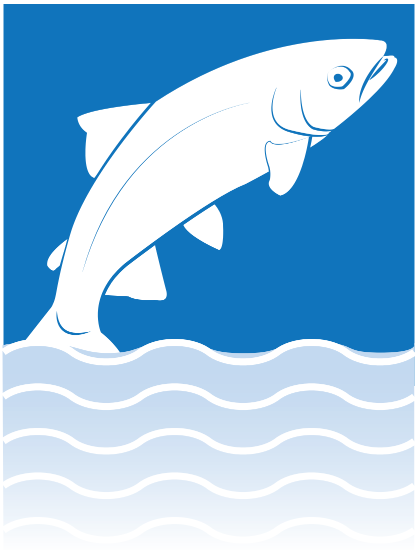
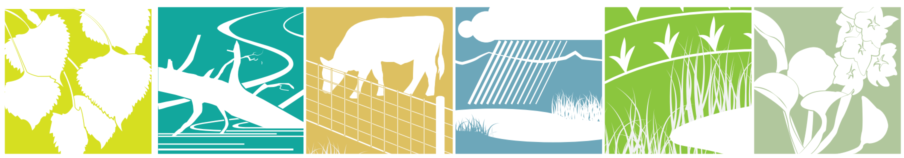


Chapter 4
Six Key Projects

The restoration projects described in this chapter were carefully chosen to represent a broad range of methods of restoring habitats and managing water quality. They are applicable to most of California, proven to be effective, and critical to restoring habitat and water quality in the state. This is not meant to be an exhaustive list; there are many more projects and practices available to restoration practitioners. Additional projects may be added to this evolving manual as their effectiveness and importance are evaluated.

Each project write-up is meant to provide general guidelines for planning and implementing that particular project, either alone or as part of a larger restoration effort. The practitioner is advised to seek out additional resources and experts for help determining if a particular project is appropriate and for assistance in subsequent planning, preparation, and implementation.

Each project offers a wide range of benefits to wildlife, stream health, and water quality. The table below identifies some of the specific benefits associated with each one.



	Removing an In-stream Barrier	Emplacing Large Woody Material	Fencing a Riparian Area	Trapping Stormwater	Buffering a Wetland	Managing Wetland Water Level
Allow fish migration	💧					
Restore hydrologic processes	💧	💧				💧
Increase habitat complexity		💧			💧	💧
Control erosion & sedimentation		💧	💧	💧	💧	
Restore habitat	💧	💧	💧			
Improve water quality			💧	💧	💧	💧
Recharge groundwater				💧	💧	
Control non-native species			💧			💧
Support wildlife populations	💧	💧	💧		💧	💧

This Project description is part of the full publication "Habitat Restoration and Water Quality Management"

For more information email info@elkhornsloughctp.org

Project 5
Creating a Buffer between a Wetland or Riparian Area and Adjacent Agricultural Land

Buffers are vegetated areas separating rivers, streams, creeks, and wetlands from adjacent land subject to intensive human use, usually farming or grazing. The buffer helps protect the natural area from various potential impacts (pollutant run-off, sedimentation, etc.) and may also yield benefits to the agricultural land.

Background

Restoring and protecting sensitive wetland and riparian areas is a top priority amongst restoration practitioners. These environments provide important ecological services such as wildlife habitat, water purification, flood control, and carbon sequestration. When they are adjacent to land used intensively by humans, their ability to provide these services is often compromised. Vegetated buffers can be effective in mitigating these effects.

Benefits

Wetland and riparian buffers can improve water quality by reducing the input of sediments and pollutants. They can reduce erosion, restore and improve wildlife habitat, and increase plant species diversity in the target areas.

Reduces sedimentation. Vegetation in wetland and riparian buffers helps to slow water flow, capturing sediment in runoff from adjoining land uses. In many cases, coarse sediments are removed efficiently in the first 16 to 66 feet of a buffer (Rein 1999; Sheldon, et al. 2005; Reid 2007). Vegetated buffers 80 feet in width reduce suspended sediment by as much as 92% from such high-impact land uses as feedlots (Young et al. 1980).

Reduces phosphorus pollution. Phosphorus is mostly attached to sediment particles, and so it is captured along with sediment (Wenger 1999). Even when a buffer becomes saturated with phosphorus, it can help to regulate the flow of phosphorus and prevent large pulses of the nutrient from reaching wetlands and riparian areas (Wenger 1999).

