire will have on the area you are looking to burn as well as the effect it will have on the ecosystem as a whole. For example, if weed management is your goal, then you need to ask yourself questions such as: Will fire control the weeds on my land? When do I need to burn in order to impact the target weed species? What will replace the weeds after the burn? How often will I have to burn to achieve the control I am looking for? Am I willing to put the time and resources into implementing a long-term fire management system on my land?

Once you have determined fire is an appropriate land management tool for your property and that it will help you in meeting your land management goals, you will want to consider creating a long-term fire management strategy that incorporates prescribed burning into your overall long-term management activities. This is particularly important for larger management areas, where burning can be an annual activity as different sites (i.e. burn units) are burned on different cycles. Most likely you will want to collaborate with CDF and/or the agency or group that is coordinating fire management in your region. This will help you gain a perspective on fire management in the region and become aware of opportunities and resources available to aid you with your fire management objectives. The components of a long-term fire management strategy include:

1. Site background information: the environmental attributes of the managed area, including wildfire history and the natural role of fire of the ecosystem.
2. Description of the human and ecologically based management goals of the site.
3. Justification for fire management at the site: describes the natural fire regime of the site and demonstrates how fire management will meet the human and ecologically based management goals for the site.
4. Description of the fire management goals, burn units, and a burn schedule: this is a very important and complicated step that includes taking into consideration topography, land use, natural and human made fire breaks, ideal weather conditions (e.g. wind direction, relative humidity, temperature), when to burn (i.e. season), air quality, type of burn most appropriate for the site, among other things.
5. Creation of a map that incorporates the above information, such as fire breaks, ignition points, type of burn, wind direction, structures, etc.
6. Develop a monitoring plan that outlines observations to be made before, during, and after the burn in order to evaluate whether the fire management goals were met.

You will need to create and submit a burn plan to CDF (if burning on “state responsibility areas”) or possibly your local fire department (if burning in the valley) in order to receive a burn permit. You will need a permit from the Air Quality Management District (530.757.3660) and clearance on the day of the burn. The AQMD Permit fee is $30 plus $1/acre. You also need to contact Yolo Dispatch (530.666.8920) on the day of the burn to let them know that you are implementing a prescribed burn.

For small-scale prescribed burns (10 acres or less), such as along roadsides, it is not necessary to go through such an extensive long-term planning process. However, you should still consider the questions prompted by 1 through 4 above as you develop a prescribed burn plan for your site. You will still need to submit a 1-page prescribed burn plan to CDF and/or the local fire department and the AQMD in order to receive your permits to burn.

Use the contact and web resources information below to learn more about fire management and what programs are currently underway in your area.

- CDF Sonoma-Lake-Napa Unit. Bill Klebe, Battalion Chief. (530) 796-3506.
- Air Quality Management District. Dave Smith. (530)757-3660
Rural Road Construction and Maintenance

Description and Benefits of Rural Road Construction and Maintenance

The construction, reconstruction and maintenance of forest and ranch roads are important and complex subjects. So complex, in fact, that it is recommended that you consult the “Handbook for Forest and Ranch Roads,” (Weaver, W.E. and D.K. Hagans, 1994) if you intend to do any major road work. Therefore, this practice covers only a few techniques that if properly implemented will result in multiple benefits, including: reduced annual maintenance, reduced erosion, reduced sedimentation of water courses, improved natural drainage, improved reliability, and overall reduced costs. The techniques include outsloping, rolling dips, and proper culvert installation.

Outsloping describes a road that is graded so that the inboard edge is higher than the outer edge (see Figure 8). This allows for sheet flow of runoff across the road. Sheet flow is very low energy and causes minimal, if any, damage to the road. Rolling dips look like long drawn-out waterbars (see Figure 9), which makes them easily passible by large and small vehicles alike. Rolling dips do not plug up or break down and fail like waterbars. They are placed where small swales cross the road or at regular intervals when the slope of the road is greater than 8%. Culverts should be sized and installed to pass the expected 50- or 100-year flow and with the lowest possible diversion potential.

Conditions Where Rural Road Construction and Maintenance Applies

Existing or planned forest and ranch roads that do not have an overly steep grade and that are built on stable fillslopes are typically well suited to outsloping. Rolling dips need to be installed on outsloped roads that exceed eight percent. (Weaver and Hagans, 1994). The focus of culvert installation for this practice is limited to small ephemeral (flow during and after storm events only) and intermittent (seasonal) stream crossings. Many of the concepts outlined in this practice can also be applied to the construction and maintenance of trails; the only difference is the scale.

Materials / Equipment Needed

Road Construction / Reconstruction:
- Heavy Equipment - One or more of the following: hydraulic excavator, bulldozer, loader, grader, water truck, dump truck.
- Culverts for stream crossings (various sizes)
- Gravel for the road surface (if needed)
- Straw bales
- Native grass/legume/wildflower seed mix - rely on the advice of the seed distributor to select the best mix for your site.

Road Maintenance:
- Heavy Equipment - backhoe, grader, bulldozer.
- Gravel for the road surface (if needed)

References


Implementation

Unless you are proficient with the use of the various types of heavy equipment needed, it is recommended that you research and contract with a road construction company or heavy equipment operator for any road work. For many, road construction and maintenance is not a “do-it-yourself” practice, and you will save time and money by first researching and requesting quotes from contractors and then selecting the contractor that best fits your needs.

Most forest and ranch roads require annual maintenance to remain passable and useful. Sometimes maintenance needs are minor (i.e. regrade a few ruts), but sometimes heavy precipitation over the winter causes major problems (i.e. washouts, stream diversions, large ruts) making the road impassable. Annual maintenance can be time consuming and costly. The problem with many existing forest and ranch roads is that they were designed and built to capture runoff and transport it in ditches and culverts. The inboard ditches and culverts need ongoing maintenance to function properly. Without it they inevitably fail, causing damage to the road. The following are the basics you need to know about outsloping, rolling dips,
Rural Road Construction and Maintenance

Implementation cont...

and culverts. They are intended to make it easier for you to assess and discuss your road maintenance needs with your road maintenance contractor. Again, if you plan to do the work yourself, purchase a copy of the Handbook for Forest and Ranch Roads.

**Outsloping:** The key to outsloping is to disperse (not concentrate) and drain runoff from the road surface along its entire outer edge (not in an inboard ditch). Most insloped roads have an inboard ditch and a berm on the outer edge of the road surface. Changing an insloped road into an outsloped road requires removing the berm and placing the spoils in the inboard ditch, which becomes part of the road surface. The road surface is then graded with an outsloped pitch with a drop of 3/8” to 1” per foot depending on the road grade (4% = 3/8” / ft.; 5% = 1/2” / ft.; 6% = 5/8” / ft.; 7% = 3/4” / ft.; 8% or more = 1” / ft.). The outer edge of the road should be planted with a mix of native grasses, legumes, and wildflowers (25 lbs. / acre) and covered with straw mulch (1 bale per 700-1,000 sq. ft.) for erosion control.

**Rolling Dips:** Rolling dips are smooth angled depressions in the road surface. They should have a long shallow approach on the up-road side and a more abrupt rise on the down-road side (see Figure 9). In general they are built at a 30 to 45 degree angle to the road, with a grade of at least 1% greater than the road. There are two situations where rolling dips are necessary on an outsloped road. First, a rolling dip needs to be installed at every swale that intersects the road. Unlike an insloped road that captures uphill runoff in a ditch before it reaches the road surface, outsloped roads allow the runoff to flow across the road and continue down the natural swale. The key is to not concentrate the runoff or allow it to divert down the road surface. The second situation is when the road grade is greater than 8% and the runoff tends to divert down the road surface before it can drain across the road. Often the rolling dips placed at the swales are sufficient to drain the road surface before rills and gullies form. When there are no swale crossings and the road grade is greater than 8%, rolling dips should be built at regular intervals. The distance between rolling dips depends on the road grade, road surface material, and anticipated rainfall. The best thing to do is to look at other roads with a similar grade and surface in your area to see when runoff begins to create rills. In some cases rills can form in less than 10 feet, in which case the road would need to be a series of rolling dips.

**Culverts:** Culverts should be installed at most ephemeral and intermittent stream crossings. In some cases low water crossings and bridges are more practical applications. A non-scientific rule of thumb for deciding when to install a culvert as opposed to a rolling dip is to look for exposed rocks, roots or bare soil in the swale uphill of the road. These would indicate that the swale receives sufficient flow to cause erosion, thus a culvert would be a good choice. The two most important aspects to culvert installation are size and alignment. The culvert should be sized to pass the anticipated 100-year storm flow. Use the culvert sizing worksheet in Appendix B. The culvert should be aligned with and placed in the natural stream bed so that flow enters and exits the culvert without having to turn. A rolling dip should be built at all stream crossings, whether a culvert is installed or not. This insures that if the culvert becomes plugged and fails that the water can flow over the road and continue down the stream channel and not divert down the road. This simple practice can mean the difference between the loss of a crossing (worst case) and the loss of hundreds of feet of road.
Description and Benefits of Repairing Gullies

Gullies are a common nuisance in rangeland settings, causing road damage, sedimentation of streams, and other hazards to humans and livestock. Traditionally, gullies were repaired using what is known as a check dam. Check dams are essentially grade control structures typically built with rocks or logs. Unfortunately most traditional check dams eventually fail, causing a widening of the gully. Similarly, a common misconception about gullies is that they can be fixed by filling them up with slash, trash, straw bales, refrigerators, cars, or whatever else happens to be handy. This “solution” often only makes the gully bigger and uglier. A gully is typically a symptom of some other problem, such as a poorly placed culvert or some other factor that has concentrated and increased water flow over the land. In some cases a stream will downcut, initially creating a gully, in response to the downcutting of the stream it feeds. In this case you will see the headcut of the gully actually travel upstream from year to year (See Headcut Repair). This practice should give you a better insight into why gullies form and offer some suggestions of practices that can be employed to repair them. These practices include woven willow “check dams,” turf reinforcement mats, and various bank stabilization techniques.

Conditions Where Gully Repair Applies

Gullies should be repaired only after the source of the problem has been identified and treated. In cases where the source of the problem cannot be treated, treatment of the gully is most likely a temporary fix. In the case that the source of the problem no longer exists or has “run its course,” repairing the gully will help accelerate the return of the natural landform and ecological functions of the area affected. This practice applies only to ephemeral and intermittent streams and swales.

Materials Needed

- Heavy Equipment - backhoe, dozer, excavator (for large projects).
- Handtools - shovels, rakes, anvil loppers, hand pruners, fence wire tool, sledge hammer.
- Live Cuttings - use native plant material that is most appropriate to the site as well as abundant near the site (willow, cottonwood, dogwood, coyotebrush, other easily rooted species).
- Water source for soaking live cuttings - pond, troughs, stream, burlap and sprinklers.
- Wooden Stakes - 2 to 3 feet long with a notch for securing wire approximately 3 inches from the top.
- Medium Guage Wire - fencing wire is a good example.
- Native Grass/Legume/Wildflower Seed - rely on the advice of the seed distributor to select the best mix for your site.
- Straw Mulch
- Erosion Control Blankets, Turf Reinforcement Mats, Coir Rolls (as needed).
- Also see materials needed for Headcut Repair.

References

Gully Repair

Implementation

As mentioned previously, the first (and most important) step in repairing a gully is to determine the problem that is causing (or caused) the gully to form. The second step is to treat that problem. Only after that should you treat the gully itself. In general, gullies form for two different reasons and the practices used to repair them will depend on how and why they formed. One way gullies form can be thought of as “top-down,” where runoff is concentrated and/or flow increases causing an increase in the erosion potential of the stream or drainage. A gully will begin to form at the point where the channel bottom or soil can not withstand the erosiveness of the water. This point is often referred to as the nickpoint. The gully will continue to downcut and widen below the nickpoint and the headcut will migrate upstream creating new nickpoints.

Stabilizing the headcut (see Headcut Repair) can help slow or stop the upstream migration of the gully. The other way gullies form is from a large stream downcuts, or becomes incised. The tributary streams associated with that stream will respond by also downcutting. This downcutting will originate at the confluence with the large stream and travel up the tributaries until they reach equilibrium. This “bottom-up” process can reach up into the small swales that feed the tributary. When the downcutting happens rapidly, the tributary and the swales that feed it will take on a gully-like appearance.

Top-down Gully Repair: ‘Top-down’ gullies are typically associated with roads. On many roads the runoff is concentrated into an inboard ditch and is transported under the road through a culvert, which discharges the water onto the land below. Installing these culverts without regard to the natural topography directs a large amount of water where it never flowed before (See Figure 11). The result is a gully that will eventually affect the stability of the road. See Road Construction and Maintenance for proper culvert placement and outsloping information.

Bottom-up Gully Repair: The key is to recognize and understand that the stream is adjusting. This is a natural process so do not pour truckloads of money and time into trying to stop it. Rather do what you can do stabilize the newly formed and most likely steep stream banks that result from the downcutting. Please refer to the following practices for stream bank stabilization techniques: Live Staking, Pole Planting, Willow Wattles, Coir Rolls, Brush Mattress, Brush Layering, and Turf Reinforcement Mats. Protect road crossings by stabilizing the headcut before it reaches the road.

Once the source of the runoff that caused the gully is identified and treated, the task of repairing the gully remains. If the gully formed in a previously existing stream channel or swale (i.e. someplace water naturally flows), your task is to stabilize the headcut and the banks of the gully. Refer to the practices mentioned above for specific techniques. This may require a Streambed Alteration Agreement from CCFG (See Permits and Regulations). If the gully formed where water wouldn’t naturally flow and you have redirected the runoff discharging into the gully to a more appropriate location, the most complete repair would be to fill in and restore the natural landform. The ground work should be followed by seeding native perennial grasses, legumes, and wildflowers and covering the disturbed soil with straw mulch. If the landform is not completely restored and a swale exists where the gully was, runoff may collect in the swale and eventually cut a new gully.

If filling in the gully is not feasible, stabilizing the headcut and the banks of the gully is the best solution. In situations where the gully is dry most of the year, the banks should be pulled back to at least a 2:1 slope, smoothed, seeded with native perennial grasses, legumes, and wildflowers and covered with straw mulch. If adequate soil moisture exists in the gully throughout the year, willow wattles can be installed across the channel at regular intervals along the length of the gully. The willow wattles capture sediment as it is transported down the gully and slowly build up the elevation of the bottom of the gully.
Headcut Repair

Description and Benefits of Repairing Headcuts
A headcut is typically found at the upstream end of a gully, although some cases several headcuts may be observed in a single gully. Each headcut, with the exception of the uppermost headcut, represents a former nickpoint and can continue to cause downcutting of the channel. Water pours over the headcut like a small waterfall, causing bank erosion and undercutting the base of the headcut, causing it to “migrate” upstream. To slow or stop this migration and continued erosion, the headcut must be stabilized. This practice will outline several techniques for stabilizing headcuts. In general the headcut is regraded to a more stable angle and the soil is covered by a variety of materials, from soil and concrete filled sandbags to rock riprap. If the area has year-round moisture, vegetation can be planted to further stabilize the banks. Keep in mind that gullies (and headcuts) are typically symptoms of a larger problem. First identify and treat the larger problem (see Gully Repair).

Conditions Where Headcut Repair Applies
The techniques described for headcut repair apply to ephemeral and intermittent streams and drainages. Headcuts should be repaired only after the cause of the gully has been identified and treated. The headcut can be caused by overland or subsurface flows. There must be enough space upstream of the headcut to pull back the bank to at least a 2:1 slope. Work should be done when the stream or drainage is dry.

Materials Needed
- Heavy Equipment: backhoe
- Hand Tools: shovel, rake, McCleod, sledge hammer, 4’ concrete stake
- Filter Fabric (also known as geotextile fabric)
- Landscape Staples
- Sandbags
- Wooden Stakes (1” x 2” x 2’)
- Willow Stakes (if moist conditions exitst)
- Rock Riprap
- Concrete
- Native Grass/Legume/Wildflower Seed Mix - rely on the advice of the seed distributor to select the best mix for your site.

References
Headcut Repair

Implementation
Repairing headcuts can be a simple, straight-forward operation. Access to the site can determine the suitability and cost effectiveness of the various techniques used to repair headcuts. Topography and vegetation can limit the equipment that can reach the site. Minimal disturbance to the existing landscape should be a primary goal for any technique.

All Sites and Techniques: Pull back the headcut and adjacent banks to at least a 2:1 slope using a backhoe or hand tools. Further excavate where sandbags or rock riprap will be placed (the channel bed) so that they will be level with the adjacent banks (see Figure 12). Dig a small trench at the base of the slope of the channel to key in the sandbags or rock riprap. Dig another small trench at least four feet upstream from the top of the slope of the channel and at least one foot uphill from the top of the banks to key in the filter fabric. Smooth the surface of the new channel and banks, seed with native grasses, and lay the filter fabric over the area. Begin by laying the filter fabric in the channel, from trench to trench. Use a single piece if the filter fabric is wide enough to extend up the banks. If more than one piece is used, lay additional pieces similar to the first piece (from downstream to upstream) being sure to overlap at least one foot with the previous piece. Staple the filter fabric in place using landscape staples every 1-2 feet and starting in the channel and working your way upstream and upslope. It is very important to key in the top of the filter fabric (see Turf Reinforcement Mats or Erosion Control Blankets for details). Once the area has been reshaped and the filter fabric secured, you can choose the option below that best fits the location and the project budget.

Rock Riprap: This is the least labor intensive technique. Delivery and ability to place rock is the limiting factor. Place rock riprap in the channel section of the reshaped slope. Begin by placing the largest rocks in the trench at the base of the slope and work your way to the upstream trench. In most cases one layer of rock will suffice. Choose quarried (angular) rock that with diameters that averages 1/4 to 1/3 of the width of the channel bed. For example, if the channel bed is two feet wide, choose rock with a 6” to 8” average diameter. Willow stakes can be installed in the adjacent banks using the concrete stake and sledge hammer to create a pilot hole.

Soil and Concrete Filled Sandbags: Fill sandbags with a 50-50 mix of soil and concrete. Another option is to sew your own filter fabric ‘sandbags’ and fill them with only soil. Securely staple the open end of each sandbag closed. Place the sandbags in the channel section of the reshaped slope. Lay the first row of sand bags in the trench at the base of the slope with the stapled end upstream. Stagger the next row so that each sand bag is centered on the seem between the two under it. Continue to the upstream trench. Secure every third sandbag by first creating a pilot hole with the concrete stake and driving a wooden stake into the pilot hole through the sandbag.
Turf Reinforcement Mats

Description and Benefits of Turf Reinforcement Mats
This practice will focus on the use of turf reinforcement mats for permanent stabilization of stream channels and swales. Turf reinforcement mats can also be used to stabilize steep slopes, but that use will be covered in the Erosion Control Blankets practice. Turf reinforcement mats are a durable, long lasting synthetic matrix that comes in rolls. Installed, they create a stable soil surface providing conditions suitable for long-term establishment of vegetation. This practice will describe the use of turf reinforcement mats in conjunction with native grasses to create grass-lined channels. Keep in mind that turf reinforcement mats are long lasting, so if your goal is to recreate a “natural” landscape you may want to consider using more temporary, biodegradable erosion control blankets.

Conditions Where Turf Reinforcement Mats Apply
Turf reinforcement mats can be used to create permanent stable grass-lined channels in natural and human constructed gently sloping drainages with flows of 2-10 ft³/sec. Turf reinforcement mats require thorough contact with the soil surface, so drainages with a rocky substrate are not appropriate. Typically, turf reinforcement mats are installed following disturbance of a channel, such as grading or gully repair. Turf reinforcement mats are also appropriate for creating permanent, stable roadside ditches. Do not install turf reinforcement mats where regular maintenance of the drainage may be required (i.e. irrigation ditches that need to be cleared of sediment periodically).

Materials Needed
- Heavy Equipment: bulldozer, small tractor with loader and grader attachments.
- Hand Tools: landscape rake, push broom, shovel, small sledge hammer.
- Turf Reinforcement Mats - rely on the advice of the manufacturer or distributor to select the product that best fits your situation.
- Landscape Staples (11 gauge, 6-8 inches long) or Metal Stake Pins (3/16” diameter with a 1 1/2” washer, 6-8 inches long).
- Native Grass/Legume/Wildflower Seed - rely on the advice of the seed distributor to select the best mix for your site.

References
Turf Reinforcement Mats

Implementation

Site Preparation: It is important that the soil surface is graded and smoothed so that the turf reinforcement mats have complete contact with the soil. Remove all rocks, logs/sticks, and clumps of dirt from the area.

Installation, Seeding and Maintenance: The most likely cause of failure for this practice is not properly keying in the turf reinforcement mats. Keying in all edges (upstream, downstream and the sides) is very important.

- Begin by digging the anchor trenches (12” deep and 6” wide) across the channel at the downstream and upstream ends of the project site. Also dig check slots (6” deep and 6” wide) across the channel at 30-foot intervals between the upstream and downstream anchor trenches. Dig a small trench (4” deep and 4” wide) parallel to and on both sides of the channel at a height that is 3” above the anticipated high water level.
- Starting at the anchor trench at the downstream end and in the center of the channel, secure the end of the roll in the anchor trench with staples or pins at 1’ intervals (see Figure 13). Install adjacent rolls in the same manner with a 3” overlap of the edges. Note that the rolls at this point should be downstream of the anchor trench with the end of the roll coming off the top.
- Once all the rolls are secured, backfill the anchor trench and compact the soil. Then unroll the turf reinforcement mats upstream, beginning with the center roll and moving out from there. Install staples or pins at 1’ intervals across the channel just upstream of the anchor trench. Install staples or pins at 4’ intervals (or per manufacturer’s instructions) over the rest of the area.
- Secure the turf reinforcement mats at each check slot with staples or pins at 1’ intervals (see Figure 13). Backfill the check slot, compact the soil and continue unrolling upstream. Begin new rolls at the check slots.
- Continue to the upstream anchor trench and secure the end of the turf reinforcement mat using staples or pins at 1’ intervals (see Figure 13). Also secure the sides in the small trench (see Figure 13).
- Spread native grass seed mix over the turf reinforcement mats at the rate recommended by the supplier.
- Spread 1/2” - 3/4” of topsoil over the turf reinforcement mats. Use the backside of a landscape rake or a stiff bristled push broom to incorporate the topsoil into the matrix of the turf reinforcement mats. The top of the mats should just be visible when complete.
- It is important to inspect the turf reinforcement mats following the first storm event. Repair any areas where the mats have come loose or have been undercut by the water.

Figure 13: Turf Reinforcement Mats can be used at culvert outlets and natural channels.
Mulching

Description and Benefits of Mulching
Mulching is the spreading of a layer of straw, woodchips, or other suitable “loose” material over the soil surface. Mulching is intended to provide temporary protection while permanent vegetation becomes established. Mulching has multiple applications and benefits. Applications are listed in the next section. Benefits include weed suppression, erosion protection, and soil moisture retention. Both non-native and native straw mulch is available, although native straw bales are typically more expensive. Native straw tends to spread easier and often contains residual native grass seeds which can bolster native grass establishment on the site. “Dirty” straw that contains weed seeds can be a new source of weeds on your property if used.

Conditions Where Mulching Applies
Apply straw mulch to recently disturbed soil surfaces for protection from raindrop impact erosion and sheet erosion. Application of straw mulch to recently disturbed slopes is highly recommended, although the straw mulch may need to be secured using a tackifier or netting, or by crimping with tracked heavy equipment (for large areas) or a shovel (small areas). Straw mulch is suitable for large or small areas that have been seeded for grass establishment following the completion of construction. Using seed-rich native straw can be an alternative to seeding and mulching separately. Apply straw mulch to bare soil in anticipation of a rain event on construction sites, restoration sites or stockpiles of soil near waterways. Use straw mulch, woodchips or crushed walnut shells around recently planted trees and shrubs for weed suppression. Use mulch sparingly around trees and shrubs planted in clay or otherwise poorly draining soils.

