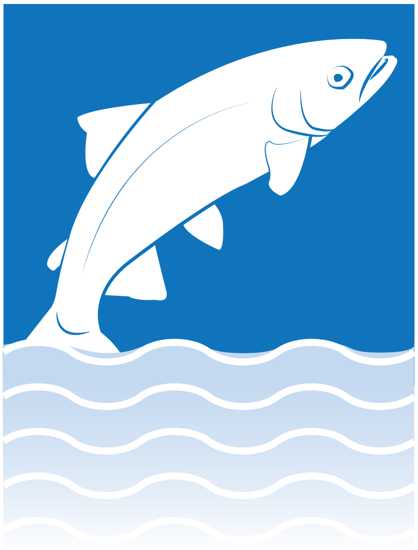
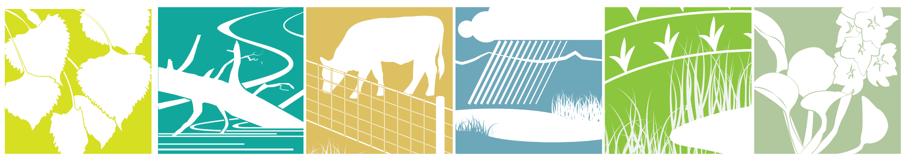


Chapter 4
Six Key Projects

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.



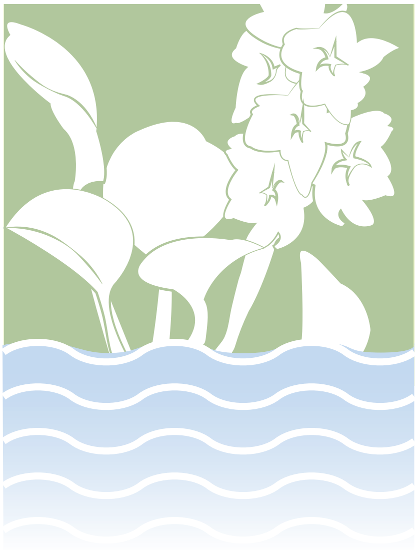
	Removing an In-stream Barrier	Emplacing Large Woody Material	Fencing a Riparian Area	Trapping Stormwater	Buffering a Wetland	Managing Wetland Water Level
Allow fish migration	✓					
Restore hydrologic processes	✓	✓				✓
Increase habitat complexity		✓			✓	✓
Control erosion & sedimentation		✓	✓	✓	✓	
Restore 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 6
Installing Structures for Managing the Water Level of a Wetland

Wetland water-level management structures are used to restore natural hydrological processes, ensuring that water flows with the desired volume and periodicity and that water levels support management goals.



Background

Human development in the watershed associated with a wetland, as well as disturbance of the wetland itself, may alter its natural hydrology, thereby degrading its habitat values and reducing its ability to improve water quality and provide other ecosystem services. Gaining the ability to manage the water level of wetlands affected in this way allows managers to mitigate or compensate for changes in wetland hydrology.

Benefits

Depending on which of its ecological functions have been compromised, a wetland can benefit in a variety of ways from the installation of water-level management structures.

Improves water quality. Water-level control has been shown to be a crucial factor in the reduction of pollutants in wetlands managed for water quality improvement (Garcia et al. 2005). Water-level control structures allow the land manager or restoration practitioner to regulate the rate of flow into and out of a wetland, potentially extending the hydrological period of an area and allowing for greater pollutant and nutrient removal by wetland vegetation.

Aids in flood control. Proper use of water-level control structures allows for seasonal flood control in sensitive wetland habitat.

Recharges ground water. Water control structures may be used to slow and reroute the runoff during rainy seasons to areas in need of recharge. In the coming years, the need for managed ground water recharge will increase due to climatic changes and increased groundwater use.

Aids in the recovery of wildlife and plant populations. Water-level management structures allow managers to create or maintain the conditions that promote particular plant communities or wildlife populations (Hammer 1997). Maintaining shallow water depth, for example, promotes upland game and waterfowl (Maul 1997; Elphick 2003), while deeper water allows some species (e.g., the California red-legged frog) to escape predation. Controlled flooding allows for fish movement into wetlands for spawning and provides rich nursery habitat for fry.