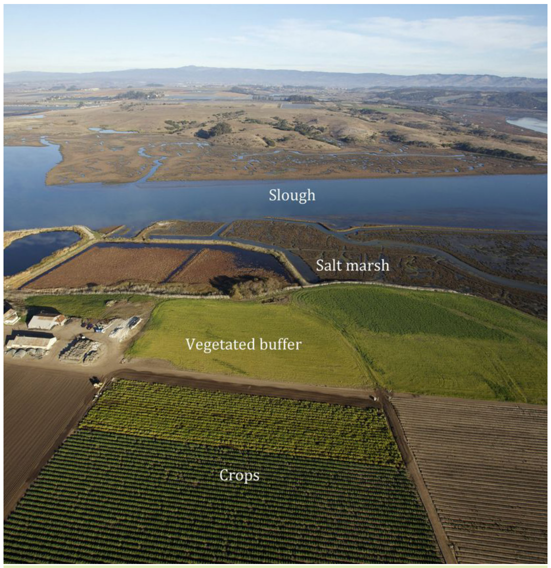


Photo P5.1 Riparian buffer adjacent to agricultural area. Photo Keith Ellenbogen

Reduces nitrogen pollution. Nitrogen contained in runoff is removed as denitrifying bacteria in the soil convert nitrate to nitrogen gas and plants growing in the buffer take up nitrates through their roots. Nitrogen removal efficiencies of 50, 75, and 90 percent have been reported for buffers approximately 10, 92, and 367 feet wide, respectively (Mayer et al. 2005).

Controls erosion. Buffers can help to control erosion in wetland and riparian areas by minimizing disturbances by humans and livestock. Trampling by livestock can reduce vegetation cover in riparian areas, leading to bank erosion. Varied vegetation structure (i.e., dense thickets, trees, briars) in a buffer physically blocks livestock access to wetlands and riparian areas, controlling erosion (Chase, Deming et al. 1995).

Improves habitats for multiple species. Wetland and riparian buffers protect and expand vegetation, protecting plants within and alongside these habitats, leading to expanded habitat area for many species. Vegetation in a buffer can add structural elements that provide refuge and nesting habitats (Castelle, Conolly et al. 1992) for both birds and terrestrial mammals. Many semi-aquatic species depend on the mesic ecotones surrounding wetlands and riparian areas for resting and basking as well as nesting and refugia. Riparian buffers improve aquatic habitat for fish and invertebrates by shading, which helps to cool water (Castelle, Conolly et al. 1992).

Planning

The decision to create a wetland or riparian buffer is normally the result of a comprehensive watershed management planning process intended to reduce point and non-point sources of pollutants (Mayer et al. 2005). Whether or not such a watershed plan exists, initial planning for the creation of a buffer should be a collaborative process involving the managers of the site as well as the landowners and focusing on developing a set of goals and objectives based on the available science.

Advance Analysis

Site Assessment

Buffer creation begins with assessment of the soil-related, hydrological, and biological conditions of the site. An inventory of existing conditions is essential for informing the objectives-setting phase of project planning. Overall goals and perhaps even objectives may have been determined by the earlier watershed planning phase (when a buffer was determined to be appropriate) but objectives are often refined as assessment of the site conditions reveals more information.

A biotic inventory identifies specific conservation concerns at the site; these in turn help to determine the optimal width of the buffer and other design considerations. An assessment of existing ecosystem functions also helps to determine the potential for the site to support various species that could be considered in a buffer planting. In addition, assessment of potential erosion and human/livestock disturbances is important. Soil inventories inform vegetation restoration potential as well as the potential for runoff filtration and infiltration.

Expertise Needed

Botanist. Appropriate plant choice is critical to the successful creation of riparian buffers. A trained botanist selects plants appropriate for the site and for meeting restoration objectives and water quality goals. He or she also considers how plant choices affect maintenance costs over the long run.

Photo P5.2 Volunteers planting native grasses Photo: ESNERR

Wildlife biologist. Wildlife biologists are critical in determining the species present and defining their needs in relationship to the buffer. Breeding, foraging, and migrating needs are important considerations when protecting and creating habitat with a riparian/wetland buffer.

Soils expert. A soils expert assesses the potential for sediment erosion along streambanks, the potential for pollutant runoff from stormwater and irrigation, and the permeability and stability of the soils. These factors have an important bearing on buffer width.

Engineer. The use of filter strips requires an engineer's assistance to calculate hydrologic factors associated with nutrient uptake.

Seasonality

Planting of new vegetation in the buffer should be done at a time of year when the survival rates and growth of the plants will be maximized (NRCS 2007).