Materials Needed
- Mulch Material - straw bales, woodchips, crushed walnut shells, etc. Be sure to get “clean” straw bales as they will have fewer weed seeds.
- Truck or Trailer for hauling mulch material.
- Wheelbarrow

References
Mulching

Implementation

Spreading straw mulch is a simple, yet time consuming practice. A work crew will make spreading straw mulch over large areas a more manageable task. If the area is extremely large or on a steep slope, you may want to consider using a hydroseeding contractor. They can spray the area with seed, straw mulch and a tacifier that will hold it in place. Straw mulch can be sprayed without seed as well for large areas.

Seeded Areas:

- Remember that mulch is intended to provide temporary protection. Seed disturbed soil with the appropriate mix of native grasses and forbes for the site prior to mulching. See Farm Edge Native Grass Establishment and Native Perennial Grass Establishment for details on preparing the seedbed and seed application rates.
- Apply straw mulch at a rate of roughly one bale (65 lbs.) per 500-750 ft\(^2\). Cover the area with no more than 2-3 inches of straw mulch. Too much mulch will inhibit grass seed germination and establishment.
- Anchor the straw on steep slopes by one of the following methods:
  - Use a dull shovel to punch the straw in every 1-2 feet.
  - Use a dozer (or other tracked equipment) to track over the area. Be sure to run the equipment up and down the slope to create small shelves with the tracks that are perpendicular to the fall-line.
  - Quickly herd goats or sheep through the area (trample method).

Around Trees and Shrubs:

- Hoe, pull or apply herbicide to the weeds around the plant. Be careful not to damage the plant’s roots, which may be near the soil surface.
- Apply a 4-6 inch mulch layer of straw, woodchips, etc. in a 4 foot diameter area around each plant.
- Plants will not need to be watered as often as without mulch. Check plants occasionally to see if too much water is being applied.

As a Seeding Method:

- Many native grass seed suppliers also have seed-rich native grass straw available. Seed-rich straw is cut and baled with the mature seeds still intact.
- Using seed-rich native grass straw provides a less expensive alternative to seeding and mulching separately, although the amount of seed applied to the area that comes in contact with the soil will also be less.
- Spread the seed-rich native grass straw in the same manner as described above in “Seeded Areas.”
Erosion Control Blankets

Description and Benefits of Erosion Control Blankets
Erosion control blankets provide immediate protection from surface erosion for steep slopes (typically greater than 3:1). They also create an ideal environment for native grass seed germination. Erosion control blankets can also be used to temporarily stabilize soil in grass lined channels (see Turf Reinforcement Mats), although this practice will focus on their use for stabilizing steep slopes. The main purpose of erosion control blankets is to provide initial erosion protection while the native grasses, which will provide permanent protection, become established. Erosion control blankets are a combination of natural fibers sandwiched between, or otherwise attached to a synthetic netting. Like turf reinforcement mats, erosion control blankets come in rolls. They vary in thickness, durability and life expectancy. Erosion control blankets are biodegradable and last from 1-5 years.

Conditions Where Erosion Control Blankets Apply
Erosion control blankets can be installed on any slope where the soil has been disturbed, when the slope is too steep (3:1 or greater) for straw mulch to provide adequate erosion protection. The site needs be suitable for growing native grasses. The site also needs to be free of rock outcroppings or other obstructions. Erosion control blankets need thorough contact with the soil. Typical uses are on stream banks, road cuts, and construction sites.

Materials Needed
- Heavy Equipment: bulldozer, small tractor with loader and grader attachments.
- Hand Tools: shovel, small sledge hammer, heavy duty scissors.
- Erosion Control Blankets - rely on the advice of the manufacturer or distributor to select the product that best fits your situation.
- Landscape Staples (11 gauge, 6-8 inches long) or Metal Stake Pins (3/16” diameter with a 1 1/2” washer, 6-8 inches long).
- Native Grass/Legume/Wildflower Seed Mix - rely on the advice of the seed distributor to select the best mix for your site.

References
Erosion Control Blankets

Implementation

**Site Preparation:** It is important that the soil surface is graded and smoothed so that the erosion control blankets have complete contact with the soil. Remove all rocks, logs/sticks, and clumps of dirt from the area. Loosen the top 2-3 inches of soil in preparation for seeding.

**Installation:** Installing erosion control blankets is fairly straightforward, but this practice will fail if you do not properly key in the top of the erosion control blanket.

- Begin by digging an anchor trench (6” deep and 6” wide) across the top of the slope, preferably 3-4 feet from the edge. Place the spoils on the upslope side of the trench.
- Seed the area from the trench to the bottom of the slope with native grass seed. Try not to walk on the seeded area. If an area is disturbed, smooth the area and re-seed.
- Secure the end of the erosion control blanket in the anchor trench using staples or pins at 1’ intervals (see Figure 14). Backfill the trench and compact the soil. Seed the trench and fold over and secure the end flap of the roll, again using staples or pins at 1’ intervals.
- Overlap adjacent rolls 3 inches. Start at one end of the slope and work across. If installing on a stream bank, start at the downstream end of the site.
- Roll the erosion control blankets down the slope. Secure with staples or pins every 3 feet starting at the top of the slope and working down. Be sure not to stretch the erosion control blanket. Remember you want complete contact with the soil.
- When splicing together rolls mid-slope, slip the end of the new roll under the end of the roll that just ran out. Be sure there is at least 1-foot of overlap. Staple or pin the overlap area at 1’ staggered intervals.
- Simply cut the erosion control blanket at the bottom of the slope using heavy-duty scissors.

![Figure 14: Erosion Control Blanket construction detail. Proper installation is critical to the effectiveness of erosion control blankets.](image-url)
Brush Box

Description and Benefits of Brush Boxes

Brush Boxes are a simple practice that can be used to stabilize slope toes in upland and streamside situations. They can serve as a sort of live retaining wall. Brush boxes can vary in size depending on the needs of the site, but they are typically between 1 to 2 feet wide and 1 to 2 feet tall. Brush boxes are constructed by packing long, live cuttings between two rows of wooden stakes and binding the “wall” together using medium gauge wire. Up to 50% of the cuttings can be non-living cuttings, although this can decrease the overall strength of the structure. The spaces between the cuttings and the uphill side of the brush box is backfilled with soil. As the live cuttings take root, they help strengthen and stabilize the toe of the slope. The resulting shoot growth slows runoff and helps trap sediment behind the brush box. The bench that is created provides ideal conditions for new plant establishment.

Conditions Where Brush Boxes Apply

Brush boxes can be applied to various situations related to unstable slopes or streambanks. They should be built on stable ground, with the exception of the construction of small curved brush boxes to stabilize minor slumps on fill slopes. Small brush boxes can be built at the base of small slumps on cut or fill slopes associated with roads or trails. Brush boxes can be built at any length to provide support at the base of oversteep streambanks or slopes. Be cautious when using brush boxes for streambank stabilization. It may be difficult to adequately secure the brush box so that storm flows do not erode it. Therefore consider brush boxes for use in small tributary streams.

Materials Needed

- Heavy Equipment - backhoe (for large projects).
- Hand Tools - shovels, rakes, anvil loppers, hand pruners, fence wire tool, sledge hammer.
- Live Cuttings - use native plant material that is most appropriate to the site as well as abundant near the site (willow, cottonwood, dogwood, coyotebrush, other easily rooted species).
- Water source for soaking live cuttings - pond, troughs, stream, burlap and sprinklers.
- Wooden Stakes - 3 to 4 feet long with a notch for securing wire approximately 3 inches from the top.
- Medium Gauge Wire - fencing wire is a good example.
- Native Grass/Legume/Wildflower Seed Mix - rely on the advice of the seed distributor to select the best mix for your site.
- Straw Mulch

References

Brush Box

Implementation

Brush box construction is similar for all applications, except for the use of curved brush boxes to stabilize small slumps on fill slopes. As the name implies, curved brush boxes are built as semi-circles and enclose the base of the slump, with the ends keying into the slope. As with any practice involving live cuttings, the plant’s dormant season (late fall through early spring) is when brush boxes should be installed.

Installation:

- Conduct any repair work to the slope and prepare the slope surface prior to constructing the brush box.
- Begin by digging a 1 foot deep by 1 to 2 feet wide trench at the base of the slope. The length of the trench depends on the size of the area being stabilized. For streambank situations, curve the trench into the slope at the upstream end of the project site so as to prevent the stream from cutting behind the structure.
- Pound the wooden stakes into the ground in pairs with one on each side of the trench. Space the stakes approximately every 2 feet along the length of the trench and pound in to a depth of about 1 foot (you will be pounding them in more later).
- Place the live cuttings in the trench lengthwise. Alternate the direction of the shoot-end and the root-end of the cuttings so that there are shoot-ends spaced throughout the brush box. Incorporate non-living cuttings primarily in the core and on the face of the structure. Be sure there are live cuttings at the base of the face and along the bottom, back and top of the brush box. Continue placing cuttings until they reach the notch in the wooden stakes.
- Secure a length of wire between the parallel wooden stakes.
- Pound the wooden stakes further into the ground. This will compress the cuttings in the trench.
- Backfill and compact the area behind the brush box with soil. Also backfill the the brush box itself so that there is sufficient contact between the soil and the cuttings.
- Wetting down the area will help movement of soil into the brush box and will improve initial rooting.

![Brush Box construction detail. Brush boxes act as living retaining walls at the base of the slope.](image-url)
Brush Layering

**Description and Benefits of Brush Layering**

Brush layering is a simple practice that can be applied to many different situations. This practice will discuss the use of brush layering in upland slope situations, although brush layering is also appropriate for streambank situations. Brush layering is the placement of layers of live vegetated cuttings (willow, mule fat, coyotebrush, black locust, etc.) in between layers of soil. The layers are created in benches, which can require significant soil movement depending on the scale of the project. For the purpose of this manual, the focus of this practice will be on small to medium sized projects that can be installed using a backhoe and/or handtools. Brush layering can provide multiple benefits to failing or unstable slopes. First, the cuttings reinforce the soil structure and root growth provides additional soil stability. Second, the tips of the cuttings protruding from the soil slow and/or stop runoff and other debris as it travels down the slope. Third, new shoot growth provides raindrop erosion protection and wildlife habitat in addition to slowing (and improving infiltration) of runoff. To further reduce soil erosion and improve slope stability, the soil layers can be wrapped in geotextile fabric during construction. See *Reinforced Brush Layering* in the Riparian Area Practices section for more details. This is an appropriate modification for steep slopes and streambanks.

**Conditions Where Brush Layering Applies**

As mentioned above, brush layering is an appropriate practice for stabilizing slopes (often associated with roads) and streambanks. Cut slopes and fill slopes created during road construction often require permanent stabilization. Ideally, brush layering is implemented during the construction of the road at points where soil stability is questionable. Brush layering can also be implemented to stabilize existing fill slopes (downhill side of roads) that chronically fail and jeopardize the road.

**Materials Needed**

- Heavy Equipment: depending on the scale of the project an excavator or backhoe may be needed.
- Hand Tools: shovels, rakes, gloves.
- Live Cuttings - use native plant material that is most appropriate to the site as well as abundant near the site (willow, cottonwood, dogwood, coyotebrush, other easily rooted species).
- Native Grass/Legume/Wildflower Seed Mix - rely on the advice of the seed distributor to select the best mix for your site.
- Straw Mulch

**References**

Brush Layering

Implementation

This practice focuses on the implementation of brush layering on upland slopes. For streamside applications see Reinforced Brush Layering. This practice is recommended for slopes up to 2:1 in steepness. Slope length should not exceed 20 feet. Harvest and manage live cuttings following the guidelines described in Live Staking and Pole Planting, except that some side branches can be left on, and those side branches that are trimmed off can be saved and used as part of the brush layer matrix. Live cuttings should be soaked for at least 24 hours prior to installation. For best results, install brush layers as soon as the species selected for live cuttings goes dormant.

Installation:

- Begin by excavating a bench along the contour at the base of the slope. Make the bench 2 to 3 feet wide and angled back into the slope 10-20 degrees so that the outside edge is higher than the inside.
- Place 3 to 5 layers of live cuttings on the bench so that the bases of the cuttings are at the inside edge of the bench and the growing tips extend from the outer edge about 1 foot.
- Backfill the bench and live cuttings with the soil excavated from the next bench. Be sure to compact the backfilled soil to ensure maximum contact between the soil and the live cuttings.
- Space benches 3 to 5 feet apart depending on the slope. The steeper the slope the closer the spacing.
- Seed and mulch the bare soil between the benches after all of the brush layers have been installed.
- If possible, install a drip hose with inline emitters every 1 foot along the top of each brush layer. Irrigate once a week until winter rains moisten the soil. Additional irrigation the following summer will result in better plant establishment. If a drip system is not feasible, any supplemental irrigation will be helpful.

Figure 16: Brush Layering construction detail.
Live Fascines and Live Pole Drains

Description and Benefits of Live Fascines and Live Pole Drains

Live fascines are long cylindrical bundles of live cuttings used to reduce erosion, aid drainage, and improve infiltration on upland slopes. Fascines are similar to wattles, with the exception being that in fascines the cuttings are all arranged in the same direction. Fascines are installed in shallow staggered trenches on the slope. The trenches are dug with a slight downslope angle (not on the contour) to aid drainage. The staggered series of fascines breaks the slope length into several short slopes. This regulates the energy of the runoff flowing down the surface of the slope providing for improved infiltration and reduced rilling. Live pole drains are a method of using fascines to capture and direct subsurface flows that seep typically from cut banks and landslides. They are constructed in the small gullies formed by the seepages or in a manner that safely directs the water to a stable channel. As the cuttings in both live fascines and live pole drains become established, they serve to further stabilize the slope and provide habitat for wildlife.

Conditions for Live Fascines and Live Pole Drains

Live Fascines are appropriate for use on both dry and wet slopes, although they are better suited to wet slopes. They are typically installed on fill and cut slopes associated with roads as they are particularly useful for reducing surface erosion on steep slopes where rills and small gullies have formed. However, live fascines will not stabilize larger earth movements such as mass wasting and landslides. Live fascines are also appropriate for controlling drainage and infiltration on recontoured slopes following landscape restoration. Live pole drains should be used where subsurface seepage is creating a gully. Often the gully will threaten the use of an adjacent road or trail.

Materials Needed

- Handtools: shovels, rakes, anvil loppers, hand pruners, fence wire tool, sledge hammer.
- Live cuttings (stakes and poles): use native plant material that is most appropriate to the site as well as abundant near the site (willow, cottonwood, dogwood, coyotebrush, other easily rooted species).
- Water source for soaking live cuttings: pond, troughs, stream, burlap and sprinklers.
- Wooden stakes: 2 to 4 feet long with a notch for securing wire approximately 3 inches from the top.
- Wire or rope: medium gauge fencing wire or polypropylene rope for securing the live fascines and pole drains.
- Native grass/legume/wildflower seed mix - rely on the advice of the seed distributor to select the best mix for your site.

References

Live Fascines and Live Pole Drains

Implementation

Live Fascine construction:
- First soak the cuttings for at least 24 hours.
- Tie together the live cuttings into bundles of 10 to 30 feet in length and 6 to 16 inches in diameter. Be sure that all the shoot tips are oriented in the same direction and that the cuttings are staggered throughout the length of the fascine. Tie the fascine together with twine every 2 feet.

Installation:
- Complete any surface grading or repair work to the slope prior to installing fascines and pole drains. Determine the distance between fascines and the direction you want to direct runoff.
- Begin at the base of the slope. Dig the first shallow trench at the predetermined height (distance between fascines) uphill from the base of the slope. The trench should be just large enough to accommodate the fascine and dug at a slight angle off the contour. Orient the fascine so that the shoot tips point to the higher end of the trench.
- Drive a wooden stake every 2 to 3 feet into the center of the fascine. Additionally drive live stakes on the downslope side of the fascine in the intervals between the wooden stakes. In some cases you may need to drive parallel wooden stakes upslope and downslope of the fascine and secure the fascine to the ground with a wire that runs between the two wooden stakes.
- Fill in the trench around the fascine leaving some of the top of the fascine exposed.
- Continue installing fascines to the top of the slope. Consider staggering and overlapping the fascines (see Figure 16) and alternating the drainage angle as you move up the slope.
- The procedure for installing live pole drains is the same as for fascines except the live pole drains can be installed more perpendicular to the contour, often in existing small gullies that are fed by subsurface seeps. Prepare the gully as you would the trench (above). For large seepages you may need to feed several smaller pole drains into a larger main pole drain. Shoot tips should point upslope.

Figure 16: Live Fascines and Live Pole Drains construction detail.
Introduction

The Lowland and Agricultural Land Practices category focuses on resource concerns and opportunities to improve agricultural operations (e.g. commercial farming, organic farming, tree crops, and vineyards). The practices can also be very useful for non-agricultural landowners who want to enhance the natural functions and wildlife habitat on their land. Most of the practices encourage planting native vegetation, whether it be around the home, along fence lines or roads, or between agricultural fields. The goals of these practices range from erosion control to improving crop health to providing habitat for wildlife and beneficial insects. Most the practices in this category do not require permits, and there are several technical assistance and cost-share programs through the USDA Natural Resource Conservation Service (NRCS) to help plan and pay for implementation. Also note that many of the practices in the Upland and Rangeland category and the Riparian Area category are also appropriate for lowland valley and agricultural areas.
Notes:
Farm Edge Native Grass Establishment

Description and Benefits of Farm Edge Native Grasses

Farm edge native grass establishment refers to the soil preparation, planting and maintenance of California native perennial grasses in all of those areas not cropped and which otherwise tend to be weedy. This process involves 6 months or more of effort put toward weed reduction before planting, good seedbed preparation, selection of a species or species mix to plant that will survive well at the site, and a well-timed fall planting. Rural roadsides are an important “farm edge” that is typically covered by noxious and invasive weeds. The roadsides are traditionally scraped and sprayed with herbicide to reduce noxious and invasive weed cover. The main management goals are to maintain visibility, reduce fire hazards, and provide a safe right of way for automobiles. By revegetating roadsides and other farm edges with non-weedy native perennial grasses and using integrated weed management techniques to help the natives get established in the first three years, you develop a long living stand of competitive grass that can acquire the desired level of weed control in addition to many other benefits including: reduced runoff and improved water penetration along deeper root channels; filtration of agricultural and roadside pollutants; stabilization of roadside soils via the extensive root system of perennial grasses; a more gradual slope and stabilized shoulder for safe automobile and equipment use if necessary; attracts beneficial insects; provides effective, long-term competition with weeds and reduces the need for herbicides for weed control; and increases the aesthetic value of your home, fields, yards, and cropland.

Conditions Where Farm Edge Native Grass Establishment Applies

Native Grass plantings can be used on most field borders and edges where weeds have become established and where the use of regular soil cultivation equipment can be avoided. Established native grass plantings should not be discs or harrowed, so places where tractors with cultivation equipment must regularly turn or be driven over will not work. However, the site should be accessible to equipment for site preparation, seeding and long-term maintenance (e.g. mowing) Fencelines, borders between fields, corners and roadsides are all ideal situations for such a planting.

Materials Needed

The three phases of native grass establishment will require different equipment.

Site preparation:
- Tractor with disc and/or other cultivating equipment for weed reduction at the planting site
- Herbicide and sprayer (optional if organic approach used)

Planting:
- Drill-seeder and tractor, or . . .
- Broadcast seeder and tractor, or . . .
- Belly-grinder and gloves, and
- Tractor (in some cases, ATV) and Harrow to cover seed lightly
- Native perennial grass seed (application rate of 12-30 lbs./acre)

Maintenance:
- Mower (flail or rotary), and/or
- Herbicide and sprayer (optional if organic approach is used)
- Occasional burning (every few years) may require a drip-torch and fuel, as well as fire safety gear and a water truck for fire management.
- “No Spray, No Disc” sign from the Yolo County RCD

References

Farm Edge Native Grass Establishment

Implementation

The implementation process follows the three phases already mentioned:

Site preparation:
Begin preparing in March or earlier for a fall planting. Use combinations of discing, spraying, and/or mowing to reduce weed populations and especially to prevent new weed seed being set and shed onto the ground. A late summer or early fall burn can be very effective in cleaning up a site prior to planting. Roadsides may need to be reshaped if there is a steep roadside ditch in order to create a gradual slope allowing farming equipment access to the site. In September, prepare a good, fine seedbed in preparation for broadcast planting. If a range drill will be used, this seedbed preparation may not be necessary. Keep track of weather patterns and plan to plant when seed will not sit in the ground too long before a germinating rain. October to November are usually ideal months for planting, although planting can be done as late as February.

Planting:
Broadcast or drill the seed. Native perennial grass seed is usually broadcast at a rate of 25-30 lbs/acre. Seed can be spread using a broadcast seeder driven by an ATV, a belly grinder, or by hand. A harrow or roller must then be driven over the seed in order to cover/press the seed with/into the soil, protecting it from predation and ensuring soil to seed contact. Drill seeding can be performed with a specially adapted no-till drill. Disking may not be needed with this method although herbicides or a prescribed burn may be needed to clear off weeds and thatch from the site prior to seeding. Drill seeding rates are usually from 12-25 lbs/acre. If a new flush of weeds germinates before the native grass seed germinates, an overspray of glyphosate, or some other weed control measure is advised to reduce weed competition. Native grass seed will germinate in about 2 weeks in good weather, however, if cold, it may take up to 4 weeks. Dig up a few seedlings to see what seed is attached in order to determine if the plant is a weed, or a native.

Maintenance:
Short and long-term maintenance is typically focused on weed control. If weed control is done well within the first two years, subsequent weed control will be reduced to only occasional spot-spraying. During the spring after planting, plan to do some broadleaf weed control. A broadleaf herbicide can be used, or alternatively, a well-timed mowing. If mowing, cut to a height that will remove the majority of the broadleaf or annual grassy weed, but minimize the effect on the natives (native perennial bunchgrasses will typically be much shorter than annual weeds at this stage). Time the mowing according to plant growth stage. Mowing is most effective for reducing weeds if done when they have begun the reproductive phase (flowering and seed production) but before the seeds are mature. Maintenance in subsequent years might involve application of a pre-emergence herbicide in the fall, or further well-timed mowings. Grazing and burning can also be very effective weed management tools once the native grasses are well-established. A “No Discing, No Spraying” sign can be purchased ($12 ea.) from the Yolo County RCD and posted at each end of the native perennial vegetation site to alert workers not to disc or apply herbicide to the site.

Figure 17: Native grasses can be planted on roadsides to help control weeds and reduce long-term maintenance needs.
Hedgerows

Description and Benefits of Hedgerows

Hedgerows are rows or groups of trees, shrubs, perennial forbs, and grasses that are planted along field edges or other unused areas around the farm. Hedgerows typically consist of native plants, which require minimal maintenance once established. These native plant hedgerows can provide many benefits to an agricultural operation. They can reduce wind and water erosion, improve the permeability of the soil, suppress weeds by direct competition, provide wildlife habitat, and probably most importantly provide habitat for beneficial insects. Hedgerows can also filter surface runoff and subsurface flows, preventing excess sediment, nutrients, and pesticides from entering waterways. An often overlooked benefit of hedgerows is the improvement to the aesthetics of the farm landscape.

Conditions Where Hedgerows Apply

Hedgerows are appropriate for areas between fields, along fencelines and driveways, adjacent to roads and roadside ditches, and next to canals or streams. Because of the many benefits associated with hedgerows, they can be installed in agricultural and nonagricultural situations. They are ideal for landowners with small parcels who want to improve the aesthetics and wildlife habitat on their land. In either case, site selection is important and there are three main considerations to account for. First, there needs to be access to water for irrigating the hedgerow plantings for the first 2-3 years of establishment. Second, the site needs to be not vulnerable to flooding, which will kill most of the native plants suited to dry conditions. Third, consider what equipment is used on the adjacent fields, roads, or canals, and be sure that the hedgerow will not hinder proper use of this equipment.