Controls undesired species. Wetland water-level management structures can provide various means for controlling undesired species. They can be used as physical barriers to prevent nuisance species from entering the system from downstream. By allowing draw-down of wetlands, they can enable managers to reduce the hydroperiod, favoring species (typically natives) that can survive a shorter period of inundation. Reducing the hydroperiod can be an important means of eliminating bullfrogs and non-native fish, for example (Adams and Pearl 2007). Draw-down can also provide managers access for more active elimination of species.

Planning

Successful installation and use of wetland water-level management structures requires restoration planning, informed design and installation, and oversight by an appropriate team of experts.

Because their effects may be far-reaching, wetland water-level management structures should be installed only after the preparation of a comprehensive restoration plan that considers all aspects of the proposed project. A wetland restoration plan typically includes an assessment of the site's hydrology, soils, and biotic features; this assessment then informs restoration goals and the specific water-level management strategies that will be used to pursue the goals.

Different wetland restoration goals require different hydrological management strategies. It may not be possible to pursue all goals at the same time, and not all goals require water-level management structures. To recover wildlife and plant populations, it is often necessary to emulate the natural hydrology of wetlands, accounting for California's historically Mediterranean climate as well as the seasonal rain patterns specific to the region (Pacific Estuarine Research Laboratory 1990). To improve water quality, adequate water flow and depth are important considerations (Garcia et al. 2005). It is important, therefore, to have a clear idea of your restoration and conservation goals before implementing the project.

Table P6.1 provides an example of how different management strategies can have widely varying effects on a wetland's value as habitat.

Table P6.1 Wetland habitat values associated with various summer water levels

	Summer water level		
	Moist soil (mudflat)	15 cm	> 30 cm
Plant species diversity	fair	excellent	fair
Wildlife use and diversity	fair	excellent	good
Fish abundance	none	good	excellent
Migratory bird use	excellent	good	fair
Invasion by nuisance species	high	low	low

Table adapted from Mitsch and Gosselink 1993.

Advance Analysis

Site Assessment

If the initial restoration planning process determines the need for wetland water-level management structures, a detailed site analysis is needed to inform structure design. In all cases, engineering calculations are necessary, and biotic concerns such as fish passage are often also a concern (Mitsch 1993). A soils assessment is also important as only hydric soils have the capacity to hold water on or near the ground surface for at least a portion of the year (Zelek 1999). Hydric soils form over a long period of time and are very difficult to create. For this reason, wetland water-level management structures are generally successful in restoring wetlands only where these special soils are present (Sargent 1999). However, when hydric soils are absent, clay or synthetic liners can be installed to increase the hydroperiod.

Revegetation

Revegetation often accompanies the installation of water-level management structures in a wetland. Refer to the *Revegetation with Native Plants* section in Chapter 1.

Expertise Needed

Hydrologist. A hydrologist should perform a baseline assessment and a hydrological analysis. Expertise in predictive modeling is important given that this project is designed to create changes in hydrology.

Biologist. A biologist familiar with the affected aquatic biota should perform a baseline analysis of desired and undesired species and determine the best course of action given biotic targets. Expertise in aquatic ecosystems is important; in some cases expertise in the species being targeted for restoration or control is also important.

Water Quality Scientist. If improvement of water quality is a primary goal, a water quality scientist can assist with understanding baseline conditions and factors to consider in designing the project to improve water quality. If a specific water quality impairment is targeted, the scientist should be familiar with the appropriate management and monitoring measures.

Engineer. An engineer works closely with the project hydrologist to design the structure and advise on its installation. Experience with wetland water-level control structures and regional hydrological patterns is advisable.

Implementation

Management goals and the characteristics of the specific site determine the type of structure to be installed; they also determine to some extent the structure's design and the materials that may be used.

Design

Water-level management structures are as varied as the wetlands in which they are installed. Core aspects of their design, however, are fairly consistent. A water-level control structure generally consists of some kind of barrier (a berm or levee) in which there is embedded a gate-like means for allowing water to penetrate the barrier. They are often employed in pairs, with one controlling the input of water into the wetland and another the output.

Traditional floodgates. These are simple systems that can be hinged at the ends of culverts or headwalls to allow flow of water in a single direction. The opening and closing of floodgates is dependent on changes of the water level caused by rainfall, floods, or tidal fluctuations. Floodgates are effective in managing the impacts of minor floods and may be used to drain low-lying wetlands, but they also can have serious environmental impacts if not managed properly.

Manually operated floodgate modifications. Winching systems, penstocks, and sluice gates can be added to the ends of culverts to allow for manual regulation of water flow. These modified floodgates provide for excellent water-level control and flood protection. They are reliable, adjustable, and require low maintenance. Depending on the design and materials they can be expensive.