Implementation

Design

The key design factor for a buffer is its width. Because buffers can become saturated with sediments and nutrients, gradually reducing their effectiveness, wider buffers are more effective over the long run. Locations with high sediment loads and steep slopes may also require wider buffers, all other things being equal, as the sediment removal efficiency of buffers decreases as slope increases (Wenger 1999; Sheldon, et al. 2005). The most effective buffers are at least 30 meters (98 feet) wide (Wenger 2000).

Depending on site conditions, much of the sediment and nutrient removal may occur within the first 15–30 feet of the buffer, but buffers 30–100 feet or more in width can remove pollutants more consistently (Dillaha, et al. 1988; Dillaha 1989; Magette, et al. 1989; Schoonover 2006). A minimum of 50 feet is recommended for effective nitrogen removal, depending on the soils (Wenger 1999). Phosphorous can be removed within the first 15 to 30 feet of a buffer, but it is more consistently removed by buffers of 30 to 100 feet (Dillaha, et al. 1988; Dillaha 1989; Kuusemets 2001; Lowrence 2005; Syverson 2005).

When wildlife conservation is the primary goal, wider is always better. However, different types of animals have been shown to have different requirements (see Table P5.3). Effective buffer sizes for wildlife protection may range from 33 to 5,000 feet, depending on the species (Environmental Law Institute 2003).

Table P5.3. Ideal buffer widths for different taxonomic groups

	Buffer Width
Birds	49 to 5,000+ feet (Fischer 2000)
Mammals	98 to 600 feet (McElfish 2003)
Reptiles	417 to 948 feet (Semlitsch 2003)
Amphibians	521 to 951 feet (Semlitsch 2003)

Source: Environmental Law Institute 2003

A second key design consideration is the vegetation of the buffer. The type of vegetation to be planted is generally considered in terms of zonation. Riparian buffers are usually defined as having three zones: Zone 1 begins at the water's edge; Zone 3 is immediately adjacent to the surrounding land use; and Zone 2 is the area in between the two. Each zone is typically planted with different types of plants, and the width of each is determined by the desired functions of the buffer and other site-specific factors. Figure P5.4 illustrates a typical zonation scheme. To the extent possible, each zone should be composed of native vegetation.

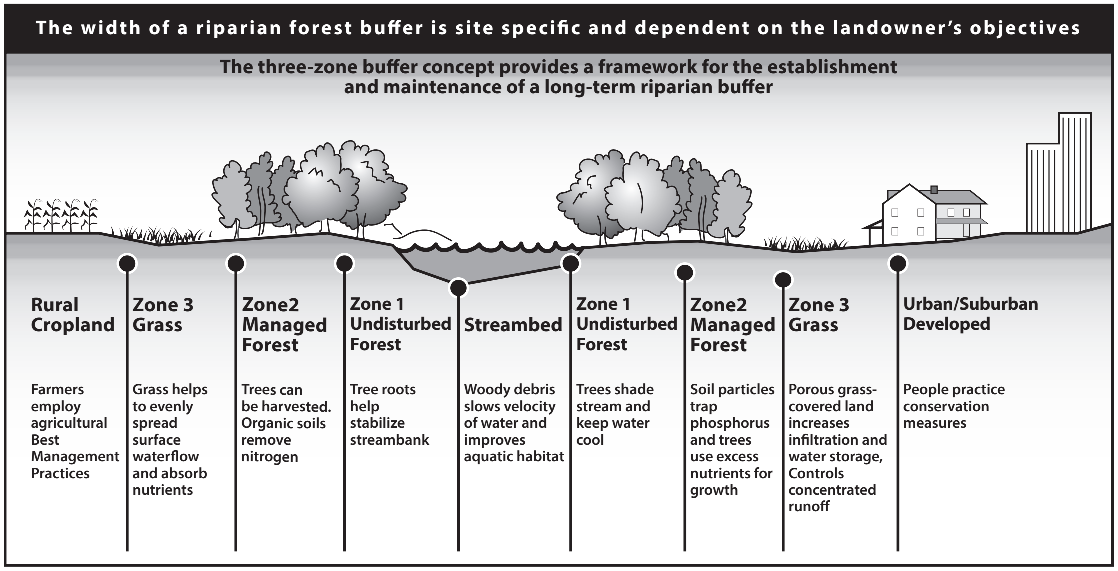


Figure P5.4 Buffer zones. (Source: Tjaden, R.L. and Weber, G.M. 1998)

Not all components of a buffer's vegetation need to be planted. Many plants will establish naturally, dispersed from upstream sources of seeds or other propagules. If the plan calls for relying on natural regeneration to establish a buffer, it is necessary to first assess the regeneration potential of the site.