Materials Needed

- Small Tractor or ATV: for discing, leveling, mowing and applying herbicide to the site.
- Hand Tools: shovels, rakes, dibble sticks, 5 gal. bucket.
- Lawn mower and/or Weed Wacker
- Drip Irrigation System
- Native Plants: trees, shrubs, perennial forbs and grasses.
- Herbicide: backpack sprayer and/or wick applicator.
- Mulch: wood chips, crushed walnut shells, other suitable material.
- “No Spray, No Disc” sign from the Yolo County RCD

References

Hedgerows

Implementation

Select a Site: The first step is to select a site. Possible sites include roadsides, fencelines, along streams or canals, and between fields. Some native plant species used in hedgerows are very water sensitive (i.e. sensitive to overwatering), so good drainage is very important. The site should also have access to water and not conflict with normal equipment operations. Access and availability of water to a new hedgerow planting is the single most important factor affecting plant survival in the first year. Choose a site that will give the most benefits to your operation and that best fits your needs. The length and width of the site will vary. Greater widths will allow for more complex plantings (i.e. various species of native trees, shrubs, forbs and grasses).

Draw a Plan: It will be very helpful for you to draw a scale site plan for your hedgerow. Begin by drawing the existing site, including any features that will remain (e.g. trees, fences, canals, roads. buildings). After you have decided on the plant species to include in your hedgerow, overlay the existing site plan with a planting plan that indicates the species and spacing of the plantings. Overlay the planting plan with an irrigation system plan that shows the water source and indicates the sizes of the irrigation tubing/pipe and the gph rate of the emitters for the various species.

Site Preparation and Weed Control: It will be likely that your chosen hedgerow site will have weeds growing on it. If so, you will need to plan your weed control strategy to begin at least one year prior to planting your hedgerow. One approach may be to first establish a ground layer of native grasses and forbs during the first two years, followed by planting trees and shrubs the third year. Refer to Invasive Grass/Weed Control and Farm Edge Native Grass Establishment in this manual for details on site preparation. If you are fortunate and have a weed free site to work with, then disc the area in the late summer or early fall to make the soil workable. Then harrow the area to prepare an even, well-drained bed. A flush of weeds may appear after the first rains following the discing. These can be treated with a broad spectrum herbicide before the area is planted or up to 2 weeks after the area was seeded.

Plant Selection: First identify any variability in the soil characteristics at your site. Work with your local nursery or plant expert to choose the plant species that are best suited to the soil, moisture, and other characteristics of your site. Remember, many native species such as Toyon, Ceanothus spp., and California Buckwheat, are extremely drought tolerant. Too much soil moisture, whether it be from winter ponding, an irrigation system or tailwater from an adjacent field, will cause the plants to die. On the other hand, some native species, such as Willow and Cottonwood, are water-loving species that can
Hedgerows

Implementation cont...

tolerate frequent wet conditions. Further refine your plant selection based on the intended purpose of the hedgerow. Contact an IPM specialist (see the website www.ipm.ucdavis.edu for more information) to determine what plant species will attract insects that will most benefit your crops. 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. 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. Figure 18 shows the flowering periods for several California native insectary plants. The most beneficial hedgerows are those with a combination of trees, shrubs, forbs and grasses. In some situations, the tree and shrub plantings may need protection from herbivores. Metal wire cages work well, provided protection while allowing for natural growth. Be careful not to plant large trees under power lines. Planting should be done from late fall through spring.

**Irrigation:** Identify your water source and assess water delivery capabilities. Design either a drip (preferred) or furrow irrigation system. Determine the watering needs of the plant species you chose and work with your local irrigation supplier to select needed materials. Installing a drip system with adjustable emitters will allow you to adjust the amount of water applied to each plant based on that species specific needs. The irrigation system will be used for the first 2-3 years to provide supplemental watering during the dry season until the plants have developed an adequate root system. Watering infrequently (i.e. every 1-2 weeks) but for a long duration (i.e. 2-8 hours) can help develop hardier plants with deeper root systems.

### Native Plant Species

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*Figure 19: The flowering periods of California Native Insectary Plants.*
Hedgerows

Implementation cont...

*Maintenance:* Hedgerows require regular maintenance during the 2-3 year establishment period. A major maintenance need is weed control. Spot spraying or wicking with herbicide in the spring and fall can be effective. A well-timed mowing in the spring to reduce the weed seed bank is another option. The most effective weed control for hedgerows without grass or forb plantings is a 6 inch layer of mulch (wood chips, crushed walnut shells, etc.) over the entire area. At the very least, placing a ring of wood chip mulch around each plant can have several benefits. Weed cloths around each plant are also very effective at suppressing weeds and maintaining adequate soil moisture. Some companies make specially-designed weed cloths for use around new plantings. Weed cloths will reduce the watering requirement. Monitor soil moisture regularly for the first month after planting to determine the proper watering frequency and duration. The irrigation system should be checked often during the period of use - emitters can become clogged and animals may chew on the irrigation lines. Cages may need to be installed around some tree and shrub plantings. Occasionally a plant may die and need to be replaced.
Grass-lined Canals & Ditches

Description and Benefits of Grass-lined Canals & Ditches

A grass-lined ditch or canal refers to a waterway with banks that contain permanently established, non-weedy vegetation rather than bare soil and weeds. This approach to canal bank maintenance can reduce or eliminate most herbicide application and stabilize the banks - thus improving water quality, reduce the need for annual ditch cleaning, and provide waterside habitat for a variety of small wildlife. All of this can be accomplished without significantly impeding water flow.

A variety of vegetation types are used on canal banks in order to accommodate the changing water levels throughout the spring and summer. Typically, dryland grass species are planted on the top portions of the canal, often near a road edge. Grasses that tolerate summer water are planted on the slopes, and sedges and rushes are planted at the water-line because they are more tolerant of continuous inundation and are small enough that they do not significantly affect water flow.

Conditions Where Grass-lined Canals & Ditches Apply

Nearly all permanent supply or drainage canals can be planted with perennial vegetation. Temporary ditches that are pulled or taken down on an annual basis are not appropriate for this practice.

Materials Needed

Some equipment, such as a tractor or ATV plus sprayer will be needed. If no herbicide is used, fencing may be needed to contain grazing animals, or burning safety equipment if a burn is used for weed control. Equipment needs for canal bank planting is minimal. The upper, dry edges of the canal bank may be seeded with a small, broadcast seeder that is pulled by an ATV, or with a belly-grinder. This “upland” portion should then be harrowed. Other vegetation is typically planted as “plugs,” which are 1” x 1” x 3” root-volume plants, that are hand-planted into the sloped banks. When planting plugs, a dibble-stick is useful. This is a long or short handled implement with a metal base that is the shape of a plug. It is used to create the correct sized planting hole for plugs and can increase the efficiency of planting time, especially when working in pairs. A “No Spray, No Disc” sign can be purchased from the Yolo County RCD and posted at each end of the grass-lined canal or ditch.

References

Grass-lined Canals & Ditches

Implementation

Site Preparation:
Select a section of canal bank for revegetation and begin the weed control process at least one year before the expected planting date. Use weed control appropriate to the farm, the area, and downstream water users. Weed control on canal banks can be especially difficult, so be diligent. Use a combination of herbicides, mowing, discing, grazing, and burning to reduce or eliminate the weeds on the upland as well as the sloped portion of the banks. If possible, re-grade the canal banks to a 3:1 slope to ease planting and maintenance.

Planting:
In the fall, when good germinating rains are expected, plant an appropriate native grass seed mix, using the method of your choice, on the upland portion of the bank. Lightly harrow in the seed. If weather allows, grass, sedge, and rush plugs can also be hand-planted on the bank portions that are too steep for a planter. Most sedge species are only available as transplants (plugs). If high water flows are a risk after a fall planting, it may be necessary to plant into bank-stabilization fabric. This is a bio-degradable mat that will protect bare portions of the bank from damaging flows. See Turf Reinforcement Mats and Erosion Control Blankets for details on installing erosion control fabrics. If weather is uncooperative, transplanting on the steeper banks can also be done in the spring.

Maintenance:
During the first, and possibly the second growing season, some irrigation may be necessary to get the planting well established. The need for irrigation will depend on the canal size, plant distance from the water table, and soil type.

A successful canal bank planting will depend on diligent weed control during the first two years. One aspect of post-establishment weed control can include the use of spring and summer applications of selective, broadleaf herbicides applied either pre-or post emergence. Well-timed mowings can be an effective means of controlling weedy annual grasses as well as broadleaves within the planting of native bunch grasses. If mowing, time the mowing according to plant growth stage. Mowing is most effective for reducing weeds if done when the weeds have begun the reproductive phase (flowering and seed production) and before the seeds are mature. Cut to a height that will remove the majority of the broadleaf or annual grassy weed, but minimize the effect on the natives. Native perennial bunchgrasses will typically be much shorter than annual weeds in the first year, and in subsequent years can tolerate mowing well. Maintenance in subsequent years might involve application of a pre-emergent herbicide in the fall (select herbicides approved for use near waterways), further well-timed mowings, grazing and the occasional prescribed burn.

Figure 20: Grass-lined Canals & Ditches cross-section detail.
Cover Crops

Description and Benefits of Cover Crops

Cover crops have been grown in agricultural situations in California since the early part of the last century. They have been used in perennial crops and in a variety of field and row crops, either as an integral part of the annual cropping system or as a rotational crop. Cover crops are associated with soil benefits such as improved tilth and fertility, reduced erosion and crusting, and increased water-holding capacity. Field margins, roadsides, banks, levees and slopes can also be planted with cover crops for weed suppression. Cover crops also provide valuable cover, nesting and foraging habitat for a variety of wildlife and can support beneficial insects, which aid in pest control.

A variety of perennial and annual grasses and forbs (broadleafed plants) can be used for cover crops as either single-species or multi-species mixes depending on the farmer’s needs. Fast-growing grass species provide high biomass for boosting organic matter in the soil, while some species of legumes can provide high volumes of nitrogen for the following cash crop. Mixed cover crops can be used to provide a combination of biomass and crop nutrient production. “Green manure” cover crops are typically incorporated into the soil before a cash crop is planted. In an orchard or vineyard setting, many annual cover crops can be managed to self-seed, minimizing needs for replanting and soil disturbance. Perennial grass cover crops can provide basic soil cover, and are typically selected to minimize water and sunlight competition with adjacent trees and vines.

Conditions Where Cover Crops Apply

Cover cropping is useful in a variety of agronomic situations where either rainfall or adequate irrigation are available. In an annual cropping system, the cover crop can be planted after harvest of one crop and before planting of the next to provide soil management and fertility benefits. In a perennial cropping system, a cover crop can be managed between plant rows for similar benefits.

Materials Needed

The basic ingredients for a cover crop are outlined below:

- Seed & inoculum (for legumes)
- Standard farming equipment for bed preparation, planting, incorporation and smoothing could include disk, harrow, planer or roller, seed drill or broadcaster, power mulcher, and herbicide. Choice of tools is dependent upon the farmer’s choice and available equipment.
- Mower (for cover crops in orchard and vineyard settings or for cover crop “knock down”)
- Standard irrigation equipment and/or rainfall

References


University of California Sustainable Agriculture Research and Education Program (UC SAREP)
Cover Crops

Implementation

Before a cover crop is planted, a suitable seedbed should be prepared. This is usually started after the post-harvest irrigation for perennial crops or after seedbed preparation for annual crops. On farmland, light disking or some other form of tillage is usually sufficient for most cover crops. Disking should be followed by some smoothing operation such as floating or planing so that larger clods are broken and the seedbed is smooth. This is particularly important for smaller seeded cover crops such as clovers. In non-tillage orchards, or with shallow-rooted citrus trees, care should be taken not to till too deeply where a large percentage of tree roots may have grown near the surface.

Unless non-leguminous or grass-only cover crops are used, additional fertilizer is not usually required for cover crops. Otherwise, follow your seed company representative’s recommendation for fertilizer type and rate. Excess nitrogen fertilizer may actually reduce overall nitrogen fixation and give weedy species a competitive edge.

Prior to planting, mixes including large-seeded legumes should be inoculated with the appropriate rhizobial bacteria. Host-specific bacteria work in combination with special root structures to bind or ‘fix’ nitrogen into plant tissues. Some seed is sold pre-inoculated, but large-seeded legumes such as vetch, peas and beans should be inoculated immediately before planting at a rate of about 8 oz. of inoculum per 100 lb. of seed and layering it into the planter hopper. If the seed is broadcast rather than drilled, it should be wet-inoculated to provide better adhesion of the inoculum to the seed.

For planting, the cover crop seed can be broadcast or drilled in. Drilling may require less ground preparation, and is the method of choice for first-time plantings. For single species or larger seeded types, an alfalfa drill can be used. Broadcasting seed is faster and less expensive, but will require a light harrowing to incorporate the seed followed by a final floating or rolling to finish the seedbed. In established perennial cover crops, supplemental seeding may be needed every 2-5 years.

If fall rains are not expected immediately, a light irrigation will settle soil around the seed and hasten germination. Summer annual cover crops will require regular irrigations just as any other warm season crop.

In orchards or vineyards, two to six mowings, beginning in February or March, may be needed from cover crop planting until the cash crop is harvested. If self-seeding is desired, mowing should be delayed until the cover crop has matured seed. When mowing a cover crop mix that includes legumes, care should be taken not to cut below the growing point, or regrowth will be hindered. Mowing, spot-spraying or hand-hoeing may be needed to keep sprinkler or drip emitters clear, but using low-growing cover crops or extending sprinkler risers could reduce the need for such maintenance.

Incorporation of the cover crop (if necessary) should be timed to allow at least two weeks of decomposition in the soil before planting. Timing of incorporation should also be made in consideration of adequate soil moisture for decomposition, otherwise additional irrigation may be necessary to adequately break down the organic matter for proper seedbed preparation for the following crop. In spring, care must also be taken not to enter a field with excessive soil moisture, which would obviously hinder equipment access and also damage the soil with excessive compaction and clodding. The simplest scenario for cover crop incorporation involves “knocking down” the cover crop with either mowing or herbicide, followed by disking the plant material into the soil. After a period of decomposition, the soil surface would then be reshaped and smoothed, as needed. Power incorporators such as the Wilcox Performer have also been used in Yolo County without any other equipment to chop and incorporate a cover crop and prepare the bed for the following cash crop in as few as three passes with ideal soil conditions.
Vegetated Filter Strips

Description and Benefits of Vegetated Filter Strips

A filter strip is an area of grass or other permanent vegetation used to “filter” sediment, organics, nutrients, pesticides, and other contaminants from farm sheet flow runoff in order to maintain or improve water quality in local waterbodies, such as streams and ponds. Filter strips slow the velocity of water, allowing the settling out of suspended soil particles, infiltration of runoff and soluble pollutants, adsorption of pollutants on soil and plant surfaces, and plant uptake of soluble pollutants. Filter strips are typically no narrower than twelve feet, and increased width typically increases the filtering or water quality benefit. Filter strips can be an aesthetic means of stabilizing field border soil and can also serve as forage (on-farm use or cash crop), turnrows and headlands, and field access. Filter strips can enhance wildlife objectives depending on the vegetative species used and management practiced. When planted with native or adapted vegetative species they can provide food and cover for important wildlife.

Conditions Where Vegetated Filter Strips Apply

Filter strips are most effective and useful on slopes less than 10% at the lower edge of crop fields where there is sheet or uniform shallow flow or edges of fields along streams, ponds, lakes, and drainageways. They can also serve as part of a riparian forest buffer system or as part of an agricultural waste management system.

Materials Needed

Items for establishing and maintaining a filter strip are similar to those for any planting project:

- Soil/bed preparation equipment
- Seed and/or other planting materials
- Seed broadcaster or drill or transplanter
- Mower for maintenance
- Irrigation supplies (if needed)

References


Vegetated Filter Strips

Implementation

- The filter strip should be designed to accommodate anticipated flows and slope to maximize the potential benefit. To determine the optimum width of a filter strip, consult with an NRCS engineer who will evaluate the individual site.
- Before a filter strip is planted, a suitable seedbed should be prepared. On farmland, light diskng or some other form of tillage is usually sufficient. Disking should be followed by some smoothing operation such as floating or planing so that larger clods are broken and the seedbed is smooth. This is particularly important for smaller seeded species such as clovers.
- For non-leguminous or grass-only plantings, additional fertilizer may be needed to aid establishment. Fertilize and amend the soil according to soil test results from the site and the needs of the species to be planted. Excess nitrogen fertilizer can be washed or leached out of the site (causing a water quality concern) or even give weedy species a competitive edge over the planted species.
- If legumes are to be included in the planting, make sure that they are either pre-inoculated or that you inoculate them with the appropriate rhizobial bacteria prior to planting at a rate of about 8 oz. of inoculum per 100 lb. of seed.
- For planting, the filter strip seed can be broadcast or drilled in. Drilling may require less ground preparation, and is the planting method of choice. For single species or larger seeded types, an alfalfa drill can be used. Broadcasting seed is faster and less expensive, but will require a light harrowing to incorporate the seed followed by a final floating or rolling to finish the seedbed. If necessary, mulch the newly seeded area with straw for soil protection during germination. Supplemental seeding may be needed every 2-5 years.
- If fall rains are not expected immediately, a light irrigation will settle soil around the seed and hasten germination.
- Mow (and harvest if possible) filter strip grasses several times a year to encourage dense vegetative growth. For ground nesting wildlife, care should be taken to avoid mowing during nesting periods. If self-seeding is desired, mowing should be delayed until the desired filter strip species have matured seed. When mowing a planting that includes legumes, care should be taken to not cut below the growing point, or re-growth will be hindered.
- Be careful to maintain original width and depth of the planted area in order to maintain the intended benefits of the filter strip. Inspect and repair after storm events to fill in gullies, remove flow disrupting debris and sediment accumulation, reseed disturbed areas, and take other measures to prevent concentrated flow in the filter strip.
- Undesirable weed species can often be suppressed with well-timed mowings, which are preferable to herbicide in a filter strip. If herbicide is needed, it should be applied at low rates or in spot treatments and with adequate time for degradation before anticipated storms or irrigations (runoff events).
- Take care to exclude livestock and vehicular traffic from the filter strip during wet periods of the year since filter strips rely on infiltration for reducing contaminants. It is recommended that this type of traffic be excluded at all times to the extent that is practical.
- Restoration of the filter strip will be required once it has accumulated so much sediment that it is no longer effective.

Figure 21: Vegetated Filter Strip cross section detail.
Description and Benefits of Habitat and 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, 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 from winter storms. Runoff not only removes topsoil from farmland but deposits this resource downstream, at unwanted places throughout the watershed and beyond. 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.

Construction of a small double-pond system is a straightforward, cost-effective solution to all these problems 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. This in turn reduces the maintenance requirements for the second, larger pond, which can serve multiple purposes: water storage, ground water recharge, water return systems, and plant and wildlife habitat (See photo).

Conditions Where Habitat and Tailwater Ponds Apply

A two-stage tailwater pond is best situated at the low end of a field that receives regular summer irrigation runoff (typically from surface irrigation). Depending on one’s goals for the pond, either sandy or clay soil would be desirable to either facilitate percolation of water into the ground or retainment of water for a year-round pond. The amount of land required to accommodate a pond depends on the size of pond needed or desired as well as plans for creating any associated upland wildlife habitat adjacent to the pond. For a two-stage pond, space must be allowed for equipment access for periodic cleaning of the sediment trap and more infrequent (i.e. every 5-10 years) maintenance of the large pond.

Materials Needed

- Earthmoving equipment such as an excavator or backhoe
- Water control structures for pond inlet and outlet (culverts and/or flashboard risers are typical)
- Return pump (typ. 5 hp) and 6-8” pvc pipe if a return system is planned
- Planting materials for pond banks and berms/uplands if desired:
  - Native grass/legume/wildflower seed, plugs for waterline plants and trees and shrubs, live stakes for trees such as willow and cottonwood

References

Habitat and Tailwater Ponds

Implementation

The main 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 horizontal 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 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.

If you plan to have your pond simply slow and retain a portion of irrigation runoff, sizing and design is mostly a matter of how much space you have or how much land you are willing to take out of production. The pond inlets and outlets will still need to be sized according to anticipated flows. 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 or use 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. An NRCS engineer can assist in determining appropriate sizing. 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.
Introduction
The word “riparian” comes from the Latin word “riparius,” which means bank or shore. The use of the word riparian in this manual refers to the area influenced by a stream. This influence is visually noticeable by a change in vegetation type, evidence that water flows through the area, or the observed extent of the floodplain. Due to the influence of water, riparian areas often exhibit an abundance of vegetation. Many species, such as willows and cottonwoods, are typically limited to growing in riparian areas. There are also many water-loving grasses, rushes and sedges that can be found along the streambank. In cases where a stream flows only seasonally (i.e. ephemeral) or after a rain event (i.e. intermittent) a change in vegetation type near the stream may not be readily noticeable. In such cases, the riparian area may be very narrow, often only associated with the immediate streambank.

The Riparian Area Practices focus on stabilizing eroding streambanks by planting vegetation and using other natural materials such as rock and rootwads to protect the vegetation as it becomes established. The goals of the practices are to remove non-native vegetation (e.g. Tamarisk, Arundo) from riparian areas, stabilize eroding streambanks with native vegetation, and provide habitat for wildlife and beneficial insects. Work in the stream channel typically requires permits from state and federal regulatory agencies, such as the Department of Fish and Game, the Regional Water Quality Control Board, and the U.S. Army Corps of Engineers. Refer to the Permits and Regulations section of this manual for more information.
Notes:
Tamarisk and Arundo Management

Description and Benefits of Tamarisk and Arundo Management

This practice describes several management techniques for control and eradication of Tamarisk and Arundo. Tamarisk (Tamarix spp.), also known as Salt cedar, is a non-native woody plant that aggressively invades riparian (streamside) areas, displacing and replacing native vegetation. It is a long-lived plant that produces large quantities of small seed every year. Tamarisk consumes large quantities of water and accumulates salts in its leaves. As leaf litter accumulates under the plant the soil becomes highly saline, inhibiting the establishment of other plants. Arundo (Arundo donax), also known as Giant reed, is a fast growing, bamboo-like plant in the grass family that grows in dense, multi-stemmed clumps in and adjacent to stream channels. It spreads by way of rhizomes, quickly forming large colonies that displace native vegetation. Managing Tamarisk and Arundo can improve riparian wildlife habitat and reduce flooding and erosion problems.

Conditions Where Tamarisk and Arundo Management Applies

This practice applies to any area that is infested with Tamarisk and/or Arundo. Different techniques may be needed to control and eradicate Tamarisk and Arundo depending on the size of the infestation, the terrain, the weather, adjacent land use, and the amount of adjacent native vegetation. The “spray only” technique is appropriate for large infestations with little to no native vegetation. The “cut, resprout, and spray” technique is appropriate for small to large areas with interspersed native vegetation, however it is very labor intensive. The “cut stump” technique is better suited to moderate to small infestations that are mixed with healthy stands of native vegetation. It is also labor intensive. The “root removal” technique works well for moderate to small infestations and will most likely require the use of heavy equipment.

Materials Needed

- Heavy Equipment: bulldozer, backhoe, excavator (with rotary chopper attachment), farm tractor
- Hand Tools: anvil loppers, chainsaw, handsaw, shovels, rakes, gloves
- Large Wood Chipper
- Herbicide: herbicide (triclopyr, imazapyr, glyphosate), adjuvant (surfactant or spreader), water, dye, soap, paper towels, absorptive material for spills (kitty litter), graduated cylinder or measuring cup, eye protection, tyvex jumpsuit, rubber gloves and shoes, long sleeve shirt and long pants, permits from ag commissioners office if necessary, herbicide label, location of nearest hospital, notepad to record amount of herbicide used and rate for county records.
- Herbicide Application Equipment: back pack sprayer (for spot applications), boom (for wider spray coverage); ATV, spray tank, and boom (for large area application); label containing name of chemical being used and applicator contact information.

References

Tamarisk and Arundo Management

Implementation

All but one of the techniques below involves the application of herbicide. The use of herbicides to control and eradicate Tamarisk and Arundo on your property may require an applicator’s permit, depending on the type of herbicide you use, the size of the project area, and whether you are the applicator. Contact the Yolo County Agricultural Commissioner’s office (530-666-8140) for more information. Any work being done in the stream channel may require a Streambed Alteration Agreement from the California Department of Fish and Game. Contact the local CDFG warden for a consultation.