Photo P6.2 Tide gate Photo: ESNERR

Weirs. Weirs are retention structures that require no adjustment after installation. Weir retention structures can guarantee a minimum water level in the system behind the structure to satisfy management objectives such as rehabilitating wetlands. Water control gates can be installed to allow fish passage. Sheet pilling weirs are an excellent design for use in sensitive environments where minimal disturbance to the system is required.

Adjustable water retention structures. Flashboard riser water-level control structures, with their increase-decrease style of incremental movable boards, have been used for centuries to control water levels in ponds, wetlands, and marshes. The movable board or log systems are ideal for adjusting the water level of small ponds or water containment basins. Pre-fab concrete structures offer excellent water control and are easy to adjust, easy to install, and inexpensive. Maintenance is important and structures should be regularly monitored to insure against tampering and vandalism.

Subsurface drainage. Subsurface drainage can be used to bring water from surrounding areas into a wetland. It is appropriate where the soil is permeable enough to allow economical spacing of the drains. A subsurface drain will provide trouble-free service for many years as long as it is carefully planned, properly installed, and constructed of high-quality materials. When planning a subsurface drainage system, make sure that a suitable surface or subsurface outlet is available or can be constructed. Where a surface outlet channel is used, all subsurface drains emptying into the outlet should be protected against erosion, against damage that occurs during periods of submergence, against damage caused by floating debris, and against entry of rodents or other animals.

Additionally, emergency spillways are often installed in existing or created berms or levees for water drainage during flood events. Spillway design and size will depend on the surrounding watershed and the total acreage of impounded wetland.

Essential to water level management is choosing the correct placement of a water control structure. Control structures should be positioned at the lowest elevation in a wetland to allow for complete drainage or drawdown if needed. Every wetland restoration is unique in its own way; consequently, landowners must identify the water control system that best suits their project needs and budget. The appropriate size and number of control structures required will often depend on topography, overall size of the wetland, and size of the surrounding watershed.

The Wetlands Engineering Handbook by the Army Corps of Engineers (Hayes 2000) discusses wetland engineering procedures, including design of wetland water-level management structures. Section four of the publication covers geotechnical aspects, describing soil handling and earthwork techniques including excavation and containment of dredged material.

Materials

Cost and durability are factors to consider in choosing materials, but types of materials are determined primarily by the type of control structure being installed.

Spillways. Spillways can consist of pipes; they can also be constructed from concrete or rock and turf-reinforcement netting. At a small scale, they can be installed by hand; larger projects may need heavy equipment (see Figure P6.4).

Photo P6.3 Spillway in use during flood

Culverts/Flashboard risers/weirs. Construction involves the installation of a concrete, plastic, or corrugated metal structure that creates a partial blockage to water flow. The center has a gap and each side has railings into which the dropboards are placed. Pre-fabricated concrete sides require heavy lifting equipment to install. The dropboards are of a size that can be managed manually and allow the passage of an appropriate volume of water.

Adaptive Management

Adaptive management planning is best addressed collaboratively; landowners, project managers, and project consultants should be among those involved. The design should take into account long-term site-specific management constraints and the need for long-term monitoring (Natural Resource Conservation Service 2007).

Monitoring

Monitoring targets will be defined by the objectives of the restoration project; they will likely include the status of fish and wildlife populations, the progress of the re-vegetation process, and measures of water quality. Water levels will need to be monitored to inform flashboard heights.

Maintenance

Routine maintenance is required for all water-control structures to maintain proper functioning. Control of inappropriate vegetation growth (especially on spillways), as well as erosion inspection and repair, should be part of a routine maintenance plan. Removing obstructing debris is necessary to avoid flooding and potential damage to structures. A maintenance plan typically includes an established inspection schedule and a protocol for inspection during and immediately following a large storm. Inspections during and after storm events can allow for removal of debris before problems become worse; installing structures to prevent debris impacts can also help (Bradley et al. 2005).

Potential Concerns

Blocked fish passage. Fish passage may be blocked by water control structures that are not placed or managed properly. A hydrological analysis of the wetland and a biological survey that assesses the presence of fish can identify potential issues and allow the project managers and land managers to address these in advance. A hydrologic analysis can determine where to place the structure to insure that fish movement is not impeded (Rampano 2009).