Many buffer designs involve only planting of seedlings, sowing of seeds, and/or natural revegetation. However, some sites and designs will require engineering work (possibly with heavy equipment), soil manipulation, installation of fencing, or removal of invasive species.

Materials

The primary materials used in creating a buffer are the trees, shrubs, grasses, and forbs planted in the area of the buffer. As noted above, a qualified botanist should assist in the selection of the appropriate native plants for the site. Appropriateness is a function of site characteristics, restoration goals, and the type of vegetation that was present in the area before human disturbance. It is recommended that practitioners refer to the *Revegetation with Native Plants* discussion in Chapter 1.

Adaptive Management

Monitoring

Post-implementation monitoring will vary depending on the goals and objectives of the project. Since improvement of water quality is a typical goal of a buffer project, water-quality monitoring is a common focus. When a riparian area or wetland is being buffered from agricultural or grazing land, monitoring of water quality should include regular testing of nitrate and phosphorus levels. As noted in the *Monitoring* section of Chapter 3, the monitoring plan should be based on the goals and objectives of the project, and it should establish a regular schedule of monitoring activities. As with any restoration project, a pre-implementation assessment of baseline conditions provides an important reference point for evaluating monitoring data and project success.

Maintenance

The maintenance required for a buffer project can be extensive. It may be necessary to replace trees or shrubs that die, irrigate plantings until they are well established, remove storm debris, and control invasive plants. Watering new plantings and removing invasive weeds are the primary maintenance requirements for restored riparian buffers. Ongoing maintenance for buffers may also include selective cutting and/or pruning and mowing. Riparian buffer areas should not be mowed frequently—only about once per year for newly created buffer areas. Existing, mature riparian areas require no mowing at all. If a fence is installed to prohibit tractors and other farm equipment from entering the buffer, it will need to be maintained. Provision should be made for unscheduled inspections after storm events. If saturation with phosphorus becomes an issue, harvesting vegetation from buffer areas can help to permanently remove some phosphorus from the system (Wenger 1999).

Potential Concerns

Introduction of invasive and exotic species. Buffer creation requires planting large areas of grasses and other vegetation along sensitive riparian habitat; this activity carries the risk of introducing invasive and or exotic species into the system. To reduce this risk, use only reputable sources of seed and seedlings, and always plant natives.

Predators gaining access to nesting and foraging habitat. Generalist predators, like cowbirds, ravens, and raccoons, may inhabit buffer areas and move from them into sensitive riparian and wetland habitats, preying on nestlings, amphibians, and other animals. To mitigate this concern, restoration practitioners can provide appropriate refuge habitat within the buffer that offers cover and forage areas for sensitive species.

Accumulation of fuel. If left unmanaged, buffers can become overgrown and dense with accumulated fuel, both living and dead. Fire safety demands that restoration practitioners collaborate with landowners to develop a fire management plan during the planning phase. A fire safety plan consists of scheduled manual thinning and seasonal removal of dead vegetation. It may also incorporate a livestock management plan to assist with fire fuel control. There may be additional recommendations and requirements available through regional fire management agencies and these should be sought out.

Flooding hazards. Trees growing adjacent to a stream may be felled by erosion, wind, or ice, potentially blocking the stream and causing flooding. This potential flood hazard can be avoided with proper choice of trees planted during the implementation phase. Restoration practitioners should avoid selecting trees that grow too large and lack proper root growth to support their size. As part of a thorough management plan, buffer zones should be periodically monitored for weakened and fallen trees after large storm events (Griggs 2009).

Costs

Costs associated with creating a riparian buffer vary depending on the size of the buffer, the type of planting, and the scope of the long-term maintenance and monitoring plan. Costs are incurred for site preparation, plants, other materials, labor, and maintenance (Lynch 2000).

The land area to be converted to a buffer affects the quantity of plants required and the labor needed. Defining buffer goals in advance allows the restoration practitioner to determine the buffer size that meets those goals while remaining within a budget.

Maintenance and planting costs increase with the size of the buffer but are greatly affected by the type of buffer. Forested buffers cost more than simple grass buffers to maintain; they also require more site preparation, involve higher costs for the plants themselves, and are more labor intensive to implement. Additionally, forested buffers require some degree of replanting to account for tree loss in the first year (Lynch 2000).

Table P5.5. Estimated costs per acre of two buffer types.