Spray Only:
This technique is best suited for large stands consisting of only Tamarisk and Arundo. For Arundo, spray the leaves and stems of the plants with a systemic herbicide such as glyphosate. For Tamarisk, spray the leaves and stems with imazapyr. The foliar herbicide application should be done in late summer or fall. Care should be taken not to spray adjacent native vegetation. Do not cut the plants for at least 6 months. Follow up applications, in late summer or fall, will be required for at least three years.

Cut, Resprout, and Spray:
This highly effective technique is well suited to small and large stands of Tamarisk and Arundo interspersed with native vegetation. Cut Tamarisk and Arundo in late spring or summer to about 1-3 feet above the ground. Cutting can be done using anvil loppers, chainsaws, handsaws, or a special rotary chopper that attaches to the arm of an excavator. The cut vegetation can be hauled off site, left where it fell or run through a chipper on-site and used as mulch, or gathered into piles on-site and burned or left to decompose. All cut vegetation should be removed from the stream channel, or fragments can root and resprout where they lodge downstream after a high flow event.

Allow the Tamarisk and Arundo to resprout and grow for 2-3 months. In late summer or fall do a foliar herbicide application. For Arundo, spray the leaves and stems of the plants with a systemic herbicide such as glyphosate (e.g. Roundup or its aquatic equivalent Rodeo). For Tamarisk, spray the leaves and stems with imazapyr (e.g. Arsenal) or imazapyr in combination with glyphosate. Do not cut the plants for at least six months. Repeat the procedure for 3-5 years.

Cut Stump:
This technique is well suited to moderate to small stands of Tamarisk and Arundo where healthy stands of native vegetation also exist. Cut Tamarisk and Arundo in late summer or fall to about 1-2 feet above the ground. Cutting can be done using anvil loppers, chainsaws, handsaws or a special rotary chopper that attaches to the arm of an excavator. Remove the cut vegetation from the project site or run it through a wood chipper and use it as mulch on-site. Working in teams of 2 or 3, one person cutting and two people applying herbicide, cut the remaining stumps to within 3” of the ground and treat the perimeter of each stump with a concentrate herbicide within a couple of minutes. For Arundo, use undiluted glyphosate or other appropriate herbicide. For Tamarisk, use triclopyr or imazapyr. Treat resprouts with a foliar herbicide application the following year. Monitor the project site for at least three to five years and spot spray any regrowth each fall.

Root Removal:
This moderately effective technique is well suited for moderate to small stands of Tamarisk and Arundo where the application of herbicide is not permissible. Use a bulldozer, backhoe, excavator or other piece of farm equipment to pull, push, or dig entire plants out of the ground. The stumps and any cut vegetation can be hauled off site, run through a chipper on-site and used as mulch, or gathered into piles on-site and burned or left to decompose. All cut vegetation should be removed from the stream channel. Removing plants in the spring, while the soil is still moist, will make the job much easier, although removal can be done anytime. Any roots, rhizomes, or stems left behind may resprout, so this technique should be repeated annually. Regrade disturbed soil.

Revegetation:
Revegetation with native grasses, shrubs, and trees is important to the overall recovery of the project site. Revegetation efforts should be planned so as not to interfere with the techniques for Tamarisk and Arundo control and eradication. In some cases, revegetation of the project site should be delayed until the second or third year of the project. See Riparian Buffers, Native Perennial Grass Establishment, and Hedgerows for more details on revegetation.
Riparian Buffers

Description and Benefits of Riparian Buffers

Riparian areas are lands adjacent to rivers, streams, sloughs, wetlands, and other waterways. The availability of water and flooding patterns (i.e. floodplains) define the extent of the riparian area. Both factors provide for a unique assemblage of vegetation. Some of the plant species commonly associated with riparian areas include Willow, Cottonwood, Valley oak, Sycamore, Elderberry, Mule fat, California wild grape, and many grasses and sedges. This riparian vegetation provides protection from streambank erosion and influences, to a certain extent, the shape of the waterway it is adjacent to. Riparian areas and the associated floodplains are designed by nature to accommodate flood waters during high flow events. Riparian areas provide valuable habitat for fish and wildlife. Riparian area restoration projects can vary in size and scope depending on the size of the waterway and adjacent land use activities. A project may be as simple as identifying the floodplain and extent of the riparian zone and planting a mixture of riparian plant species. In some cases the channel may have incised (downcut) and/or widened to the extent that a floodplain no longer exists. In such cases the channel may need to be reshaped, which is too complicated of a process to adequately describe in this text. Restoring riparian vegetation can provide numerous ecological and economic benefits. Well-established riparian vegetation can help protect against streambank erosion, while also providing habitat for fish and wildlife. This practice of restoring riparian vegetation is also referred to as creating riparian buffers. Riparian buffers can be useful in agricultural settings, as the above ground vegetation intercepts sediment- and nutrient-rich surface runoff, and the roots take up nutrients from the subsurface runoff, in effect filtering the agricultural runoff before it reaches the stream.

Conditions Where Riparian Buffers Apply

“Less than ten percent of the Central Valley’s original riparian cover remains.” (Barbour et al, 1994) There are endless opportunities to restore riparian areas. Riparian buffers can be planted along any waterway, from large rivers to small drainage swales, where riparian vegetation historically existed. Riparian vegetation can also be planted alongside human-made irrigation canals and ditches, although canal and ditch maintenance needs to be factored into the planning process. The size and scope of the restoration project and the vegetation to be planted will depend on many factors. Size of the waterway, the existence and extent of its associated floodplain, and adjacent land use determine the boundaries of the project site. The timing and seasonality of water flow in the channel and the depth to the water table will determine the appropriate vegetation for the site.

Materials Needed

- Heavy Equipment: Backhoe with a “Stinger” attachment; farm tractor
- Hand Tools: Shovels, hoes, rakes, post hole diggers, picks, 5-gal. bucket, gloves
- Riparian Plants: see plant list on page 77
- Plant Protectors: Fencing, rebar, metal t-posts
- Mulch: Wood chips, straw, crushed walnut shells
- Irrigation System

References

Riparian Buffers

Implementation

- Restoring riparian areas may require permits from the California Department of Fish and Game, the Army Corps of Engineers, and the State Water Resources Control Board. Contact your Fish and Game warden for consultation during the site selection and planning phases of your project. Chances are if there are no endangered species on the site and work is kept out of the channel, you won’t need any permits.

- Site selection is an important first step. Determine if your waterway exhibits a floodplain. Check the depth to the water table. Check soil types. Take note of existing vegetation. Is it native or non-native? Will the removal of non-native vegetation be a part of your project? Assess adjacent land use activities. Is supplemental irrigation available? Choose a site that will best be able to support the vegetation after an initial establishment period of 3-5 years. Access to and availability of water in the soil is your main concern.

- Expect to spend as much time, if not more, planning your riparian buffer project as you do for actually doing the work. Drawing a map of your site will help. On your map you will want to identify the low flow channel, the hydrologic floodplain, and the topographic floodplain (See Watershed Basics for more information). Also note any existing vegetation, structures (e.g. bridge piers, irrigation pumps, etc.), roads, and erosion sites.

- Now that you have selected and mapped your site, it is time to decide what you want to plant and where you want to plant it. Referencing an adjacent healthy riparian area can tell you a lot about what species grow and how they are distributed. If a healthy riparian reference reach is not available, use your map and knowledge of the height and frequency of flows to determine planting zones. In general, you should delineate three zones: low-flow (or summer flow) streambank vegetation zone - mostly rushes, grasses and sedges; lower (hydrologic) floodplain vegetation zone - mostly shrub-like plants able to withstand inundation; and upper (topographic) floodplain zone - a mixture of grasses, shrubs, and trees. For riparian areas adjacent to agricultural fields a fourth zone of primarily grasses and forbs can be planted between the field and the riparian plantings (See Vegetated Filter Strips).

- Refer to the Riparian Area Plant List in this manual for native plant species commonly found in the different zones in the Cache Creek watershed. You will also want to work with one of the local native plant nurseries to decide what plants are most appropriate for your site and to determine what plants are available. Whether you are planting in one zone or in all four, choose several species for each zone. Delineate on your site plan the extent of the plantings in each zone and what species will be planted there.

- In general it is best to plant vegetation from late fall through early spring. Planting on the low-flow channel streambank and on the lower floodplain may not be possible during periods of high flow associated with winter storms. Planting these zones may need to occur in the spring. It is not necessary to plant the trees, shrubs, etc. in rows or at regular intervals, although this can make irrigation easier. It may be best to plant the riparian vegetation in clusters of 3-5 plants. The plants can be different species.

- Maintaining the plantings is vital to the success of the project. Protective cages may need to be built around the trees and shrubs to protect from herbivore browsing. Four to five foot wire fencing works best. Cut the fencing and wrap it around the planting to create a circular enclosure at least 3 feet in diameter. Stake the wire cage down using rebar or fence stakes. Mulching around the plantings with woodchips or other type of mulch will help control weeds. Irrigating the plantings during the summer (or when otherwise dry conditions exist) for the first three years is important to the success of the plantings. Create a wide, shallow watering basin for each plant. Provide the plants with a deep watering once a week. You can use whatever method (i.e. drip irrigation, flood, sprinkler, 5-gal bucket, hose) of irrigation that is available.

Figure 22: Riparian Area Zones
Live Staking and Pole Planting

Description and Benefits of Live Staking and Pole Planting
Both live staking and pole planting involve the insertion of live, rootable vegetative cuttings into the ground. If correctly prepared and placed, the live stakes and poles will develop a root system and vegetated shoots. Live stakes are typically 1/2” to 2” in diameter and 3’ to 4’ in length. Pole cuttings are typically 1” to 3” in diameter and 4’ to 10’ in length. Willow and cottonwood are most commonly used for live staking and pole planting. The root system serves to stabilize the soil, protecting it from erosion. When planted near a stream or in the floodplain, the shoots reduce the velocity of the water during high flows, resulting in sediment accumulation. When planted in a regular pattern on a streambank or slope, live stakes serve to anchor the soil.

Conditions Where Live Staking and Pole Planting Apply
Live stakes can be used in upland and riparian (streamside) areas. Live stakes can be used alone, but they are often combined with other biotechnical practices. Live stakes are used in upland areas to stabilize eroding gullies and small slumps. Live stakes can be used to anchor and enhance habitat benefits of erosion control blankets and turf reinforcement mats, willow wattles, straw wattles, and other erosion control products. Live stakes can be added to such hard structures as riprap and gabions to provide added soil stabilization and improved wildlife habitat. Live stakes need to be planted in an area where the roots will have year-round access to water or where irrigation can be provided during the dry season for the first 3-5 years of establishment.

Pole plantings are mostly used in streamside and floodplain areas. They are ideal for project sites with widely fluctuating water tables and areas where supplemental irrigation is not feasible. Pole plantings can be used alone, but they are often combined with other biotechnical practices. Poles can be added to such hard structures as riprap and gabions during installation to provide added soil stabilization and improved wildlife habitat. Pole planting usually requires the use of heavy equipment (typically a backhoe). Be sure your project site is accessible to heavy equipment.

Materials Needed
There are three phases to live staking. A flatbed or pickup may be needed to transport cuttings from the harvest site to the storage site and to the planting site.

Harvest:
Large, healthy stand of willow or cottonwood
Large loppers (anvil type works best), hand pruners, pruning saw or small chainsaw
Rope or twine

Storage:
Some means to keep the cuttings wet for 1 to 30 days, such as a lake or pond, a stream, or burlap and sprinklers.

Planting:
Large loppers (anvil type works best), hand pruners, pruning saw or small chainsaw
Small sledge hammer and a dead blow mallet
A 4-foot concrete stake or a gas powered auger

References
Live Staking and Pole Planting

Implementation

There are three phases to live staking and pole planting: Harvest, Storage, and Planting.

Harvest:
Stakes and poles should be harvested during the plant’s dormant season (typically November through April). Live stakes and pole cuttings should be cut from straight, healthy 2-5 year old branches. Do not “clear cut” your harvest stand, rather thin out the branches that will make the best live stakes and not compromise the stand. Try to harvest from plants that are growing near to where you will be planting. If there is not a suitable harvest stand in the immediate area, harvest from a stand that is growing in similar conditions to your planting site. Branches that have already begun flowering (i.e. bud swell) will not root as well because rooting hormones are translocating to support flowering.

Suitable stakes are 1/2” to 2” in diameter and should be cut into 3’ to 4’ lengths. Suitable poles are 1” to 3” in diameter and should be cut into 4’ to 10’ lengths. Make clean cuts and avoid splitting ends. Large anvil style loppers work best for making these cuts. If the loppers can’t cut the branch, then it is too big to be a stake or pole. The butt ends of the stakes and poles need to be trimmed to a 45-degree angle and the tops need to be cut flat. This allows for easy identification of which end goes in the ground during planting. If you are unsure which end is up, look at the leaf bud scars. They always point up. Trim all lateral stems from the stakes and poles as flush as possible.

Storage:
The key to successful live staking and pole planting is keeping the stakes and poles wet. You will get the best results if you soak the cuttings in water for about a week. At a minimum soak cuttings for 24 hours. Tie stakes or poles together into bundles that are easy to manage. Completely submerge the bundles in any body of water. If you do not have access to a body of water you can soak the bundles in a large garbage can filled with water or cover the bundles with burlap and keep them wet using a sprinkler. The sooner you get the cuttings in the water the better.

Planting:
Stakes - Create a pilot hole using a small sledge hammer to drive a 3’ - 4’ concrete stake into the ground. You may have to hit the side of the stake to loosen up the soil so you can remove the stake. Insert the butt end of the live stake (with 45-degree cut) into the pilot hole using the dead blow hammer if necessary to pound in the stake. Insert the stake so that 80% of its length is below the ground (see Figure 24). Trim the top if it becomes smashed or split during planting. Tamp the soil around the stake and water heavily soon after planting. Plant stakes every 1 - 3 feet.

Poles - Use a backhoe with a “Stinger” or an auger to create a planting hole that reaches into the water table. Insert the butt end of the stake (with 45-degree cut) into the planting hole. Insert 1 - 2 poles so that 80% of the pole is below the ground. Trim the top if more than 1 foot remains above ground. Tamp the soil around the stake and water heavily soon after planting so as to eliminate air pockets in the soil around the pole. Plant poles every 1 - 3 feet.
Willow Wattles

Description and Benefits of Willow Wattles
Willow wattles are long cylindrical bundles of live cuttings that can be used for both streambank protection and to reduce erosion, aid drainage, and improve infiltration on dry upland slopes. Willow wattles are similar to fascines (see *Live Fascines and Live Pole Drains*), with the exception that for wattles the cuttings are arranged in alternating directions throughout the length of the wattle. Wattles are typically installed in combination with other streambank protection practices (e.g. brush mattresses, live siltation, reinforced brush layering), but they also have useful application as a stand alone practice. In streamside situations, wattles placed at the toe of the streambank can help protect against the stream cutting into the bank as well as capture sediment that sloughs from the upper bank. Wattles can also be installed in shallow staggered trenches on upland slopes. The trenches are dug on contour. The staggered series of wattles breaks the slope length into several short slopes. This regulates the energy of the runoff flowing down the surface of the slope providing for improved infiltration and reduced erosion. As the cuttings in the wattles become established, they serve to further stabilize the slope and provide habitat for wildlife.

Conditions Where Willow Wattles Apply
Willow wattles are well suited for streamside use as well as on upland slopes. Wattles are used in streamside situations where immediate as well as long-term stabilization is needed. Wattles can be installed at the toe of the streambank (similar to coir rolls), but will require sustained flows through the dry season to ensure establishment. Wattles are often used as toe protection in combination with other practices. They can also be installed in several rows up an eroding slope or high streambank in cases where the rills are forming on the slope or sloughing is occurring due to the affects of overland flow.

Materials Needed
- Hand Tools: shovels, rakes, anvil loppers, hand pruners, fence wire tool, sledge hammer.
- Live Cuttings (stakes and poles): use native plant material that is most appropriate to the site as well as abundant near the site (Willow, Cottonwood, Mulefat, Coyotebrush, other easily rooted species).
- Water source for soaking live cuttings: pond, troughs, stream, burlap and sprinklers.
- Wooden Stakes: 2 to 4 feet long with a notch for securing wire approximately 3 inches from the top.
- Wire or Rope: medium gauge fencing wire or polypropylene rope for securing the live fascines and pole drains.
- Native Grass Seed and Mulch.

References
Willow Wattles

Implementation

Willow wattle construction:

- First harvest the cuttings according to the guidelines for Pole Planting and soak the cuttings for at least 24 hours. Willow can be used for most applications, even on dry upland slopes. Other locally available material may also be used provided that it will root from cuttings.
- Tie together the live cuttings into bundles of 10 to 30 feet in length and 6 to 16 inches in diameter. Be sure that the cuttings alternate in orientation and that the tips of the cuttings are staggered throughout the length of the wattle. Tie the wattle together with twine every 2 feet. Taper the ends of the wattle in case it will be joined to another one during installation (see Figure 25).

Installation:

- Perform any slope repairs or regrading prior to wattle installation.
- Dig a shallow trench on the contour at the mean low water level (i.e. summer flows) at the toe of the streambank along the length of the site. The trench should be as wide as the wattle and half as deep. If the streambank has a long slope with a sloughing vertical bank at the top, a second or third wattle can be installed at intervals up the slope.
- Lay the wattle in the trench along the length of the site. If more than one wattle is needed, be sure to tie together the ends of the adjoining wattles with rope. Also be sure that a stake is aligned at the joint.
- Drive a wooden stake every 2 to 3 feet into the center of the fascine. Additionally drive live stakes on the downslope side of the fascine in the intervals between the wooden stakes. In some cases (particularly at joints) you may need to drive parallel wooden stakes upslope and downslope of the fascine and secure the fascine to the ground with a wire that runs between the two wooden stakes.
- Tie wire or rope between the parallel wooden stakes at the notch and pound into the ground until the wattle is held secure. If the ground is too rocky for wooden stakes, use rebar or metal concrete form stakes instead.
- Backfill the area behind the wattle forming a small bench.
- Dig a trench approximately 2 feet wide by 2 feet deep perpendicular to the contour, from the mean low water level to above the mean high water level at the upstream and downstream ends of the wattle (this is a trench that is running up and down the slope).
- Install rock riprap or rootwads into the trench. The purpose is to keep the stream from cutting behind the wattle. If installing rock riprap or rootwads is not feasible, dig the trench half as deep and install an additional wattle.

For dry upland slope situations, follow the guidelines for live fascines, except install the wattles on contour (not at an angle). For dry slopes the goal is to improve infiltration of runoff into the soil, not direct the runoff off the slope as is the case with live fascines and pole drains.

Figure 26: Using Willow Wattles as part of a streambank stabilization project.
Coir Rolls (Fiberschines)

Description and Benefits of Using Coir Rolls

Coir rolls (also known as Fiberschines) are long cylindrical tubelike rolls composed of coconut fibers wrapped with a coir netting. They come in a variety of sizes - typical diameters are 12 to 20 inches and lengths are up to 20 feet. Coir rolls can be used alone to help stabilize eroding streambanks, but they are more effective when used in conjunction with other practices (e.g. reinforced brush layers, brush mattress, live siltation). Coir rolls are a good alternative to using rock riprap to prevent streambank erosion at the average waterline. They are easier to handle than rock or rootwads and can provide immediate protection.

Conditions Where Coir Rolls Apply

Use coir rolls for streambank erosion protection along low gradient streams. One or more rows of coir rolls can be installed on the slope of the streambank to provide erosion protection at various water levels (i.e. one coir roll at the mean low water level and one at the mean high water level). Coir rolls are a good alternative to rock riprap and/or rootwads in areas inaccessible to heavy equipment.

Materials Needed

- Heavy Equipment: slope repair may require an excavator or a backhoe.
- Hand Tools: shovels, rakes, picks, sledgehammer, fence wire tool, gloves.
- Coir Rolls: work with the distributor to determine the appropriate size and length for your site.
- Wooden Stakes: 2 to 4 foot long wooden stakes with a notch 3 inches from the top.
- Wire or Rope: Medium gauge fencing wire or polypropylene rope for securing the coir roll.
- Rock riprap or Rootwads: A small amount of either may be needed to key in the ends of the coir roll.

References

Coir Rolls (Fiberschines)

Implementation

This practice describes the steps to install coir rolls. Keep in mind that coir rolls are not living material and that long-term streambank stabilization will require the addition of live cuttings. This practice may require permits. Contact your local California Fish and Game warden for consultation.

Installation:

- Perform any slope repairs or regrading prior to coir roll installation.
- Dig a shallow trench on the contour along the length of the site. The trench should only be about 6 inches deep and the width of a shovel. Dig the trench at the mean low water level or the mean high water level, whichever is experiencing accelerated erosion. If accelerated erosion is occurring at both levels, install coir rolls at both levels.
- Pound wooden stakes into the ground every 5 feet on the downhill side of the trench. Pound the stakes only about 1 foot deep at first.
- Lay the coir roll in the trench along the length of the site. If more than one coir roll is needed, be sure to “sew” together the ends of the adjoining rolls with rope.
- Pound additional wooden stakes above the coir roll parallel to the existing stakes. Willow stakes can also be installed in the spaces between the wooden stakes to provide extra support along the length of the coir roll.
- Tie wire or rope between the wooden stakes at the notch and pound into the ground until the coir roll is held secure. If the ground is too rocky for wooden stakes, use rebar or metal concrete form stakes instead.
- Backfill the area behind the coir roll forming a small bench.
- Dig a trench approximately 2 feet wide by 2 feet deep perpendicular to the contour, from the mean low water level (if a coir roll is installed at that level) to above the mean high water level at the upstream and downstream ends of the coir roll installation.
- Install rock riprap or rootwads into the trench. The purpose is to keep the stream from cutting behind the coir roll. If installing rock riprap or rootwads is not feasible, dig the trench half as deep and turn the coir roll into the trench.

Figure 27: Coir Roll installation detail.
Brush Mattress

Description and Benefits of Brush Mattresses

A brush mattress involves placing a dense mat of live cuttings along the slope of an eroding streambank. The brush mattress provides immediate erosion protection, as well as long-term protection once the cuttings become established and begin to grow. The roots stabilize the soil while the shoots slow water flow, making the brush mattress effective at capturing sediment during high flows. So instead of the streambank eroding, it is actually building. Brush mattresses are a technically simple practice, although they are labor intensive and require large amounts of live cuttings.

Conditions Where Brush Mattresses Apply

Brush mattresses are ideal for stabilizing (and rebuilding) streambanks that erode during high flows. The streambank should be smooth and graded back to a slope no steeper than 2:1. The base of the mattress should be permanently in water or in contact with the water table if live cutting establishment is desired. The size/length of the brush mattress can vary depending on the needs of the site.

Materials Needed

- Heavy Equipment: depending on the scale of the project an excavator or backhoe may be needed.
- Hand Tools: shovels, rakes, sledge hammer, dead blow hammer, concrete form stake, fence wire tool, 5 gal. bucket.
- Live Cuttings: willow and cottonwood pole cuttings are typically most abundant and establish easily; pole cuttings should be 6 feet long or longer; live stakes can be used in place of some or all of the wooden stakes.
- Wooden Stakes: 2 to 4 foot long wooden stakes with a notch 3 inches from the top.
- Wire or Rope: medium gauge fencing wire or polypropylene rope for securing the coir roll.
- Toe Protection: rock riprap, rootwads, coir rolls for stabilizing the base of the brush mattress.

References

Brush Mattress

Implementation

Collect live cuttings following the guidelines described in Pole Planting. Install brush mattresses during the dormant season for the live cuttings (November through March). This practice may require permits. Contact your local California Fish and Game warden for consultation.