Flooding. Hydrologic analysis of the wetland and adjacent area should be completed during the planning stage to predetermine the potential for flooding. A strategic plan for mitigating this potential should be addressed with those individuals who will be maintaining the structure (Rampano 2009).

Sediment accumulation. As water flows across a wetland, sediment naturally moves and settles out. There is a risk, however, of sediment accumulating in front of water control structures, effectively blocking and compromising them. Filter strips and buffers with proper vegetation can limit the amount of sediment entering a newly created wetland and thus eliminate the potential for excess sediment accumulation at water control structures. These filter strips and vegetated buffers can also provide additional habitat for wildlife.

Costs

Costs associated with the installation of water-level control structures are highly variable and depend upon specific site requirements and desired conservation objectives. The cost of structural design and installation is influenced by many factors, including the need for engineering and scientific analysis, the type of structure, choice of construction materials, size and number of structures, nature of supporting infrastructure, cost of transport, need for erosion control, and on-going maintenance requirements

Installation costs are also be influenced by site accessibility and site conditions. Engineering and scientific advice is required with this project and cannot be overlooked.

Related Resources

- The American Society of Professional Wetland Engineers (American Society of Professional Wetland Engineers 2010) offers information on flashboard risers at: http://wetlandengineering.rcharney.com/index.php/Flashboard_riser_sources

- Wetland water level management structures are reviewed in: Water Control Structures: Design Suitability for Natural Resource Management on Coastal Floodplains (Rampano 2009)

Case Study

Structure for Water Control to Manage Prospect Pond

Ellicott National Wildlife Refuge, Watsonville, California

United States Fish and Wildlife and the Resource Conservation District of Santa Cruz County

Summary

Ellicott Slough National Wildlife Refuge, a 315-acre complex managed by United States Fish and Wildlife Service (USFWS), was acquired to provide vital wetland and upland habitat for a number of migratory birds and terrestrial and amphibian species, including the endangered and state-designated fully protected Santa Cruz Long-toed Salamander (SCLTS), the threatened California Red-legged Frog (CRLF), and the threatened California Tiger Salamander (CTS). In an effort to improve habitat and increase salamander populations on the refuge, Prospect Pond was constructed in 1997. However, the pond failed to retain adequate water throughout the time period needed to ensure salamander metamorphosis from aquatic larvae to terrestrial juveniles.

Implementation

A new pond was constructed in 2012 to improve wetland habitat and fulfill an objective in the 1999 Revised Recovery Plan for the Santa Cruz Long-Toed Salamander: to establish two functional breeding ponds as a measure to recover the species. To ensure adequate water, a 10-foot deep subsurface drain was constructed upslope of the pond to direct subsurface flow. Three water control valves were installed to regulate the amount and timing of this water entering the pond. In addition, a 24-inch high-density polyethylene riser pipe was installed within the pond. The riser pipe ensures that during large rain events, water does not overtop the pond embankment, which could result in structural failure; it also functions in conjunction with a 6-inch PVC pipe running through the berm and a control valve system that regulates water levels within the pond. The latter system allows water to be drained slowly from the pond to promote amphibian metamorphosis or to drain the pond if colonized by non-native fish or bullfrogs.

Results

Amphibian breeding occurred immediately after pond construction in the 2012/2013 winter season. Thirty-five CTS metamorphs were found in April 2013 during aquatic surveys, and nighttime surveys in November 2013 and February 2014 found juvenile CTS moving out of the pond. Given the ongoing drought, wetland management has focused on ensuring that water is retained. The system has not needed to be drained to encourage metamorphosis or to control non-native species.

Task Checklist

Design the project

- [ ] Contact landowner to discuss work
- [ ] Create a team of experts
- [ ] Describe objectives and purpose of restoration work
- [ ] Choose water control structure that allows access for manipulation
- [ ] Choose water control structure based on anticipated management
- [ ] Define adaptive management strategy
- [ ] Contact regulatory agency to understand pertinent regulations
- [ ] Account for machine access
- [ ] Create work plan
- [ ] Contract with sub-contractors

Analyze the site

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

Revegetate

- [ ] Choose appropriate plants
- [ ] Identify planting supervisor
- [ ] Organize planting either with hired crew or volunteers
- [ ] Sow seeds and plant seedlings as appropriate
- [ ] Mulch
- [ ] Irrigate

Maintenance the first year

- [ ] Regulate water level
- [ ] Remove debris
- [ ] Control invasives
- [ ] Replant where necessary

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