Tree-dominated buffer, 400-600 trees			Grass-dominated buffer	
	Cost per acre			Cost per acre
Planting by machine	$75–130		Planting	$10–50
Planting by hand	$60–174		Seeds	$100–225
Plant material	$60–275		Site preparation	$18–40
Herbicides for site preparation	$110–170		Fertilizer/lime	$30–50
Replanting	$30-50		Maintenance	$10–60
Herbicides for maintenance	$30–60			
Mowing	$12–60			
TOTAL	$218–729		TOTAL	$168–400

Photo P5.6 Agricultural Buffer Photo: Ken Collins

Related Resources

The California Landowners Incentive Program (LIP) is a voluntary, incentive-based program that provides funding to cover some of the costs associated with restoring riparian buffers. The program is managed by the California Department of Fish & Wildlife. Technical assistance is also available through this program (State of California 2007).

- NRCS Field Office Technical Guide (eFOTG), Section IV, Conservation Practice Standard—Riparian Forest Buffer, 391.
- NRCS National Forestry Handbook (NFH), Part 636.4.
- NRCS National Environmental Compliance Handbook.
- NRCS Cultural Resources Handbook.
- The River Partners, California Riparian Restoration Handbook, additional budget planning guidelines associated with riparian restoration work (Griggs 2009).
- The Wetlands-At-Risk Protection Tool (WARPT), developed by the Center for Watershed Protection under cooperative agreement with the U.S. EPA, Office of Wetlands, Oceans and Watersheds. Visit online to access these tools, each of which includes case studies: http://wetlandprotection.org/protect-wetlands.html

Case Study

An Economic Analysis of Vegetative Buffer Strip Implementation

Elkhorn Slough, Monterey Bay, California

The Elkhorn Slough Estuarine Reserve, located on the Monterey Bay in California, protects a highly impacted estuary surrounded by strawberry growers and a dairy. Approximately 10,000 of the 44,900 acres of the estuary's watershed are in agricultural production; strawberries are grown on 3,600 of these acres, and the farming methods typically result in significant soil erosion. In 1999, The Nature Conservancy (TNC), in coordination with the Agricultural Land Trust and the Elkhorn Slough Foundation, implemented buffer strips on the reserve at a ratio of 1 acre of buffer to every 35 acres of strawberry field. The goal of the research project was to evaluate the environmental costs and benefits of implementing these buffers, considered from the perspective of the grower and of the society as a whole.

Implementation

The study (Rein 1999) was conducted in two parts. The first analyzed the quantifiable costs and benefits to the farmer, and the second assessed the benefits to the watershed and to society.

Results

Buffers result in several costs to the grower: agricultural revenue is lost from the acreage converted to buffer and costs are incurred in installing and maintaining the buffer. These costs, however, were found to be minimal in comparison to the money saved in minimizing erosion of farmland. The first year of the study saw a total cost to the grower of $1,850 per acre and a soil-saving benefit estimated to be $3,338 per acre. This result represents a net benefit of $1,488 per acre. By the 5th year of the study, the net benefit to the grower was $6,171 per acre.

Data from the second part of the study showed a significant reduction in sediment runoff due to buffer implementation. The reduction in sediment runoff translated to cost savings to society in the form of reduced road repair, reduced culvert repair, reduced harbor dredging, improved water quality, flood control, and mosquito abatement.

The overall environmental benefits of buffers—improved water quality, erosion control, and habitat improvement—coupled with the reduction of costs to growers and society suggest that creating buffers between agricultural land and wetlands is worthwhile and advantageous to all parties.

Task Checklist

Design the project

- [ ] Contact landowner to discuss work
- [ ] Create a team of experts
- [ ] Describe objectives and purpose of restoration work
- [ ] Design buffer to accommodate anticipated slope and soil type
- [ ] Determine the appropriate width for the buffer based on objectives of the project
- [ ] Create work plan
- [ ] Contact regulatory agency to understand pertinent regulations
- [ ] Contract with sub-contractors

Analyze the site

- [ ] Conduct soil assessment
- [ ] Conduct biological survey
- [ ] Conduct hydrology study
- [ ] Conduct cultural assessment

Prepare site for planting

- [ ] Till, smooth, and amend soil as necessary
- [ ] Remove invasive plants
- [ ] Make provision for irrigation
- [ ] Consider wildlife corridors
- [ ] Choose appropriate plants
- [ ] Identify planting supervisor
- [ ] Organize planting either with hired crew or volunteers

Plant

- [ ] Sow seed via broadcast or drill
- [ ] Plant seedlings
- [ ] Mulch
- [ ] Irrigate

Maintenance the first year

- [ ] Mow several times
- [ ] Maintain original width and depth of planted area
- [ ] Control weeds
- [ ] Exclude livestock and vehicles
- [ ] Replant where necessary

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