Installation:

- Reshape the slope of the streambank so that it is an even grade. This may require “pulling back” the top of the bank to ensure the slope is not steeper than 2:1. Pulling back the bank is preferable to filling as the latter is inherently less stable. Additionally, while reshaping the slope, excavate to a depth of about 6 inches the entire area to be covered with the brush mattress.
- Excavate a trench on contour at the toe of the slope. This should be at the mean low water level. The trench should be large enough to accommodate the base of the brush mattress and the selected toe protection (rock riprap, rootwads, coir rolls).
- Beginning at the toe of the slope in the trench, pound in wooden stakes (or live stakes) at 3 to 5 foot centers along the length of the site and up the slope. Only partially pound in the wooden stakes at this time (to a depth of about 1 foot).
- Place live cuttings on the slope with the base ends in the trench. Slightly crisscross the cuttings until they form a mat 6 to 12 inches thick.
- Tie wire or rope horizontally and in a crisscross pattern from stake to stake. Tie off each segment so that if one section breaks, the others remain intact. An alternative is to lay live pole cuttings horizontally atop the brush mattress and tie them to the wooden stakes.
- Pound the stakes into the ground until the brush mattress is secure against the slope.
- Backfill soil around and into the brush mattress. Use a bucket to throw water over the mattress. This will work the soil into the spaces between the live cuttings and will provide some moisture to help with initial root establishment. The top layer of the live cuttings should still be visible after backfilling.
- Place selected toe protection (i.e. rock, rootwads, coir roll) in the trench and in an additional trench dug perpendicular to the contour at the upstream end of the mattress. This is to prevent the stream from cutting under or behind the brush mattress.

![Figure 28: Brush Mattress installation detail.](image)
Reinforced Brush Layering

Description and Benefits of Reinforced Brush Layering

Reinforced brush layering is a more complicated practice than brush layering alone (as described in Brush Layering), as it involves adding protection at the toe of the slope and wrapping the soil between brush layers in a geotextile fabric material. These modifications make this practice more appropriate for streambank situations, although reinforced brush layering is also appropriate for steep (>2:1) upland slope situations (i.e. fill slopes, slumps, small land slides). Brush layering is the placement of layers of live vegetated cuttings (willow, mule fat, etc.) in between layers of soil. The layers are created in benches, which can require significant soil movement depending on the scale of the project. For the purpose of this manual, the focus of this practice will be on small to medium sized projects that can be installed using a backhoe and/or handtools. This practice will also focus on the use of rock riprap to protect the toe, although rootwads (see Rootwad Revetment) and coir rolls (see Coir Rolls) can also be used. The soil between brush layers are wrapped with a geotextile fabric to protect from stream cutting while the vegetation becomes established. Reinforced brush layering can provide multiple benefits to eroding or unstable streambanks. First, the cuttings reinforce the soil structure and root growth provides additional soil stability. Second, the tips of the cuttings protruding from the soil slow and/or stop runoff and other debris as it travels down the slope. Third, new shoot growth slows stream flows, reducing erosion and promoting siltation. Fourth, new shoot growth also provides fish and wildlife habitat.

Conditions Where Reinforced Brush Layering Applies

As mentioned above, reinforced brush layering is an appropriate practice for stabilizing streambanks and very steep slopes. It is intended to be installed on the banks of the active channel. The top of the protective toe is typically at the mean high water level. The brush layers are intended to be inundated only during storm events. This practice is particularly applicable to cut banks where minimal space is available to lay back the bank.

Materials Needed

- Heavy Equipment: depending on the scale of the project an excavator or backhoe may be needed.
- Live Cuttings - use native plant material that is most appropriate to the site as well as abundant near the site (willow, cottonwood, dogwood, coyotebrush, other easily rooted species).
- Native Grass/Legume/Wildflower Seed Mix - rely on the advice of the seed distributor to select the best mix for your site.
- Straw Mulch
- Geotextile Fabric
- Wooden Stakes: 2 to 3 foot long wooden stakes.
- Toe Protection: rock riprap, rootwads, coir rolls for stabilizing the base of the brush mattress.

References

Reinforced Brush Layering

Implementation

This practice focuses on the implementation of brush layering on streambanks. For upland slope applications see Brush Layering. Slope length of the streambank should not exceed 20 feet. Harvest and manage live cuttings following the guidelines described in Live Staking and Pole Planting, except that some side branches can be left on and those side branches that are trimmed off can be saved and used as part of the brush layer matrix. Live cuttings should be soaked for at least 24 hours prior to installation. For best results, install brush layers as soon as the species selected for live cuttings goes dormant (or from November through March). In most cases this practice will require permits from various governmental agencies. See the Permits and Regulations section for contact information for the appropriate agencies.

Installation:

- Begin by grading back the streambank to the extent possible. A 2:1 slope or less is preferable.
- Dig a 1-2 foot deep trench in the channel bottom parallel to and at the base of the streambank. Place rock riprap toe protection in the trench and up the streambank to the expected mean high water level. Dig a second trench from the anticipated high water mark down to the toe trench at the upstream end of the site. Place rock riprap in this trench as well. The purpose of the second trench is to prevent the stream from cutting behind the brush layering.
- Excavate a bench along the contour at the top of the rock riprap. Make the bench 2 to 5 feet wide and angled back into the slope 10-20 degrees so that the outside edge is higher than the inside.
- Place 3 to 5 layers of live cuttings on the bench so that the bases of the cuttings are at the inside edge of the bench and the growing tips extend from the outer edge about 1 foot. Backfill just enough soil to cover the brush layer.
- Unroll the geotextile fabric along the length of the bench. One edge of the fabric should extend to the inside edge of the bench. The other edge will be hanging over the brush layer and rock riprap. Knowing the width of your benches ahead of time will allow you to purchase the correct width roll of geotextile fabric. Secure the fabric onto the bench with 2-3 foot wooden stakes at 3-foot intervals.
- Backfill the bench with the soil excavated from the next bench above it. Be sure to compact the backfilled soil and wrap the fabric around the fill so that it ends in the middle of the next bench. Secure the fabric with more wooden stakes.
- Continue placing brush layers, soil, and fabric-wrapped backfill until the desired bank height is achieved. To reduce project costs, install the geotextile fabric on the bottom two or three layers only.
- Space benches 3 to 5 feet apart depending on the slope. The steeper the slope the closer the spacing.
- Seed and mulch the bare soil between the benches after all of the brush layers have been installed.
- If possible, install a drip hose with inline emitters every 12” along the top of each brush layer. Irrigate once a week until winter rains moisten the soil. Additional irrigation the following summer will result in better plant establishment. If a drip system is not feasible, any supplemental irrigation will be helpful.

Figure 29: Reinforced Brush Layering installation detail.
Brush Trenches

Description and Benefits of Brush Trenches

A brush trench is a deep trench dug on the terrace at the top of a streambank and then backfilled with live cuttings and soil. A brush trench is a simple practice that can provide multiple benefits to eroding streambanks. As the live cuttings become established, the roots extend and form a dense mat that secures the eroding streambank and the shoots help slow overland flow, filtering out sediment and other constituents.

Conditions Where Brush Trenches Apply

Brush trenches are suitable to sites where repairing the eroding streambank is not feasible or is too costly. Brush trenches will not provide immediate erosion protection. Roots will need 2-5 years of growth to aid with streambank protection. Brush trenches are not recommended for high cut banks, where reaching the capillary fringe of the ground water is not possible, unless supplemental irrigation can be provided. Brush trenches are a good addition to other streambank stabilization practices (e.g. reinforced brush layering, vegetated riprap, rootwad revetment).

Materials Needed

- Heavy Equipment: backhoe with a narrow bucket or a trencher.
- Hand Tools: shovels, rakes, wide bladed pick, gloves, 5 gal. bucket
- Live Cuttings: Pole cuttings of preferably willow at least 6 feet in length.

References

Brush Trenches

Implementation

Brush trenches can be installed in combination with other practices or as a stand alone practice. The advantage to stand alone brush trenches is that they will most likely not require a permit. Harvest live cuttings according to the guidelines in Pole Plantings. Willows are recommended because of their dense, mat-like root growth. Install brush trenches during the dormant season (November through March).

Installation:

- Complete any streambank slope repair work or regrading prior to installing the brush trench.
- Dig a trench on the terrace about 1 foot from and parallel to the top of the streambank. The trench should be deep enough to reach the water table for most of the year. The trench need only be 6 to 12 inches wide.
- Place willow cuttings vertically in the trench so that the bases are in contact with the bottom of the trench and the tips extend 1 to 2 feet above the ground level. Place 2-6 rows of live cuttings in the trench.
- Backfill the trench. Use the bucket to water down the trench to eliminate air pockets and further compact the soil.
- Weeds may need to be mowed or pulled adjacent to the trench during the first growing season.
- Supply supplemental irrigation during the summer and fall if necessary.

Figure 30: Brush Trench installation detail.
Rootwad Revetment

Description and Benefits of Rootwads

Rootwads are the root mass (or fan) of a mature tree that has been pulled out of the ground. The use of rootwads for streambank revetment structures requires that at least 6 feet of the bole (or trunk) be left attached to the root mass. The rootwads are used as toe protection in combination with other streambank stabilization practices (e.g. Reinforced Brush Layering, Brush Mattresses, Vegetated Riprap, Live Staking and Pole Planting). Rootwads armor the streambank and deflect the stream back to the center of the channel, while also providing excellent fish habitat. The removal of orchards can provide an inexpensive, readily available source of rootwads for streambank work. Rootwads can be a more affordable alternative to using rock riprap or rock filled gabions.

Conditions Where Rootwads Apply

Rootwads are typically not a stand alone practice. At minimum they should be installed with pole plantings. They are appropriate for streams that naturally experience treefall or rootwad protection along its banks (i.e. rootwads are not appropriate for open grassy meadows). Install rootwads as toe protection when installing middle and upper streambank protection practices. In some cases the rootwads will need to be placed first and keyed into the bank, before other practices can be installed. Use rootwads for toe protection if one of your goals is also fish habitat enhancement. Installing rootwads requires extensive use of heavy equipment, making them better suited to larger projects.

Materials Needed

- Heavy Equipment: excavator and/or backhoe, bulldozer.
- Hand Tools: shovels, rakes, heavy duty chains, sledge hammer, gloves, 5 gal. bucket.
- Rootwads: use rootmasses from mature trees with at least 6 feet of the bole attached; also 6 to 10 foot long footer logs.
- Rock: a few large boulders may be needed to anchor the rootwad.
- Cable and Rebar: in some cases the rootwad is cabled to long (4 to 8 feet) rebar stakes in the bank.

References

Rootwad Revetment

Implementation

This practice will most likely require permits. Contact your local Fish and Game warden for consultation. Install rootwads when the stream is at its lowest flow. Note: When using rootwads as toe protection in combination with Reinforced Brush Layering, Brush Mattresses, or Vegetated Riprap, install the root wads first.

Installation:

- Begin by digging a trench at the toe of the slope large enough to accomodate the footer log. Dig the trench running from the bank at a 45-60 degree angle downstream and at the level of the streambed (See Figure 31). Place the footer log in the trench.
- Dig a second trench perpendicular to and behind (away from the stream) the footer log. The trench should angle back into the bank.
- Place the rootwad into the trench so that it rests on the footer log and the face of the root mass is pointing upstream.
- Anchor the rootwad with large boulders or by attaching the rootwad to one or more long rebar stakes with heavy cable.
- Place live cuttings vertically in the trenches on both sides of the footer log and the rootwad.
- Backfill the trenches and regrade the slope. Use the 5 gal. bucket to water down and compact the backfill.

![Figure 31: Root Wad Revetment installation detail.](image-url)
Vegetated Riprap

Description and Benefits of Vegetated Riprap

The use of large quarried rock, or riprap, is a well known successful technique for stabilizing eroding streambanks. The addition of live vegetated cuttings during the installation of the rock is known as vegetated riprap. The vegetation improves the stability of the structure as its roots grow and spread through the soil, preventing soil loss from behind the rock. The shoots that grow from the live cuttings slow the velocity of the stream causing the deposition of sediment into the rock. This further enhances the recruitment, establishment and growth of native vegetation. In addition to strengthening the structure, the vegetation provides habitat for wildlife and fish, and it is more aesthetically appealing than rock alone. In many cases permitting agencies will not issue permits for streambank work that does not include habitat features such as vegetation.

Conditions Where Vegetated Riprap Applies

Vegetated riprap is appropriate for stabilizing eroding streambanks on any size stream. The size of the stream determines the size of the rock used. It is particularly suited to areas where bare riprap would be aesthetically unacceptable or not permissable by permitting agencies. Vegetated riprap is also appropriate for projects intended to enhance fishery resources. This practice requires the use of heavy equipment for streambank grading and placement of the rock.

Materials Needed

- Heavy Equipment: Excavator or backhoe with a bucket that has a thumb.
- Hand Tools: heavy digging rod, dead blow hammer, small sledge hammer, gloves.
- Rock: quarried (angular) rock large enough to not be mobilized by high flows of the stream.
- Live Cuttings: pole cuttings of riparian species such as willow, cottonwood, and mulefat.
- Filter Fabric

References

Vegetated Riprap

Implementation

Installing vegetated riprap requires either a patient heavy equipment operator or one with previous bioengineering experience, because placing the rock will take longer due to the incorporation of the live cuttings. Be sure to inform the heavy equipment operators that this is not a standard riprap project during the bidding process. Follow the guidelines in Live Staking and Pole Plantings to properly harvest, store, and handle the live cuttings. Vegetated riprap should be installed in the late fall to ensure successful establishment of the live cuttings. This practice will most likely require permits. Contact your local Fish and Game warden for a consultation.

Installation:

- Regrade the slope of the eroding bank to no steeper that 2:1. If necessary, excavate additional soil at the base of the slope prior to regrading. This will ensure that the live pole cuttings will be able to be inserted into the slope.
- Excavate a trench in the channel along the toe of the slope to a depth below the anticipated scour line. The trench should be wide enough to accommodate 2 or 3 of the rocks. Dig an additional trench perpendicular to the slope at the upstream end of the structure to prevent the stream from cutting behind the rock.
- Place the filter fabric on the slope. Begin at the top of the slope at the downstream end of the structure. Secure the fabric in a small trench at the top of the slope (see Erosion Control Blankets) and unroll down the slope and into the toe trench. Work your way upstream, overlapping around 1 foot of the edges of adjacent pieces of fabric, to the trench at the upstream end of the structure. The filter fabric may not be needed if the slope does not experience the seepage of subsurface flows.
- Place the largest of the rocks in the toe trench. Work from one end of the structure to the other until the toe trench is full. Return to the beginning and place 1 to 2 rows of rock on the slope along the length of the structure. Return to the beginning and repeat. This requires a lot of movement by the heavy equipment, but allows for the planting crew to safely follow behind.
- After the heavy equipment has placed the rock in the toe trench and is a safe distance away, begin inserting the live pole cuttings into the spaces between the rocks and along the top of each 1 to 2 rows of rock. Use a heavy digging bar or rebar and a sledge hammer to puncture the filter fabric and create pilot holes for the live pole cuttings if necessary. Continue “chasing” the heavy equipment, inserting poles as deep into the slope as possible about every 2 to 3 feet until you are 2/3 of the way up the slope.
- Use the bucket of the heavy equipment, a 5 gal. bucket, or some other water source to water-down the completed vegetated riprap.

Figure 32: Vegetated Riprap installation detail.
Native Plant List for Yolo County

The following is a list of possible native plants that may be grown in Capay Valley and immediate vicinities. All the plants need full sun exposure and are perennial in growth habit unless otherwise stated in the Notes section. Several of the plants are horticultural cultivars of native plants and may be more readily available at local nurseries. All of these plants require summer irrigation during their establishment period.

Native Plants Common to Riparian Areas

Low Flow Channel Edge: This area is submerged or very wet for much of the year.

<table>
<thead>
<tr>
<th>Common name</th>
<th>Scientific name</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baltic rush</td>
<td><em>Juncus balticus</em></td>
<td>1’-3’ tall, full sun to partial shade. Flowers May-Aug.</td>
</tr>
<tr>
<td>Creeping wildrye</td>
<td><em>Leymus triticoides</em></td>
<td>2’-3’ tall, cool season, spreads by rhizomes.</td>
</tr>
<tr>
<td>Deergrass</td>
<td><em>Muhlenbergia rigens</em></td>
<td>1.5’-5’ tall, warm season bunchgrass, tolerates extreme conditions.</td>
</tr>
<tr>
<td>Flat-bladed rush</td>
<td><em>Juncus xiphioides</em></td>
<td>1.5’-3’ tall, full sun to partial shade. Flowers May-Oct. Spreads by rhizomes.</td>
</tr>
<tr>
<td>Santa Barbara sedge</td>
<td><em>Carex barbarae</em></td>
<td>1’-3’ tall, full sun to partial shade, clumping. Spreads by rhizomes.</td>
</tr>
<tr>
<td>Spikerush</td>
<td><em>Eleocharis macrostachya</em></td>
<td>1’-3’ tall, full sun to partial shade. Flowers May-Aug. Spreads by rhizomes.</td>
</tr>
<tr>
<td>Tufted hairgrass</td>
<td><em>Deschampsia cespitosa</em></td>
<td>To 3’ tall, 1’ wide, cool season, tufted grass. Full sun to partial shade.</td>
</tr>
<tr>
<td>Tules</td>
<td><em>Scirpus americanas</em></td>
<td>1’-3.5’ tall. Flowers May-Aug.</td>
</tr>
</tbody>
</table>

Lower (Hydrologic) Floodplain: This area floods when the streamflow exceeds the capacity of the baseflow channel.

Grasses, Sedges, Rushes

<table>
<thead>
<tr>
<th>Common name</th>
<th>Scientific name</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baltic rush</td>
<td><em>Juncus balticus</em></td>
<td>1’-3’ tall, full sun to partial shade. Flowers May-Aug.</td>
</tr>
<tr>
<td>Bent grass</td>
<td><em>Agrostis exarata</em></td>
<td>To 3.5’ tall, cool season grass with variable form. Establishes rapidly.</td>
</tr>
<tr>
<td>Clustered field sedge</td>
<td><em>Carex praegracilis</em></td>
<td>0.5’-2.5’ tall, full sun to partial shade.</td>
</tr>
<tr>
<td>Creeping wildrye</td>
<td><em>Leymus triticoides</em></td>
<td>2’-3’ tall, cool season, spreads by rhizomes.</td>
</tr>
<tr>
<td>Deergrass</td>
<td><em>Muhlenbergia rigens</em></td>
<td>1.5’-5’ tall, warm season bunchgrass, tolerates extreme conditions.</td>
</tr>
<tr>
<td>Flat-bladed rush</td>
<td><em>Juncus xiphioides</em></td>
<td>1.5’-3’ tall, full sun to partial shade. Flowers May-Oct. Spreads by rhizomes.</td>
</tr>
</tbody>
</table>
# Native Plant List for Yolo County

## Native Plants Common to Riparian Areas cont...

<table>
<thead>
<tr>
<th>Native Plants</th>
<th>Scientific Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meadow barley</td>
<td><em>Hordeum brachyantherum</em></td>
<td>1’ tall, cool season tufted bunchgrass. Prefers wet conditions and tolerates flooding. Tolerates partial shade.</td>
</tr>
<tr>
<td>Molate fescue</td>
<td><em>Festuca rubra var. molate</em></td>
<td>1’ to 2.5’ tall, loosely tufted, cool or warm season depending on water availability. Full sun to shade, spreads by rhizomes.</td>
</tr>
<tr>
<td>Salt grass</td>
<td><em>Distichlis spicata</em></td>
<td>To 1.5’ tall, spreading rhizomatous grass. Prefers alkaline soils.</td>
</tr>
<tr>
<td>Santa Barbara sedge</td>
<td><em>Carex barbara</em></td>
<td>1’-3’ tall, full sun to partial shade, clumping. Spreads by rhizomes.</td>
</tr>
<tr>
<td>Tufted Hairgrass</td>
<td><em>Deschampsia cespitosa</em></td>
<td>To 3’ tall, 1’ wide, cool season, tufted grass. Full sun to partial shade.</td>
</tr>
<tr>
<td>Yolo slender wheatgrass</td>
<td><em>Elymus trachycaulus</em></td>
<td>(ssp. trachycaulus) 1.5’-3’ tall, cool season bunchgrass, deep good soil. Tolerates light shade.</td>
</tr>
</tbody>
</table>

### Forbs

<table>
<thead>
<tr>
<th>Forb</th>
<th>Scientific Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Goldenrod</td>
<td><em>Solidago spp.</em></td>
<td>Most spp. to 4’ tall, nearly as wide, partial shade. Flowers July-Sept.</td>
</tr>
<tr>
<td>Mugwort</td>
<td><em>Artemisia douglasiana</em></td>
<td>3’-7’ tall, full sun to partial shade. Flowers June-Oct.</td>
</tr>
</tbody>
</table>

### Shrubs

<table>
<thead>
<tr>
<th>Shrub</th>
<th>Scientific Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brown dogwood</td>
<td><em>Cornus glabrata</em></td>
<td>4’-15’ tall, partial shade. Flowers May-Jul, deciduous.</td>
</tr>
<tr>
<td>California blackberry</td>
<td><em>Rubus ursinus</em></td>
<td>To 20’ tall and wide, full sun to partial shade. Flowers Jan-May. Evergreen.</td>
</tr>
<tr>
<td>California hibiscus</td>
<td><em>Hibiscus californicus</em></td>
<td>3’-6’ tall, full sun to partial shade. Flowers Aug-Sept.</td>
</tr>
<tr>
<td>Mulefat</td>
<td><em>Baccharis viminea</em></td>
<td>6’-10’ tall, 4’-6’ wide, full sun to partial shade, occassional summer water. Flowers Mar-May. Evergreen.</td>
</tr>
<tr>
<td>Snowberry</td>
<td><em>Symphoricarpos rivularis</em></td>
<td>To 6’ tall, partial to full shade. Flowers May-Jul. Deciduous. Toxic to humans.</td>
</tr>
</tbody>
</table>

### Trees

<table>
<thead>
<tr>
<th>Tree</th>
<th>Scientific Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buttonwillow</td>
<td><em>Cephalanthus occidentalis</em></td>
<td>(‘Californicus’) 3’-12’ tall and wide, full sun to partial shade. Flowers June-Sept. Deciduous.</td>
</tr>
<tr>
<td>California sycamore</td>
<td><em>Platanus racemosa</em></td>
<td>30’-80’ tall, 20’-50’ wide. Flowers Feb-Apr Deciduous.</td>
</tr>
<tr>
<td>Fremont cottonwood</td>
<td><em>Populus fremontii</em></td>
<td>40’-60’ tall, 30’ wide. Flowers Mar-Apr. Deciduous. Easy propagation from seed.</td>
</tr>
</tbody>
</table>
# Native Plant List for Yolo County

## Native Plants Common to Riparian Areas cont...

<table>
<thead>
<tr>
<th>Plant Name</th>
<th>Scientific Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oregon ash</td>
<td><em>Fraxinus latifolia</em></td>
<td>35’-80’ tall, full sun to partial shade. Flowers Mar-May, deciduous.</td>
</tr>
<tr>
<td>Red willow</td>
<td><em>Salix laevigata</em></td>
<td>20’-40’ tall. Flowers Mar-May, deciduous. Easy propagation from seeds and cuttings.</td>
</tr>
<tr>
<td>Shining willow</td>
<td><em>Salix lucida</em></td>
<td>To 35’ tall, deciduous. Easy propagation from seeds and cuttings.</td>
</tr>
<tr>
<td>Valley oak</td>
<td><em>Quercus lobata</em></td>
<td>60’-80’ tall and wide, flowers Mar-Apr. Deciduous, easy from seed.</td>
</tr>
<tr>
<td>White alder</td>
<td><em>Alnus rhomnifolia</em></td>
<td>50’-80’ tall, flowers Jan-Apr. Deciduous.</td>
</tr>
</tbody>
</table>

## Vines

<table>
<thead>
<tr>
<th>Plant Name</th>
<th>Scientific Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>California grape</td>
<td><em>Vitis californica</em></td>
<td>To 30’ tall, full sun to partial shade, drought tolerant. Flowers May-Jul. Deciduous.</td>
</tr>
<tr>
<td>Western clematis</td>
<td><em>Clematis ligusticifolia</em></td>
<td>To 40’ tall, full sun to partial shade. Flowers Mar-Apr. Deciduous.</td>
</tr>
</tbody>
</table>

## Upper (Topographic) Floodplain: This area floods when the streamflow exceeds the capacity of the stream channel.

## Grasses

<table>
<thead>
<tr>
<th>Plant Name</th>
<th>Scientific Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blue wildrye</td>
<td><em>Elymus glaucus</em></td>
<td>2’-3’ tall, cool season bunchgrass, deep, good soils. Establishes rapidly and re-seeds well.</td>
</tr>
<tr>
<td>California barley</td>
<td><em>Hordeum californicum</em></td>
<td>2’-4’ tall, cool season, tufted. Adapted to upland dry meadows and tolerates short duration floods. Tolerates partial shade.</td>
</tr>
<tr>
<td>California brome</td>
<td><em>Bromus carinatus</em></td>
<td>1.5’-3’ tall, cool season bunchgrass, deep soils.</td>
</tr>
<tr>
<td>California oniongrass</td>
<td><em>Melica californica</em></td>
<td>1’-2’ tall, cool season, tufted grass. Tolerates partial shade. Well–drained soils.</td>
</tr>
<tr>
<td>Creeping wildrye</td>
<td><em>Leymus triticoides</em></td>
<td>2’-3’ tall, cool season, spreads by rhizomes. Suited to riparian conditions.</td>
</tr>
<tr>
<td>Deergrass</td>
<td><em>Muhlenbergia rigens</em></td>
<td>1.5’-5’ tall, warm season bunchgrass. Tolerates extreme conditions.</td>
</tr>
<tr>
<td>Idaho fescue</td>
<td><em>Festuca idahoensis</em></td>
<td>1’-2’ tall, cool season, tufted, drought tolerant. Tolerates partial shade.</td>
</tr>
<tr>
<td>Meadow barley</td>
<td><em>Hordeum brachyantherum</em></td>
<td>1’ tall, cool season, tufted bunchgrass. Prefers wet conditions and tolerates flooding. Can take partial shade.</td>
</tr>
<tr>
<td>Nodding needlegrass</td>
<td><em>Nassella cernua</em></td>
<td>1’-2’ tall, cool season bunchgrass. Well-drained soils, drought tolerant.</td>
</tr>
</tbody>
</table>
## Native Plant List for Yolo County

### Native Plants Common to Riparian Areas cont...

<table>
<thead>
<tr>
<th>Plant Name</th>
<th>Scientific Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pine bluegrass</td>
<td><em>Poa secunda</em> spp. <em>secunda</em></td>
<td>2.5’ tall, cool season, tufted bunchgrass. Full sun to partial shade. Adapted to shallow soils.</td>
</tr>
<tr>
<td>Purple needlegrass</td>
<td><em>Nassella pulchra</em></td>
<td>1’-2’ tall, cool season bunchgrass. Drought tolerant, widely adapted.</td>
</tr>
<tr>
<td>Salt grass</td>
<td><em>Distichlis spicata</em></td>
<td>To 1.5’ tall, spreading rhizomatous grass. Prefers alkaline soils.</td>
</tr>
<tr>
<td>Yolo slender wheatgrass</td>
<td><em>Elymus trachycaulus</em></td>
<td>(ssp.trachycaulus) 1.5’-3’ tall, cool season bunchgrass, deep good soil. Tolerates light shade.</td>
</tr>
<tr>
<td>Forbs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mugwort</td>
<td><em>Artemisia douglasiana</em></td>
<td>3’-7’ tall, full sun to partial shade. Flowers Jun-Oct.</td>
</tr>
<tr>
<td>Shrubs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Blue blossom</td>
<td><em>Ceanothus thyrsiflorus</em></td>
<td>6’-20’ tall and wide, infrequent summer water, flowers Mar-May. Evergreen.</td>
</tr>
<tr>
<td>Buckbrush</td>
<td><em>Ceanothus cuneatus</em></td>
<td>8’ tall and wide, very drought tolerant, flowers Feb-Apr. Evergreen.</td>
</tr>
<tr>
<td>California blackberry</td>
<td><em>Rubus ursinus</em></td>
<td>To 20’ tall and wide, full sun to partial shade. Flowers Jan-May, evergreen.</td>
</tr>
<tr>
<td>California wild rose</td>
<td><em>Rosa californica</em></td>
<td>To 6’ tall and wide, full sun to shade, infrequent summer water. Flowers May-Nov, deciduous.</td>
</tr>
<tr>
<td>Elderberry</td>
<td><em>Sambucus mexicana</em></td>
<td>15’-20’ tall and wide, full sun to partial shade, tolerates some drought, flowers Apr-Nov. Deciduous. Protected plant due to association with the federally listed Valley Elderberry Longhorn Beetle.</td>
</tr>
<tr>
<td>Poison oak</td>
<td><em>Toxicodendron diversilobum</em></td>
<td>Shrub to 6.5’, vines to 100’, small tree to 15’. Full sun to partial shade, drought tolerant. Flowers Apr-May. Deciduous. Causes mild to severe rash on most humans.</td>
</tr>
<tr>
<td>Redbud</td>
<td><em>Cercis occidentalis</em></td>
<td>6’-20’ tall, 10’-15’ wide, full sun to partial shade, occasional summer water, flowers Feb-Apr. Deciduous.</td>
</tr>
<tr>
<td>Trees</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Box elder</td>
<td><em>Acer negundo</em>’<em>Californicum</em>’</td>
<td>40’-60’ tall and wide, full sun to partial shade. Flowers Mar-Apr. Deciduous. Propagation by seedling volunteers.</td>
</tr>
</tbody>
</table>
Native Plant List for Yolo County

Native Plants Common to Riparian Areas cont...

<table>
<thead>
<tr>
<th>Common Name</th>
<th>Scientific Name</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>California black walnut</td>
<td><em>Juglans californica</em> var. <em>hindsii</em></td>
<td>45’-75’ tall and wide, drought tolerant. Flowers Apr-May, deciduous.</td>
</tr>
<tr>
<td>California buckeye</td>
<td><em>Aesculus californica</em></td>
<td>10’-20’ tall, 30’ wide, summer deciduous. Flowers May-Jul. Toxic to humans, wildlife and livestock.</td>
</tr>
<tr>
<td>California sycamore</td>
<td><em>Platanus racemosa</em></td>
<td>30’-80’ tall, 20’-50’ wide. Flowers Feb-Apr, deciduous.</td>
</tr>
<tr>
<td>Coast live oak</td>
<td><em>Quercus agrifolia</em></td>
<td>30’-60’ tall and wide, full sun to partial shade, infrequent summer water. Flowers Mar-Apr. Evergreen. Easy propagation from seed.</td>
</tr>
<tr>
<td>Fremont cottonwood</td>
<td><em>Populus fremontii</em></td>
<td>40’-60’ tall, 30’ wide. Flowers Mar-Apr, deciduous. Easy propagation from seed.</td>
</tr>
<tr>
<td>Interior live oak</td>
<td><em>Quercus wislizenii</em></td>
<td>30’-70’ tall and wider, full sun to shade, occasional summer water. Flowers Mar-May, evergreen.</td>
</tr>
<tr>
<td>Valley oak</td>
<td><em>Quercus lobata</em></td>
<td>60’-80’ tall and wide, infrequent summer water. Flowers Mar-Apr. Deciduous. Can be propagated from seed.</td>
</tr>
</tbody>
</table>

Vines

<table>
<thead>
<tr>
<th>Common Name</th>
<th>Scientific Name</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>California grape</td>
<td><em>Vitis californica</em></td>
<td>To 30’ tall, full sun to partial shade, drought tolerant. Flowers May-Jul, deciduous.</td>
</tr>
<tr>
<td>Dutchman’s pipevine</td>
<td><em>Aristolochia californica</em></td>
<td>To 16’ tall, partial shade. Flowers Mar-Apr, deciduous.</td>
</tr>
</tbody>
</table>

Native Plants Common to Non-Riparian Areas

Mountains and Valley: Plants in this list are suited for growth in both foothill and mountain environments and the valley floor.

Grasses

<table>
<thead>
<tr>
<th>Common name</th>
<th>Scientific name</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Big Squirreltail</td>
<td><em>Elymus multisetus</em></td>
<td>To 2’ tall, tufted, cool season, bunchgrass. Well-drained soils. Re-seeds readily.</td>
</tr>
<tr>
<td>Blue wildrye</td>
<td><em>Elymus glaucus</em></td>
<td>2’-3’ tall, cool season bunchgrass, deep, good soils. Establishes rapidly and re-seeds well.</td>
</tr>
<tr>
<td>California barley</td>
<td><em>Hordeum californicum</em></td>
<td>2’-4’ tall, cool season, tufted. Adapted to upland dry meadows and tolerates short duration floods. Tolerates partial shade.</td>
</tr>
<tr>
<td>California brome</td>
<td><em>Bromus carinatus</em></td>
<td>1.5’-3’ tall, cool season bunchgrass, deep soils.</td>
</tr>
<tr>
<td>California oniongrass</td>
<td><em>Melica californica</em></td>
<td>1’-2’ tall, cool season, tufted, well-drained soils. Tolerates partial shade.</td>
</tr>
<tr>
<td>Creeping wildrye</td>
<td><em>Leymus triticoides</em></td>
<td>2’-3’ tall, cool season, spreads by rhizomes.</td>
</tr>
</tbody>
</table>
## Native Plant List for Yolo County

### Native Plants Common to Non-Riparian Areas cont...

<table>
<thead>
<tr>
<th>Plant Name</th>
<th>Scientific Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deergrass</td>
<td><em>Muhlenbergia rigens</em></td>
<td>1.5’-5’ tall, warm season bunchgrass, tolerates extreme conditions.</td>
</tr>
<tr>
<td>Foothill needlegrass</td>
<td><em>Nassella lepida</em></td>
<td>1’ to 3.5’ tall, tufted, cool season bunchgrass. Dry and disturbed sites, full sun to partial shade.</td>
</tr>
<tr>
<td>Idaho fescue</td>
<td><em>Festuca idahoensis</em></td>
<td>1’-2’ tall, cool season, tufted, drought tolerant. Tolerates partial shade.</td>
</tr>
<tr>
<td>Meadow barley</td>
<td><em>Hordeum brachyantherum</em></td>
<td>1’ tall, cool season, tufted bunchgrass. Prefers wet conditions and tolerates flooding. Can take partial shade.</td>
</tr>
<tr>
<td>Nodding needlegrass</td>
<td><em>Nassella cernua</em></td>
<td>1’-2’ tall, cool season bunchgrass. Well-drained soils, drought tolerant.</td>
</tr>
<tr>
<td>Pine bluegrass</td>
<td><em>Poa secunda ssp. secunda</em></td>
<td>2.5’ tall, cool season, tufted bunchgrass. Adapted to shallow soils. Full sun to partial shade.</td>
</tr>
<tr>
<td>Purple needlegrass</td>
<td><em>Nassella pulchra</em></td>
<td>1’-2’ tall, cool season bunchgrass. Drought tolerant, widely adapted.</td>
</tr>
<tr>
<td>Salt grass</td>
<td><em>Distichlis spicata</em></td>
<td>To 1.5’ tall, spreading rhizomatous grass. Prefers alkaline soils.</td>
</tr>
<tr>
<td>Small fescue</td>
<td><em>Vulpia microstachys</em></td>
<td>0.5-2’ tall, cool season, annual. Disturbed, sandy soils.</td>
</tr>
<tr>
<td>Three-awn</td>
<td><em>Aristida hamulosa</em></td>
<td>10” tall, warm season, clumping, drought tolerant.</td>
</tr>
<tr>
<td>Torrey melic</td>
<td><em>Melica torreyana</em></td>
<td>1’-3’ tall, cool season. Full sun to partial shade, dry, well-drained soils.</td>
</tr>
<tr>
<td>Yolo slender wheatgrass</td>
<td><em>Elymus trachycaulus</em></td>
<td>(spp. trachycaulus) 1.5’-3’ tall, cool season bunchgrass, deep good soil. Tolerates light shade.</td>
</tr>
</tbody>
</table>

### Forbs

<table>
<thead>
<tr>
<th>Plant Name</th>
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<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blow wives</td>
<td><em>Achyrachaena mollis</em></td>
<td>1”-15” tall, moist, grassy fields. Flowers Apr-May. Annual.</td>
</tr>
<tr>
<td>California buckwheat</td>
<td><em>Eriogonum fasciculatum</em></td>
<td>(var. foliolosum) 4’-5’ tall, 4’ wide, drought tolerant. Flowers May-Dec.</td>
</tr>
<tr>
<td>Chick lupine</td>
<td><em>Lupinus microcarpus</em></td>
<td>To 2.5’ tall, dry, well-drained soils. Flowers Apr-May. Annual.</td>
</tr>
<tr>
<td>Common yarrow</td>
<td><em>Achillea millefolium</em></td>
<td>3’ tall and spreading, drought tolerant. Flowers Apr-Jul.</td>
</tr>
<tr>
<td>Goldenbush</td>
<td><em>Ericameria linearifolia</em></td>
<td>To 5’ tall, dry, well-drained soils. Flowers in spring.</td>
</tr>
<tr>
<td>Indian milkweed</td>
<td><em>Asclepias eriocarpa</em></td>
<td>1’-3’ tall, dry, well-drained soils. Flowers Jun-Aug, toxic to some animals.</td>
</tr>
<tr>
<td>Ithurial’s spear</td>
<td><em>Triteleia laxa</em></td>
<td>0.5’-1.5’ tall, dry, well-drained soil. Flowers Apr-Jun.</td>
</tr>
</tbody>
</table>
### Native Plant List for Yolo County

#### Native Plants Common to Non-Riparian Areas cont...

<table>
<thead>
<tr>
<th>Plant Name</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Scarlet bugler</td>
<td><em>Penstemon centranthifolius</em></td>
<td>1’-4’ tall, dry, well-drained soils. Flowers Apr-Jun.</td>
</tr>
<tr>
<td>Slender clarkia</td>
<td><em>Clarkia gracilis</em></td>
<td>To 2.5’ tall, full sun to partial shade, tolerant of dry soils. Flowers late spring, early summer. Annual.</td>
</tr>
<tr>
<td>St. Catherine’s lace</td>
<td><em>Eriogonum giganteum</em></td>
<td>4’-5’ tall and spreading, drought tolerant. Flowers Jun-Nov.</td>
</tr>
<tr>
<td>Twining snake lily</td>
<td><em>Dichelostemma vilobule</em></td>
<td>3’-6’ twining stem, full sun to partial shade, dry, well-drained soils. Flowers Apr-June.</td>
</tr>
</tbody>
</table>

**Shrubs**

<table>
<thead>
<tr>
<th>Plant Name</th>
<th>Scientific Name</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Blue blossom</td>
<td><em>Ceanothus thyrsiflorus</em></td>
<td>6’-20’ tall and wide, infrequent summer water, flowers Mar-May. Evergreen.</td>
</tr>
<tr>
<td>Brewer saltbush</td>
<td><em>Atriplex lentiformis ssp. breweri</em></td>
<td>5’-7’ tall, 6’-8’ wide, occasional summer water. Flowers June-Aug. Deciduous. Plant in areas isolated from sugarbeet crops.</td>
</tr>
<tr>
<td>Buckbrush</td>
<td><em>Ceanothus cuneatus</em></td>
<td>8’ tall and wide, very drought tolerant, flowers Feb-Apr. Evergreen.</td>
</tr>
<tr>
<td>Chamise</td>
<td><em>Adenostoma fasciculatum</em></td>
<td>2’-12’ tall and nearly as wide, drought tolerant. Flowers Feb-July. Evergreen.</td>
</tr>
<tr>
<td>Coffeeberry</td>
<td><em>Rhamnus californica</em></td>
<td>3’-15’ tall, 8’ wide, full sun to partial shade, occasional summer water. Flowers Apr-May. Evergreen. Easy propagation from seed.</td>
</tr>
<tr>
<td>Elderberry</td>
<td><em>Sambucus mexicana</em></td>
<td>15’-20’ tall and wide, full sun to partial shade, tolerates some drought, flowers Apr-Nov. Deciduous. Protected plant due to association with the federally listed Valley Elderberry Longhorn Beetle.</td>
</tr>
<tr>
<td>Golden sticky monkeyflower</td>
<td><em>Mimulus aurantiacus</em></td>
<td>To 4.5’ tall and wide, full sun to partial shade. Occasional summer water, flowers Mar-Aug. Evergreen.</td>
</tr>
</tbody>
</table>
## Native Plant List for Yolo County

### Native Plants Common to Non-Riparian Areas cont...

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</tr>
</thead>
<tbody>
<tr>
<td>Manzanita</td>
<td><em>Arctostaphylos</em> spp.</td>
<td>Variable growth forms and heights, full sun to partial shade. Infrequent summer water, flowers in spring, early summer. Evergreen.</td>
</tr>
<tr>
<td>Poison oak</td>
<td><em>Toxicodendron diversilobum</em></td>
<td>Shrub to 6.5', vines to 100’, small tree to 15’. Full sun to partial shade, drought tolerant. Flowers Apr-May. Deciduous. Causes mild to severe rash on most humans.</td>
</tr>
<tr>
<td>Quail bush</td>
<td><em>Atriplex lentiformis</em></td>
<td>3’-10’ tall, 6’-12’ wide, occasional summer water. Flowers Jul-Oct. Deciduous. Plant in areas isolated from sugarbeet crops.</td>
</tr>
<tr>
<td>Redbud</td>
<td><em>Cercis occidentalis</em></td>
<td>6’-20’ tall, 10’-15’ wide, full sun to partial shade, occasional summer water, flowers Feb-Apr. Deciduous.</td>
</tr>
<tr>
<td>Sage</td>
<td><em>Salvia</em> spp.</td>
<td>Most spp. to 3’ tall and wide, infrequent summer water. Flowers early summer.</td>
</tr>
<tr>
<td>Toyon</td>
<td><em>Heteromeles arbutifolia</em></td>
<td>15’-20’ high and wide, occasional summer water, flowers May-Jun. Deciduous. Easy propagation from seed.</td>
</tr>
<tr>
<td>Treasure Island blue blossom</td>
<td><em>Ceanothus</em> ‘Ray Hartman’</td>
<td>8’-15’ tall, 10’-15’ wide, infrequent summer water, flowers Feb-Apr. Evergreen.</td>
</tr>
<tr>
<td>Yankee Point Carmel creeper</td>
<td><em>Ceanothus griseus horizontalis</em></td>
<td>(var. ‘Yankee Point’’) 3’-5’ tall, 6’-8’ wide, occasional summer water. Flowers Mar-May, evergreen.</td>
</tr>
</tbody>
</table>

### Trees

<table>
<thead>
<tr>
<th>Tree Name</th>
<th>Scientific Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blue oak</td>
<td><em>Quercus douglasii</em></td>
<td>30’-50’ tall, 40’-70’ wide, drought tolerant. Flowers Apr-May. Deciduous.</td>
</tr>
<tr>
<td>California black walnut</td>
<td><em>Juglans californica var. hindsii</em></td>
<td>45’-75’ tall and wide, drought tolerant. Flowers Apr-May. Deciduous.</td>
</tr>
<tr>
<td>California buckeye</td>
<td><em>Aesculus californica</em></td>
<td>10’-20’ tall, 30’ wide, summer deciduous. Flowers May-Jul. Toxic to humans, wildlife and livestock.</td>
</tr>
<tr>
<td>Coast live oak</td>
<td><em>Quercus agrifolia</em></td>
<td>30’-60’ tall and wide, full sun to partial shade, infrequent summer water. Flowers Mar-Apr. Evergreen. Easy propagation from seed.</td>
</tr>
<tr>
<td>Foothill pine</td>
<td><em>Pinus sabiniana</em></td>
<td>40’-80’ tall, 30’-50’ wide, drought tolerant. Evergreen.</td>
</tr>
<tr>
<td>Interior live oak</td>
<td><em>Quercus wislizenii</em></td>
<td>30’-70’ tall and wider, full sun to shade, occasional summer water. Flowers Mar-May. Evergreen.</td>
</tr>
</tbody>
</table>
Native Plant List for Yolo County

Native Plants Common to Non-Riparian Areas cont...

**Valley oak**  
*Quercus lobata*  
60’-80’ tall and wide, infrequent summer water. Flowers Mar-Apr. Deciduous. Can be propagated from seed.

**Mountains Only:** Plants in this list are only suited for growth in the foothills and mountains.

**Forbs**

- **Coyote mint**  
  *Monardella villosa*  
  9”-18” tall, full sun to partial shade, dry, well-drained soils. Flowers Jun-Aug.

- **Bricklebush**  
  *Brickellia californica*  
  1.5’-3.5’ tall, dry, well-drained soil. Flowers Jun-Nov.

- **Durango root**  
  *Datisca glomerata*  
  3’-6’ tall, dry, gravelly soils. Flowers May-Jul. All parts toxic.

- **Golden fairy lantern**  
  *Calochortus amabilis*  

- **Parish’s nightshade**  
  *Solanum parishii*  
  1.5’-3’ tall, dry, well-drained soils. Flowers Apr-Jul.

- **Pitcher sage**  
  *Lepechinia calycina*  
  2’-4’ tall, full sun to partial shade, drought tolerant. Flowers Apr-Jun.

**Shrubs**

- **California flannelbush**  
  *Fremontodendron californicum* (ssp. californicum) 6’-15’ tall, dry, well-drained soils. Flowers May-Jun. Evergreen

- **Fremont silk tassel**  
  *Garrya fremontii*  
  4’-10’ tall, well-drained soils. Flowers Jan-Apr, Evergreen.

- **Interior live oak, shrub form**  
  *Quercus wislizeni var. frutescens*  
  3’-8’ tall, well-drained soil. Flowers Apr-May. Evergreen.

- **Mountain mahogany**  
  *Cercocarpus betuloides*  

- **Scrub oak**  
  *Quercus berberidifolia*  

- **Skunk bush**  
  *Rhus trilobata*  
  3’-5’ tall to 8’ wide, well-drained soils. Flowers Mar-Apr. Deciduous.

- **Spice bush**  
  *Calycanthus occidentalis*  
  4’-12’ tall, full sun to partial shade, moist to wet soils. Flowers May-Jun. Deciduous.

**Trees**

- **Bigleaf maple**  
  *Acer macrophyllum*  
  30’-75’ tall, 30’-50’ wide, full sun to partial shade. Prefers moist soils. Flowers Apr-May. Deciduous.

- **California bay**  
  *Umbellularia californica*  
  20’-60’ tall, full sun to partial shade, prefers moist soils. Flowers Feb-Aug. Evergreen.

- **California black oak**  
  *Quercus kelloggii*  
  30’-80’ tall and wide, shade tolerant when young. Occasional summer water; flowers Apr-May. Deciduous.
## Native Plant List for Yolo County

### Native Plants Common to Non-Riparian Areas cont...

<table>
<thead>
<tr>
<th>Native Plant</th>
<th>Scientific Name</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>California juniper</td>
<td><em>Juniperus californica</em></td>
<td>Shrub to 15’ tall, tree to 40’ tall, dry, well-drained soils. Evergreen.</td>
</tr>
<tr>
<td>Canyon live oak</td>
<td><em>Quercus chrysolepis</em></td>
<td>20’-60’ tall and wide, full sun to partial shade. Drought tolerant, flowers Apr-May. Evergreen.</td>
</tr>
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### Vines

<table>
<thead>
<tr>
<th>Native Plant</th>
<th>Scientific Name</th>
<th>Characteristics</th>
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</table>

### References


Plant Materials Sources

Local Nurseries

Belless Organic Nursery
Solomon Teklu
2657 Portage Bay East
Davis, CA 95616
phone: (530) 753-9400
fax: none
email: none
website: none

Bitterroot Restoration
11760 Atwood Road, Suite 5
Auburn, CA 95603
phone: (530) 745-9814
fax: (530) 745-9817
email: bri@bitterrootrestoration.com
website: www.bitterrootrestoration.com

Cache Creek Nursery
Frances Burke
P.O. Box 85
Rumsey, CA 95679
phone: (530) 796-3521
fax: (530) 796-3521
email: cachecreeknursery@yolo.com
website: none

CCC Napa Native Plant Nursery
P.O. Box 7199
Napa, CA 94588
phone: (707) 253-7783
fax: (707) 253-1421
email: chriss@ccc.ca.gov
website: none

CDF L.A. Moran Reforestation Center
P.O. Box 1590
Davis, CA 95617
phone: (530) 753-2441
fax: none
email: none
website: none

Cornflower Farms
P.O. Box 896
Elk Grove, CA 95759
phone: (916) 689-1015
fax: (916) 689-1968
email: natives@cornflowerfarms.com
website: www.cornflowerfarms.com

Redwood Barn Nursery
1607 Fifth St.
Davis, CA 95616
phone: (530) 758-2276
fax: (530) 758-0912
email: none
website: www.redwoodbarn.com

Three Palms Nursery
26990 County Road 95A
Davis, CA 95616
phone: (530) 756-8355
fax: none
email: none
website: none

North Coast Native Nursery
David Kaplow
P.O. Box 744
Petaluma, CA 94953
phone: (707) 769-1213
fax: (707) 769-1230
email: nursery@northcoastnursery.com
website: www.northcoastnativenuery.com

Seed Suppliers

ConservaSeed
P.O. Box 1069
Walnut Grove, CA 95690
phone: (916) 776-1200
fax: (916) 776-1112
email: info@conservaseed.com
website: www.conservaseed.com

Pacific Coast Seed
6144 Industrial Way, Building A
Livermore, CA 94550
phone: (800) 733-3462
fax: (925) 373-6855
email: pcseed@attglobal.net
website: none

S & S Seeds
P.O. Box 1275
Carpenteria, CA 93014
phone: (805) 684-0436
fax: (805) 684-2798
email: info@ssseeds.com
website: www.ssseeds.com

Lohse Mills
P.O. Box 168
Artois, CA 95913
phone: (530) 934-2157
fax: (530) 934-9106
email: none
website: none

Ramsey Seed
205 Stockton St.
Manteca, CA 95336
Tel: (800) 325-4621
fax: (209) 823-2582
email: none
website: none
## Vendors & Suppliers

### Erosion Control & Planting Products

<table>
<thead>
<tr>
<th>Name</th>
<th>Address</th>
<th>Phone</th>
<th>Fax</th>
<th>Email</th>
<th>Website</th>
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<tbody>
<tr>
<td>Blue-X Tree Shelters</td>
<td>Ron Motz, P.O. Box 2128, Elk Grove, CA 95759</td>
<td>(888) 47-BLUEX</td>
<td>(916) 689-0902</td>
<td><a href="mailto:tubemaster@growtube.com">tubemaster@growtube.com</a></td>
<td><a href="http://www.growtube.com">www.growtube.com</a></td>
</tr>
<tr>
<td>California Straw Works</td>
<td>5331 State Ave., Sacramento, CA 95810</td>
<td>(916) 453-1456</td>
<td>(916) 689-1968</td>
<td><a href="mailto:info@strawwattles.com">info@strawwattles.com</a></td>
<td><a href="http://www.strawwattles.com">www.strawwattles.com</a></td>
</tr>
<tr>
<td>Cornflower Farms</td>
<td>P.O. Box 896, Elk Grove, CA 95759</td>
<td>(916) 689-1015</td>
<td></td>
<td><a href="mailto:natives@cornflowerfarms.com">natives@cornflowerfarms.com</a></td>
<td><a href="http://www.cornflowerfarms.com">www.cornflowerfarms.com</a></td>
</tr>
<tr>
<td>Earthsaver Erosion Control Products</td>
<td>R.H. Dyck, Inc., P.O. Box 665, Winters, CA 95694</td>
<td>(866) WATTLES</td>
<td>(530) 795-3972</td>
<td>see website</td>
<td><a href="http://www.earth-savers.com">www.earth-savers.com</a></td>
</tr>
<tr>
<td>Reed &amp; Graham, Inc.</td>
<td>26 Lightsky Court, Sacramento, CA 95826</td>
<td>(916) 454-2560</td>
<td></td>
<td><a href="mailto:sales@rginc.com">sales@rginc.com</a></td>
<td><a href="http://www.rginc.com">www.rginc.com</a></td>
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### Irrigation Supplies

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<tr>
<td>Irrigation Supply Company</td>
<td>217 W. Kentucky Ave., Woodland, CA 95695</td>
<td>(530) 666-5925</td>
<td>(530) 666-4311</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>Rain for Rent</td>
<td>390 W. Kentucky Ave., Woodland, CA 95695</td>
<td>(530) 662-1024</td>
<td>(530) 662-1030</td>
<td>none</td>
<td><a href="http://www.rainforrent.com">www.rainforrent.com</a></td>
</tr>
</tbody>
</table>
Cost-Share Programs

The following is a list of USDA-NRCS and other cost-share programs available to landowners, farmers and ranchers.

**U.S.D.A Farm Service Agency (FSA) & Natural Resources Conservation Service (NRCS)**

**ENVIRONMENTAL QUALITY INCENTIVES PROGRAM (EQIP)**

The purpose of the Environmental Quality Incentives Program (EQIP) is to promote environmental quality and agricultural production. Cost share payment incentives of up to 75% are offered to farmers and ranchers to install conservation practices on their land. Some of the practices available for cost share are fencing, irrigation water management, tree and shrub planting, pond establishment, nutrient management, and hedgerow establishment. EQIP is a competitive program based on environmental points earned from the planned practices. Landowners may enter into contracts of up to ten years, with a one-year minimum. There is a $450,000 cost limit per individual over the lifetime of the 2002 Farm Bill. For more information, contact your local NRCS field office at (530) 662-2037 ext. 3.

**WILDLIFE HABITAT INCENTIVES PROGRAM (WHIP)**

Under the Wildlife Habitat Incentives Program (WHIP) wildlife habitat is developed or improved on the private land of cooperating owners. This voluntary program cost shares up to 75% for landowners wanting to establish upland, wetland, riparian, or aquatic habitats on their property. Contracts typically span five to ten years. Shorter agreements may be offered in the case of a wildlife emergency. Greater cost share percentages are given to those wishing to enter into agreements of more than fifteen years. There is a $50,000 contract cost limit. For more information, contact your local NRCS field office at (530) 662-2037 ext. 3.

**EMERGENCY WATERSHED PROGRAM (EWP)**

The objective of EWP is to assist sponsors and individuals in implementing emergency measures to relieve urgent hazards to life and property, caused by natural disasters. Aid provided through EWP may include financial and technical assistance in removing debris from streams, protecting destabilized streambanks, the establishment of cover on critically eroded lands, and the purchase of floodplain easements. For this program NRCS provides up to 75% of the funds needed, the community or a local sponsor pays the remaining 25%. For more information, contact your local NRCS field office at (530) 662-2037 ext. 3.

**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.
Cost-Share Programs

The following is a list of USDA-NRCS and other cost-share programs available to landowners, farmers and ranchers cont...

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 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 (DFG)

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.
Permits and Regulations

Acronyms

<table>
<thead>
<tr>
<th>ACOE</th>
<th>Army Corps of Engineers</th>
<th>NPDES</th>
<th>National Pollution Discharge Elimination System</th>
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<tr>
<td>CEQA</td>
<td>California Environmental Quality Act</td>
<td>NRCS</td>
<td>Natural Resource Conservation Service</td>
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<td>California Endangered Species Act</td>
<td>RWQCB</td>
<td>Regional Water Quality Control Board</td>
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<td>CWA</td>
<td>Clean Water Act</td>
<td>SAA</td>
<td>Streambed Aleration Agreement</td>
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<td>DFG</td>
<td>California Department of Fish and Game</td>
<td>SWRCB</td>
<td>State Water Resources Control Board</td>
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<td>DWR</td>
<td>Department of Water Resources</td>
<td>TMDL</td>
<td>Total Maximum Daily Load</td>
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<td>EIS</td>
<td>Environmental Impact Statement</td>
<td>UCCE</td>
<td>University of California Cooperative Extension</td>
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<tr>
<td>EPA</td>
<td>U.S. Environmental Protection Agency</td>
<td>USBR</td>
<td>U.S. Bureau of Reclamation</td>
</tr>
<tr>
<td>HCP</td>
<td>Habitat Conservation Plan</td>
<td>USFS</td>
<td>U.S. Forest Service</td>
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<td>NHPA</td>
<td>National Historic Preservation Act</td>
<td>USFWS</td>
<td>U.S. Fish and Wildlife Service</td>
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</tbody>
</table>

Description of Permits and Regulations

Introduction

Several of the practices in this manual, when implemented, will require you to adhere to Federal and State laws and regulations, even if the work is being done on private land. Many of these laws and regulations were developed in response to public demand that natural resources and wildlife be protected from industries, agencies, and individuals who, through their actions, either intentionally or unintentionally damage or degrade those natural resources and directly or indirectly harm or kill wildlife to the point of extinction. The evolution and drafting of these laws, often referred to as “environmental” laws, took many years and in some cases decades to complete.

The recent proliferation of individuals and citizen’s groups seeking to improve natural resources and wildlife habitat has created some confusion over the intent and enforcement of many of these environmental laws. It is no wonder that these well-meaning individuals and citizen’s groups are frustrated when they have to go through the permitting process. However, even those with the best of intentions can make mistakes, whether it is a result of poor planning or implementation of a project, or just a lack of knowledge. That is why environmental laws apply to everyone, regardless of the nature or intent of their proposed actions.

The regulatory agencies, and especially the people who work for them, recognize and encourage projects that seek to improve the environment. In most cases agency representatives will work with individuals and citizen’s groups to see that well planned projects are implemented and that the environment is truly improved and protected. It is their job to see that projects comply with the environmental laws and they typically would rather work with you rather than against you.

Below you find a listing of all applicable federal and state regulations regarding everything from the preservation of historic sites to the protection of waterways. The descriptions should give you a sense of the reasons behind the law, how it applies to your project, what steps you have to take to comply with regulations, and who is the local contact.

Federal Regulatory Requirements

The following laws, regulations, and policies that govern work within riparian and wetland systems are described in this section:

- National Environmental Policy Act
- Clean Water Act, Section 404
- Clean Water Act, Section 401
- Rivers and Harbors Act, Section 10
- Endangered Species Act, Section 7
- Endangered Species Act, Section 10
- National Historic Preservation Act, Section 106
Permits and Regulations

Description of Permits and Regulations cont...

NATIONAL ENVIRONMENTAL POLICY ACT (NEPA)

The National Environmental Policy Act (NEPA) is the basic charter for environmental protection. NEPA was initiated in response to an overwhelming national sentiment that federal agencies should take the lead in protecting the environment. The specific purposes of NEPA as stated in the statute are:

- to declare a national policy that will encourage productive and enjoyable harmony between humans and their environment,
- to promote efforts that will prevent or eliminate damage to the environment and biosphere and stimulate human health and welfare,
- to enrich the understanding of the ecological systems and natural resources important to the nation, and
- to establish a Council on Environmental Quality.

When a federal agency intends to carry out, fund, or approve a proposed project, it must first determine whether NEPA applies. NEPA applies to any action that requires permits, entitlement, or funding from a federal agency; is jointly undertaken with a federal agency; or is proposed on federal land. If NEPA applies, then an environmental assessment is prepared to determine whether the proposed project may have significant effects on the human environment. A finding of no significant impact is prepared if the federal agency determines that no significant impacts would occur from the proposed project. If the proposed project may significantly affect the quality of the human environment, and environmental impact statement is prepared. NEPA requires that an environmental impact statement consider, disclose, and discuss all major points of view on the environmental impacts of a proposed project and alternatives. NEPA requires every federal agency to disclose the environmental effects of its actions for public review purposes and for assisting the federal agency in assessing alternatives to and the consequences of the proposed project. Individuals and citizen’s groups will rely on the federal agency they are funded by or working with to act as the lead agency for NEPA compliance.

CLEAN WATER ACT (CWA), SECTION 404

Activities that result in discharge of dredged or fill material into waters of the United States are regulated by the U.S. Environmental Protection Agency (EPA) and the U.S. Army Corps of Engineers (ACOE) under Section 404 of the Clean Water Act. The Clean Water Act is primarily intended to authorize the EPA to regulate water quality through restriction of pollution discharges. In administering Section 404, the EPA has an oversight role over ACOE’s primary authority to regulate discharges of dredged or fill material into waters of the United States. Discharges of dredged or fill material, including placement of structures, into waters of the United States, including wetlands, generally require a permit from ACOE. ACOE may issue an individual permit or a general permit on a case-by-case basis. A nationwide permit is a type of general permit issued by ACOE, with minimal administrative processing that authorizes certain activities that will result in minimal impacts on waters of the United States. Implementation of restoration activities may be covered under Nationwide Permit 27, which includes activities in waters of the United States that are associated with the enhancement of degraded wetlands and riparian areas on nonfederal public land.

Waters of the United States include, but are not limited to, perennial and intermittent streams, lakes, ponds, and wetlands such as marshes, seasonal wetlands, and vernal pools. Once a proposed project has been selected, a wetland delineation must be prepared and submitted to USACE for verification. The verified delineation will determine the boundaries of jurisdictional waters of the United States, including wetlands, on the project site that would be affected by project implementation. If all or part of the project is on agricultural land (i.e., cropland, hayland, pastureland, rangeland, orchards, and vineyards), the wetland delineation may also need to be submitted to the Natural Resources Conservation Service for review and verification.

Contact: Justin Cutler, Regulatory Branch of the U.S. Army Corps of Engineers, 1325 J Street, Sacramento, CA. Phone: (916) 557-5250.
Permits and Regulations

Description of Permits and Regulations cont...

CLEAN WATER ACT (CWA), SECTION 401

If a proposed project involves a federal permit that may affect state water quality and the project would result in a discharge of a pollutant into waters of the United States, compliance with Section 401 of the Clean Water Act is required. Section 401 of the Clean Water Act requires that the discharge of dredged or fill material into waters of the United States, including wetlands, does not violate state water quality standards. Discharges may result from construction activities, grading, filling of wetlands, or dredging.

For a Section 404 permit issued by the ACOE to be valid, the EPA or authorized state agency must issue water quality certification as a general condition for authorization of the project. In California, the authority to either grant water quality certification the requirement for certification has been delegated to the State Water Resources Control Board (SWRCB). The Regional Water Quality Control Boards (RWQCB) typically process the requests for 401 certification. If the ACOE determines that the project does not require a permit, 401 certification is not necessary.

Water quality certification requires the evaluation of impacts with respect to water quality standards and criteria from discharge of dredged or fill material into waters of the United States. For Yolo County, the application for certification would be made directly to the Central Valley RWQCB. The Central Valley RWQCB will require evidence of CEQA compliance and a streambed alteration agreement (described below) from the California Department of Fish and Game (DFG) prior to completing the 401 certification or waiver process. The Central Valley RWQCB will require a processing fee to process the 401 certification request; the fee amount will depend on the type of processing required and the acreage of waters of the U.S. affected by the project.

Contact: Pat Gillum, Central Valley Regional Water Quality Control Board, 3443 Routier, Suite A, Sacramento, CA 95827. Telephone: (916) 255-3397.

ENDANGERED SPECIES ACT (ESA), SECTION 7

Section 7 of the federal Endangered Species Act (ESA) directs all federal agencies to use their existing authorities to conserve threatened and endangered species and, in consultation with the U.S. Fish and Wildlife Service (USFWS), to ensure that their actions do not jeopardize listed species or destroy or adversely modify critical habitat. Section 7 applies to management of federal lands as well as other federal actions that may affect listed species such as federal approval of private activities through the issuance of federal permits, licenses, or other actions.

ENDANGERED SPECIES ACT (ESA), SECTION 10

Private landowners who wish to conduct activities on their land that might incidentally harm or “take” a federally listed as threatened or endangered species must obtain an Incidental Take Permit from the U.S. Fish and Wildlife Service (USFWS) under Section 10 of the federal ESA. Take is defined under the federal Endangered Species Act as any activity that would harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect any threatened or endangered species. Harm may include significant habitat modification where the modification results in killing or injuring a listed species through impairment of essential behavior (e.g., nesting or reproduction).

A Habitat Conservation Plan (HCP) must accompany an application for an incidental take permit. The purpose of the habitat conservation planning process is to ensure there is adequate minimizing and mitigating of the effects authorized incidental take. The purpose of the incidental take permit is to authorize the incidental take of a listed species, not to authorize the activities that result in take.

Anyone who believes that their otherwise lawful activities will result in incidental take of a listed species needs a permit. The USFWS can help determine if the proposed project is likely to result in take and whether a HCP is an option. USFWS personnel can also provide technical assistance to help design the project to avoid take. The permit allows a landowner to legally proceed with a project that would otherwise result in the illegal take of a listed species.

Permits and Regulations

Description of Permits and Regulations cont...

NATIONAL HISTORIC PRESERVATION ACT (NHPA), SECTION 106

Section 106 of the National Historic Preservation Act (NHPA) requires federal agencies with jurisdiction over a federally funded, federally assisted, or federally licensed undertaking to account for effects of the agencies’ undertaking on properties listed or eligible for listing in the National Register of Historic Places (NRHP). Issuance of a USACE permit under Section 404 requires compliance with Section 106 of the NHPA before the permit is issued.

For compliance with Section 106 of the NHPA, the lead federal agency is required to 1) identify historical or archaeological properties near proposed project sites, including properties listed on the NRHP and those properties that the agency and the State Historic Preservation Officer agree are eligible for listing on the NRHP, and 2) if the project is determined to have an adverse effect on NRHP-listed properties or those eligible for listing on the NRHP, to consult with the State Historic Preservation Officer and the Advisory Council on Historic Preservation to develop alternatives or mitigation measures to allow the project to proceed.

Specific regulations for compliance with Section 106 state that, although the tasks necessary to comply with Section 106 may be delegated to others, the federal agency is ultimately responsible for ensuring that the Section 106 process is completed according to statutes.

State Regulatory Requirements

State regulatory requirements are in place both to safeguard the biological values of wetland and riverine resources and to protect public safety and flood control facilities with wetlands and riverine habitats. The following state regulations that govern work within wetland and riverine systems are described in this section:

- California Environmental Quality Act;
- California Department of Fish and Game, Streambed Alteration Agreement;
- California Department of Fish and Game, Endangered Species Act (Section 2090);
- California Department of Fish and Game, Section 2081;
- California Environmental Quality Act (CEQA)

The California Environmental Quality Act (CEQA) establishes policies to encourage the protection of the environment in California. CEQA applies to discretionary projects that have the potential to affect the environment and that are proposed to be carried out, funded, or approved by a California public agency (unless a CEQA exemption applies such as a statutory or categorical exemption). CEQA requires that the implications of the project be assessed including potential significant environmental effects and feasible mitigation measures designed to avoid or minimize the impacts addressed.

Once the final project design has been determined, the initial study checklist is prepared and will be used to prepare an initial study. Under CEQA, an initial study is generally prepared to determine whether the proposed project has the potential to cause significant adverse environmental effects. An initial study includes a project description, the environmental setting, potential environmental impacts, mitigation measures for any significant effects, and a discussion of consistency with plans and policies.

If, after preparing the initial study, the lead agency determines that there is no substantial evidence that the project may cause a significant effect on the environment, it must prepare a negative declaration. If the lead agency determines that there is substantial evidence that any aspect of the project, either individually or cumulatively, may cause a significant effect on the environment, the lead agency must either prepare an Environmental Impact Report (EIR), use a previously prepared EIR that adequately analyzes the project at hand, or use one of CEQA's allowable tiering methods to determine which of the project’s effects have been adequately examined in an earlier EIR or negative declaration. EIR contents include a project description, environmental setting, a discussion of significant environmental impacts, areas of known controversy, a reasonable range of project alternatives, and feasible mitigation measures to avoid or minimize significant environmental effects.

Contact: Terry Roscoe, California Department of Fish and Game, Sacramento Valley and Central Sierra Region, 1701 Nimbus Road, Suite A, Rancho Cordova, CA. Telephone: (916) 358-2382.
Permits and Regulations

Description of Permits and Regulations cont...

CALIFORNIA DEPT. OF FISH AND GAME (DFG), STREAMBED ALTERATION AGREEMENT

The California Department of Fish and Game (DFG) has jurisdictional authority over wetland resources associated with rivers, streams, and lakes under California Fish and Game Code Sections 1600-1607. DFG has the authority to regulate all work that substantially diverts, obstructs, or changes the natural flow of a river stream, or lake; substantially changes the bed, channel, or bank of a river, stream, or lake; or uses the material from a streambed. Private applicant’s actions are regulated under Section 1603. Federal agencies are regulated under Section 1601.

In practice, DFG defines its jurisdictional limit from the bed of the stream or lake to the top of the stream or lake bank, the outer edge of riparian vegetation, or the edge of the 100-year floodplain. Jurisdictional boundaries under Section 1600 et seq. may encompass an area greater than under Section 404 of the Clean Water Act.

The streambed alteration agreement is not a permit, but rather a mutual agreement between DFG and the project applicant. To initiate negotiations for a Section 1603 streambed alteration agreement, a Notification of Lake or Streambed Alteration (FG 2023) and Project Questionnaire (FG 2024) must be submitted. The application package will require the following information: project features; construction period; construction methods; impacts on vegetation, fish, and wildlife; and any proposed monitoring plan. Evidence of CEQA compliance is required before submitting an application. The project applicant will be required to pay an application fee to DFG; the fee is based on the cost of the project.

Contact: Dale Watkins, Environmental Specialist III, California Department of Fish and Game, Sacramento Valley and Central Sierra Region, 1701 Nimbus Road, Suite A, Rancho Cordova, CA. Telephone: (916) 358-2842.

CALIFORNIA DEPT. OF FISH AND GAME, CALIFORNIA ENDANGERED SPECIES ACT (SECTION 2090)

DFG is responsible for the protection and conservation of fish and wildlife resources in California. Under the California Endangered Species Act of 1984 (CESA), DFG is responsible for ensuring that projects do not adversely affect species listed as threatened or endangered under CESA. The current framework for California endangered species protection was established by CESA, which prohibits the “take” of plant and animal species designated by the California Fish and Game Commission as either endangered or threatened. Take includes hunting, pursuing, catching, capturing, killing, or attempting such activity.

CESA encourages the CEQA lead agency to consult with DFG in preparing CEQA documents to ensure that the project is not likely to jeopardize the continued existence of any listed species or their essential habitat. Additionally, as a trustee agency for the state’s natural resources, DFG reviews all CEQA documents for actions that could affect the state’s resources. Under the CESA, DFG’s responsibilities are to consult formally with state agencies acting as lead agencies within the CEQA process. The act also provides DFG with administrative responsibilities over the plant and wildlife species listed under the state act as threatened of endangered.

Contact: Dale Watkins, Environmental Specialist III, California Department of Fish and Game, Sacramento Valley and Central Sierra Region, 1701 Nimbus Road, Suite A, Rancho Cordova, CA. Telephone: (916) 358-2842.

CALIFORNIA DEPT. OF FISH AND GAME, CALIFORNIA ENDANGERED SPECIES ACT (SECTION 2081)

Compliance with Section 2081 of the California Fish and Game Code is required if a species in the project area is listed as a candidate, threatened, or endangered under CESA and project actions may result in the “take” of a species listed under CESA. The project applicant must submit all permit materials for review by DFG. The permit application requires the applicant to provide a complete project description, an analysis of whether and to what extent the project could result in take, impacts of the proposed taking, and whether the issuance of a permit would jeopardize the continued existence of the species. Measures to minimize and mitigate impacts of the project and a plan to monitor compliance and effectiveness of the mitigation measures are required in the permit application. Evidence of CEQA compliance is required before submitting an application.

Contact: Dale Watkins, Environmental Specialist III, California Department of Fish and Game, Sacramento Valley and Central Sierra Region, 1701 Nimbus Road, Suite A, Rancho Cordova, CA. Telephone: (916) 358-2842.
Glossary


Aggradation
To fill and raise the level of the bed of a stream by deposition of sediment.

Alluvial
Referring to deposits of silts, sands, gravels and similar detrital material which have been transported by running water.

Bank
The lateral boundary of a stream confining water flow; the bank on the left side of a channel looking downstream is called the left bank, etc.

Bankfull discharge
The discharge corresponding to the stage at which the natural channel is full.

Bar
An elongated deposit of alluvium within a channel or across its mouth.

Base flow
The flow contribution to a creek by groundwater. During dry periods, base flow constitutes the majority of stream flow.

Bed load
Sediment that moves by rolling, sliding, or skipping along the bed and is essentially in contact with the stream bed.

Bench
A horizontal surface or step in a slope.

Bioengineering
The integration of living woody and herbaceous materials along with organic and inorganic materials to increase the strength and structure of soil.

Braided stream
A stream in which flow is divided at normal stage by small islands. This type of stream has the aspect of a single large channel with which there are subordinate channels.

Canopy
The overhead branches and leaves of vegetation.

Coir
A woven mat of coconut fibers, used for soil erosion control applications.

Community (Plant)
A particular assembling of plant species reflecting the prevailing environment, soil type and management.

Concentrated flow
Flowing water that has been accumulated into a single, fairly narrow stream.

Cutting
A branch or stem pruned from a living plant.

Dead stout stake
A 2x4 timber that has been cut into a specific shape and length—usually cut diagonally.

Degradation
The process by which stream beds lower in elevation; the opposite of aggradation.

Deposition
The settlement of material out of water.

Ecotype
A naturally occurring variant of a species that is adapted to a particular set of ecological or environmental conditions.

Ephemeral
Of brief duration, as the flow of a stream in an arid region.

Erosion
Removal of surface soils and rocks by action of water, wind, frost, ice and extreme sun/heat; internal erosion leads to change of the earth structure and piping; closed vegetation is the best safeguard against erosion.

Erosion and accretion
Loss and gain of land, respectively, by the gradual action of a stream in shifting its channel by cutting one bank while it builds on the opposite bank; property is lost by erosion and gained by accretion.
Erosion control

Vegetation, such as grasses and wildflowers, and other materials such as straw, fiber, stabilizing emulsion, protective blankets, etc., placed to stabilize areas disturbed by grading operations, reduce loss of soil due to the action of water or wind, and prevent water pollution.

Establishment period

1. The time between sowing of the seed and the stage at which the plant is no longer reliant on the nutrient supply in the seed; 2. The time between planting and the stage at which special care is not required to ensure that all parts of the plant are functioning normally.

Filter fabric

An engineering fabric placed between the backfill and supporting or underlying soil through which water will pass and soil particles are retained.

Fluvial geomorphology

The study of land forms created by and pertaining to the fluvial process.

Forbs

Broadleaved herbaceous plants such as wildflowers.

Geotextile

Synthetic or natural permeable fabric used in conjunction with soil and vegetation; principally for erosion control, filtration, separation, soil reinforcement and drainage.

Gradient (slope)

The rate of ascent or descent expressed as a percent or as a decimal as determined by the ratio of the change in elevation to the length.

Gully

A steep-sided erosion feature formed by downslope water action; unstable and recently extended drainage channel that transmits ephemeral flow, has steep sides, a steep head scarp and width greater than 1 foot, depth greater than 2 feet; enlarges by bed scour, by head migration upslope and by side collapse.

Headcutting

The cutting of the streambed to a lower elevation; progressive scouring and degrading of a streambed at a relatively rapid rate in the upstream directions, usually characterized by one or a series of vertical falls.

Herbaceous plants

Non-woody vegetation

Hydrograph

A graph showing stage, flow, velocity, or other property of water with respect to time.

Hydroseeding

The rapid application of seeds, filler, mulch, soil ameliorants and fertilizers in water suspension onto an area where, for reasons of access, speed of application or ground condition, conventional grass seeding techniques cannot be used.

Incised channel

Those channels which have been cut relatively deep into underlying formations by natural processes; characteristics include relatively straight alignment and high, steep banks such that overflow rarely occurs, if ever.

Infiltration

The passage of water through the soil surface into the ground.

Inoculation

Method of artificially infecting shrubs and trees or herbaceous legumes with, respectively, mycorrhizae or rhizobium bacteria that normally live in symbiosis with them.

Legumes

Herbs, shrubs, and trees of the pulse family, that serve as nitrogen gatherers because of a specific root-clad bacteria; good soil improvers; many form specially strong and deep-reaching roots and are good ground stabilizers; an important part of seed mixes.

Live branch cuttings

Living, freshly cut branches of woody shrub and tree species that propagate from cuttings embedded in the soil.

Live fascines

Bound, elongated sausage-like bundles of live cut branches that are placed in shallow trenches, partly covered with soil, and staked in place to arrest soil erosion and shallow mass wasting.
Live pole planting  Ground bioengineering technique comprising the installation by driving or insertion into predrilled holes, of long live stakes, rods or poles of 1-2.5 meter length of cottonwood or willow (or any plant which propagates from cuttings) at close centers for slope stabilization purposes as a form of live soil nailing.

Live stake  Cuttings from living branches that are tamped or inserted into the earth; the stakes eventually root and leaf out.

Mass movement (or Mass wasting)  The movement of large, relatively intact masses of earth and/or rock along a well-defined shearing surface as a result of gravity and seepage.

Meander  In connection with streams, a winding channel usually in an erodible, alluvial valley; a reverse or S-shaped curve or series of curves formed by erosion of the concave bank, especially at the downstream end, characterized by curved flow and alternating shoals and bank erosions; meandering is a stage in the migratory movement of the channel, as a whole, down the valley.

Mulch  A natural or artificial layer of plant residue or other material that covers the land surface and conserves moisture, holds soil in place, aids in establishing vegetation, and reduces temperature fluctuations.

Nonpoint source pollution  Pollution that originates from many diffuse sources.

Ordinary high water mark  The line on the shore established by the fluctuation of water and physically indicated on the bank (1.5+ years return period)

Peak flow  Maximum momentary stage or discharge of a stream.

Perennial  Term for plants which grow and reproduce for many years.

Permeability  The property of soils which permits the passage of any fluid; permeability depends on grain size, void ratio, shape and arrangement of pores.

Piping  Flow of water through subsurface conduits in the soil.

Poised stream  A term used by river engineers applying to a stream that over a period of time is neither degrading nor aggrading its channel, and is nearly in equilibrium as to sediment transport and supply.

Reach  The length of a channel uniform with respect to discharge, depth, area, and slope; more generally, any defined length of a river or drainage course.

Revegetation  Planting of indigenous plants to replace natural vegetation that has been damaged or removed. This work includes provisions for irrigation.

Revetment  Bank protection to prevent erosion.

Rhizobium  The nitrogen-fixing bacteria capable of living in symbiotic relationship with leguminous plants in nodules on the roots.

Rhizomes  Stem growth which creeps beneath the soil surface; rooting at nodes to form new individuals; found in many grasses.

Rill  Shallow downslope erosion feature normally less than 0.3m wide and 0.6m deep.

Riparian area  An ecosystem situated between aquatic and upland environments that is at least periodically influenced by flooding.

Riprap  A layer, facing, or protective mound of broken concrete, sacked concrete, rock, rubble, or stones randomly placed to prevent erosion, scour, or sloughing of a structure or embankment; also, stone used for this purpose.

River  A large stream, usually active when any streams are flowing in the region.
<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Runoff</td>
<td>1) The surface waters that exceed the soil infiltration rate and depression storage; 2) The portion of precipitation that appears as flow in streams; drainage or flood discharge which leaves an area as surface flow or a pipeline flow, having reached a channel or pipeline by either surface or subsurface routes.</td>
</tr>
<tr>
<td>Sand</td>
<td>Granular soil coarser than silt and finer than gravel, ranging in diameter from 0.05 to 5 mm.</td>
</tr>
<tr>
<td>Scour</td>
<td>The result of erosive action of running water, primarily in streams, excavating and carrying away material from the bed and banks; wearing away by abrasive action.</td>
</tr>
<tr>
<td>Sediment</td>
<td>Fragmentary material that originates from weathering of rocks and is transported by, suspended in, or deposited by water.</td>
</tr>
<tr>
<td>Seed bank</td>
<td>The store of dormant seed in the soil.</td>
</tr>
<tr>
<td>Seepage</td>
<td>Groundwater emerging from the face of a streambank; flow of water in the pores of soil under influence of gravity or capillary action.</td>
</tr>
<tr>
<td>Shallow mass movement</td>
<td>Near-surface sliding or movement of earth and/or rock masses usually along planar failure surfaces parallel to the slope face.</td>
</tr>
<tr>
<td>Sheet erosion</td>
<td>Erosion of thin layers of soil by sheets of flowing water.</td>
</tr>
<tr>
<td>Sheet flow</td>
<td>Any flow spread out and not confined; i.e. flow across a flat open field.</td>
</tr>
<tr>
<td>Shrub</td>
<td>Woody growth whose main and side shoots form multiple branches from main stock baseline or form below-ground side shoots or on which, instead of only one stem (main stem), several stems are grown.</td>
</tr>
<tr>
<td>Silt</td>
<td>1) Waterborne sediment. Detritus carried in suspension or deposited by flowing water, ranging in diameter from 0.005 to 0.05 mm. The term is generally confined to fine earth, sand, or mud, but is sometimes both suspended and bedload. 2) Deposits of waterborne material, as in a reservoir, on a delta, or on floodplains.</td>
</tr>
<tr>
<td>Sinuosity</td>
<td>The ratio of the length of the river thalweg to the length of the valley proper.</td>
</tr>
<tr>
<td>Slide</td>
<td>Gravitational movement of an unstable mass of earth from its natural position.</td>
</tr>
<tr>
<td>Slope</td>
<td>1) Gradient of a stream; 2) Inclination of the face of an embankment, expressed as the ratio of horizontal to vertical projection; or 3) The face of an inclined embankment or cut slope. In hydraulics it is expressed as percent or in decimal form.</td>
</tr>
<tr>
<td>Soil bioengineering</td>
<td>Use of live, woody vegetative cuttings to repair slope failures and increase slope stability; the cuttings serve as primary structural components, drains, and barriers to earth movement.</td>
</tr>
<tr>
<td>Species</td>
<td>Group of plants similar in all respects and able to interbreed.</td>
</tr>
<tr>
<td>Stage</td>
<td>The elevation of a waters surface above its minimum; also above or below an established “low water” plane; hence above or below any datum of reference; gage height.</td>
</tr>
<tr>
<td>Stem cutting</td>
<td>Cuttings made from shoots; according to the nature of the wood they can be divided into hardwood, semi-softwood, softwood, and herbaceous cuttings.</td>
</tr>
<tr>
<td>Stream</td>
<td>Water flowing in a channel or conduit, ranging in size from small creeks to large rivers.</td>
</tr>
<tr>
<td>Stream power</td>
<td>An expression used in predicting bed forms and hence bed load transport in alluvial channels. It is the product of the mean velocity, the specific weight of the water-sediment mixture, the normal depth of flow and the slope.</td>
</tr>
<tr>
<td>Glossary Item</td>
<td>Definition</td>
</tr>
<tr>
<td>---------------</td>
<td>------------</td>
</tr>
<tr>
<td>Substrate</td>
<td>1) The mineral and organic material that is from the bed of the stream; 2) The layer of earth or rock immediately below the soil surface.</td>
</tr>
<tr>
<td>Surface runoff</td>
<td>The movement of water on the earth’s surface, whether flow is overland or in a channel.</td>
</tr>
<tr>
<td>Suspended load</td>
<td>Sediment that is supported by the upward components of turbulent currents in a stream and that stay in suspension for an appreciable amount of time.</td>
</tr>
<tr>
<td>Swale</td>
<td>A shallow, gentle depression in the earth’s surface. This tends to collect the waters to some extent and is considered in a sense as a drainage course, although waters in a swale are not considered stream waters.</td>
</tr>
<tr>
<td>Thalweg</td>
<td>A longitudinal line that follows the deepest part of the channel of a stream.</td>
</tr>
<tr>
<td>Transport</td>
<td>To carry solid material in a stream in solution, suspension, saltation, or entrainment.</td>
</tr>
<tr>
<td>Undermining</td>
<td>The removal of lateral support at the base of a slope by scour, piping, erosion, or excavation.</td>
</tr>
<tr>
<td>Vegetation</td>
<td>A plant cover formed of many different plant types; the whole of the plant species of one area.</td>
</tr>
<tr>
<td>Watershed</td>
<td>An area of land that drains into a particular river, lake, or ocean, usually divided by topography.</td>
</tr>
<tr>
<td>Wattle</td>
<td>A sausage-like bundle of plant cuttings used to stabilize streambanks and other slopes.</td>
</tr>
</tbody>
</table>
References

The following is a list of materials used to create this manual. Additional useful reference materials are also listed.


References cont...


Appendix
Appendix A

Setting Weed Control Priorities

1. What is the goal of the site?

2. What weeds are present?

3. Prioritize your weeds
   a. Weed #1:
   b. Weed #2:
   c. Weed #3:
   d. Weed #4:
   e. Weed #5:

4. What control methods are available for each priority weed species?
   a. Weed #1:
   b. Weed #2:
   c. Weed #3:
   d. Weed #4:
   e. Weed #5:

5. Develop a control plan or timeline for implementation of control methods (see attached).

6. Implement control plan and monitor results

7. Did you achieve your goal? If not, why?

8. Make changes to the control plan and try again modifying goals if necessary.
Appendix A

Weed Priority Rating Worksheet

For each problem weed assign a number to it for each of the 3 categories* (see rating guidelines below). Tally the score for each weed. Rank the weeds from lowest score to highest score. Focus control on the lowest scoring weeds. These are your priority weeds.

<table>
<thead>
<tr>
<th>Weed Species</th>
<th>Distribution</th>
<th>Impacts</th>
<th>Control</th>
<th>Total Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weed #1</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>Weed #2</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>8</td>
</tr>
<tr>
<td>Weed #3</td>
<td>1</td>
<td>4</td>
<td>4</td>
<td>9</td>
</tr>
</tbody>
</table>

Weed #1 in this example is our highest priority. This should be reevaluated once control options are assessed. Categories may be expanded to suite additional landowner needs.

*Rating Guidelines

<table>
<thead>
<tr>
<th>Distribution</th>
<th>Impacts</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 = noxious weeds close by but not on site</td>
<td>1 = weeds that change sedimentation, nutrient cycling, etc.</td>
<td>1 = weeds able to be controlled and desirable species can out compete</td>
</tr>
<tr>
<td>2 = new weed populations or outliers of larger weed infestations</td>
<td>2 = weeds that outcompete desirable species</td>
<td>2 = weeds able to be controlled but desirable species not able to outcompete</td>
</tr>
<tr>
<td>3 = weeds present in large amounts and expanding</td>
<td>3 = weeds that prevent desirable species from propagating and/or reduce wildlife habitat</td>
<td>3 = weeds difficult to control and methods needed may disturb desirable vegetation.</td>
</tr>
<tr>
<td>4 = weeds present in large amounts and not expanding</td>
<td>4 = weeds that only occur after disturbance (this should have a lower score if disturbance are frequent)</td>
<td>4 = weeds unlikely to be controlled with current technology</td>
</tr>
</tbody>
</table>
Appendix B

Appendix B comes directly from the *Handbook for Forest and Ranch Roads* (pages A1-A6) prepared by William E. Weaver, Ph.D. and Danny K. Hagans of Pacific Watershed Associates for the Mendocino County Resource Conservation District.

**Introduction**

Several methods have been developed for estimating the peak flood discharge that can be expected from small ungaged, wildland watersheds. These procedures are useful for determining the size (diameter) of culvert needed to install in a stream crossing that is to be constructed or reconstructed.

Determining the proper size (diameter) culvert requires: 1) estimating the volume of runoff which would occur at each stream crossing during the 50-year flood, and then 2) calculating the size of culvert which would handle that flow.

A summary of some methods, with example calculations for flood estimating is available from the California Department of Forestry and Fire Protection in an “in-house” document called *Suggested culvert sizing procedures for the 50-year storm*. This document covers such techniques as the Rational Method, the California Nomograph Method, the Magnitude and Frequency Method, the SCS Curve Number Method and the Slope Number Method. Other techniques are also available and may have been developed for your area and climatic region. Each method has its strengths and weaknesses, and relies on field or map measurements, published climatic data and subjective evaluations of watershed conditions.

Several of the methods require precipitation intensity data which are available in several reports published by the State of California. These are available from the state and can be found in good public and college libraries. Your local CDF office may also have copies of the most recent data. Ask the Forest Practice Inspector with jurisdiction for your area.

1. Department of Water Resources, 1981 (and more recently), Rainfall depth-duration-frequency for California.


The most commonly used technique for estimating 50-year flood discharges from small watersheds in north coastal California forest land is the Rational Method. The methodology and an example is described in this appendix. However, it is recommended that two or three different methods be used in an area to compare and verify the results. Field experience can also be used as
a check. Just remember, most of us have not been around for a 50-year flood and we naturally tend to underestimate the amount of water that is carried by streams during these extreme events.

**Step 1: The Rational Method of Estimating Flood Discharge from Small Watersheds**

This method is based on the equation:

\[ Q = CIA \]

Where:

- **Q** = peak runoff at crossing (in cfs)
- **C** = runoff coefficient (percent runoff)
- **I** = uniform rate of rainfall intensity (inches/hour)
- **A** = drainage area (in acres)

Advantages:

1. Frequently used and flexible enough to take into account local conditions.
2. Easy to use if local rainfall data is available.

Disadvantages:

1. Flexibility may lead to misuse, or misinterpretation of local conditions.
2. Precipitation factor “I” may be difficult to obtain in remote areas.

Information needed:

- **A** = area of watershed (acres)
- **H** = elevation difference between highest point in watershed and the crossing point (ft.).
- **L** = length of channel in miles from the head of the watershed to the crossing point.
- **I** = uniform rate of rainfall intensity. Obtained from precipitation frequency-duration data for local rain gages as in example on page A5.
- **C** = runoff coefficient from table on page Y.

Procedures:

1. Selecting “C” values:

Several different publications give a range of “C” values for the rational formula, however, the values given in the following table by Rantz (1971) appear to be the most appropriate.
Appendix B

Table of "C" Values

<table>
<thead>
<tr>
<th>Rural Areas</th>
<th>C Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sandy and gravelly soils:</td>
<td></td>
</tr>
<tr>
<td>cultivated</td>
<td>0.20</td>
</tr>
<tr>
<td>pasture</td>
<td>0.15</td>
</tr>
<tr>
<td>woodland</td>
<td>0.10</td>
</tr>
<tr>
<td>Loams and similar soils without impeded horizons</td>
<td></td>
</tr>
<tr>
<td>cultivated</td>
<td>0.40</td>
</tr>
<tr>
<td>pasture</td>
<td>0.35</td>
</tr>
<tr>
<td>woodland</td>
<td>0.30</td>
</tr>
<tr>
<td>Heavy clay soil or those with a shallow impeding horizon: shallow over bedrock:</td>
<td></td>
</tr>
<tr>
<td>cultivated</td>
<td>0.50</td>
</tr>
<tr>
<td>pasture</td>
<td>0.45</td>
</tr>
<tr>
<td>woodland</td>
<td>0.40</td>
</tr>
</tbody>
</table>

2. Selecting an "I" value:

In selecting an "I" value, two factors are considered: a) the travel time or time of concentration, $T_C$, for the runoff to reach the crossing, and b) the precipitation conditions for the particular watershed in question.

a. Time of concentration, $T_C$, can be calculated using the formula:

$$T_C = \left[ \frac{11.9L}{H} \right]^{0.385}$$

Where: $T_C$ = time of concentration (in hours)

$L$ = length of channel in miles from the head of the watershed to the crossing point

$H$ = elevation difference between highest point in watershed and the crossing point (in feet)

b. Uniform rate of rainfall intensity.

Once the time of concentration has been determined, then that value is used to determine which rainfall duration to use (i.e., if $T_C = 1$ hour, then use 50-year, 1 hour precipitation duration; if $T_C = 4$ hours, then use 50-year, 4-hour duration). Precipitation frequently, duration tables are available for precipitation stations throughout the state similar to figure 1 (DWR, 1981).
Appendix B

The values in Figure 1 must be converted to inches per hour as shown in the following examples:

Example 1:

\[ T_c = 3 \text{ hours} \]

from Figure 1, 50-year, 3-hour ppt = 1.89

\[ \frac{1.89}{3} = 0.63 \text{ inches per hour} \quad I = 0.63 \]

Example 2:

\[ T_c = 15 \text{ minutes} \]

from Figure 1, 50-year, 15-minute ppt = 0.48

\[ 0.48 \times 4 = 1.92 \text{ inches per hour} \quad I = 1.92 \]

3. Once the "C" and "I" values are determined, apply values along with area of watershed "A" to rational equation.

\[ Q = CIA \]

Example:

Digger Creek (Near Fort Bragg, California)

\[ C = 0.30 \text{ (loam woodland soil, from Table 1, page A3)} \]

\[ T_c = \left[ \frac{11.9 \times \left(\frac{1.8 \text{ mi.}}{200}\right)}{0.385} \right] \text{ where: } L = 1.8 \text{ mi.}, A = 200 \text{ ft.} \]

\[ = 0.67 \text{ or 40 min. from the Intensity Duration Frequency table (see example above and Figure 1, page A4)} \]

\[ I = 1.4 \text{ in./hr.} \]

\[ A = 536 \text{ acres} \]

\[ Q = CIA \]

\[ Q = 0.30 \times 1.4 \times 536 \]

\[ = 225 \text{ cfs} \]
Appendix B

1. Determine the “entrance type” from the sketches above.

2. Calculate the expected “Headwater Depth” in diameters from field measurements (e.g., a 36 inch culvert whose bottom will be 8 feet below the lowest point on the road grade over the crossing has a headwater depth of 8 feet, or 2.7 culvert-diameters (8 ft / 3 ft = 2.7)).

3. Place a straight edge connecting the Headwater Diameter scale (right side of nomograph) through the calculated 50-year flood discharge (from the Rational Method, in this example).

4. Read off the needed culvert diameter on the left scale of the nomograph.

5. In the example, the Headwater Depth for a Type 1 entrance (1.8), Type 2 entrance (2.1) or a Type 3 entrance (2.2) culvert to be installed on a small stream with a calculated 50-year flood discharge of 66 cubic feet per second would require a 36-inch diameter culvert.
Appendix C


Figure 5-30 Three classes of stocking methods and their associated stocking method* (adapted from Barnes, et al. 1995; Hodgson 1990)

Allocation stocking methods

Continuous set stocking

Animals access total area.

Continuous variable stocking

Area accessed by animals expands or contracts as forage supply dictates.

Set rotational stocking

Example: 6 day grazing period and 30 day recovery period.

Variable rotational stocking

Example: Grazed 8%; Recovering 92%.

Nutritional optimization stocking methods

First-last grazing

Grazed off → Last grazers

First grazers

High performers graze first and low performers graze last.

Forward creep grazing

Offspring graze ahead of mothers, using special creep openings.

Continuous stocking-creep grazing

(Base pasture) Mothers/Offspring

Special forage

Offspring

Mothers stay on base pastures, offspring creep graze special forage.

Strip grazing

Frontal grazing

Flexible areas offered each day (with back fence).

Flexible areas offered each day (without back fence).

Seasonal stocking methods

Sequence stocking

Spring → Summer

Annual or perennial cool season → Annual or perennial warm season

Stockpiled forage and/or winter annual → Stockpiled or annual cool season

Winter → Fall

Deferred stocking

Deferred → Deferred

* Each method is diagrammed to show how the livestock are deployed about the pastures.
Comments

This manual is a working document. It is designed to be periodically updated to better meet the needs of the landowners that use it. The manual will be updated based on comments received by landowners, experiences gained through implementing practices, and as new information and techniques becomes available. Please share your comments and experiences. They are important to the ongoing usefulness of the manual.

Photocopy this page and add your comments or simply type your comments on a piece of paper and mail to:

Manual Comments
c/o Yolo County RCD
221 W. Court St., Suite 1
Woodland, CA 95695

Comments:

Submitted by:
Name ____________________________
Address ____________________________
City/State/Zip ____________________________
Phone ____________________________
Email ____________________________

☐ Check here if you would like to be placed on the Cache Creek Watershed Stakeholders Group email list. You will receive occasional emails about meeting dates, watershed planning, projects, and funding opportunities.