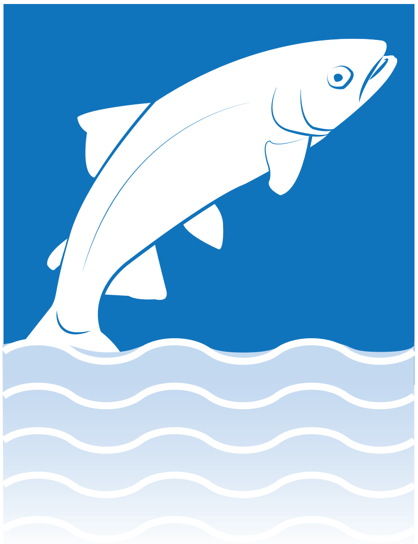

Chapter 4
Six Key Projects

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"

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Project 2
Emplacing Large Woody Material in a Stream

Placing large woody material (LWM)—logs, trees with branches, and root balls—in streams increases stream habitat complexity and stabilizes streambanks.

Background

Humans have long removed large woody material from streams and rivers to improve navigation, improve flow, and to control flooding. In addition, large channeling operations have often cleared instream woody material and removed the riparian forest that served to recruit more large woody material. Recently, it has been recognized that these activities degrade stream health and negatively affect stream channel stability (Bilby 1984).

Benefits

Many streams in California, along with their watersheds, have been subject to management or alteration that has tended to simplify and homogenize stream habitats. Because it helps to reverse or mitigate these effects, the placement of large woody material into streams provides some important benefits.

Increases habitat complexity. Large woody material placed in a stream modifies stream flow and changes sedimentation patterns. It can create riffles and cascades, banks of gravel, and pools, all of which can be critical habitat components for many aquatic species. The material itself also casts shade, forms refugia where organisms can hide from predators, provides basking sites for reptiles, and provides perching and feeding sites for birds. In these various ways, placement of LWM restores stream habitats, benefitting many species (Carlson, et al, 1990; Beechie and Sibley 1997). Because they require habitat complexity, many aquatic animals in California's streams—including salmon and trout—are dependent upon the presence of in-stream large woody debris (Beechie and Sibley 1997).

Controls erosion. The placement of LWM in streams reduces erosion by increasing the stability of streambanks.

LWM helps to reduce high-flow energy and to redirect flow that would otherwise erode streambanks (Bilby 1984; Reckendorf 2010). Another factor in reducing erosion is LWM's role in restoring more natural sediment storage (Angermeier and Karr 1984).

Planning

Ideally, large woody material placement occurs after a comprehensive riparian restoration plan is developed, but it may be done without the expense of a full plan. A comprehensive plan addresses not only the placement of large woody material but also the natural production and movement of large woody material, so that the function of LWM can be sustained in the long term without human intervention.

Oftentimes, large woody material placement is a first step in restoring habitat complexity to a stream.

Advance Analysis

Site Assessment

Typically, a LWM emplacement project begins with a historical analysis and site assessment. Hydrologists or engineers typically assess historic flows and flood plain morphology. Site surveys also assess site stability, access issues, and river-channel hydrology, and create a wood transport budget.

Site stability and site access are key factors in determining the suitability of a LWM placement project. The Department of Fish and Wildlife *California Salmonid Stream Habitat Restoration Manual* (Flosi et al. 1998) outlines the factors to be assessed in determining site stability. The list of factors is too lengthy for the scope of this document. Site access assessment focuses on the possibility of avoiding or minimizing damage to riparian habitat.

Photo P2.1 Large woody material placement using locally harvested trees.

Hydrological analysis during the planning stage insures that the project achieves desired outcomes while avoiding potential negative impacts. Each stream and project is different and responds differently to the addition of wood. Assessment of historic flow and the adjacent flood plain morphology helps to predict flooding potential as well as the possible extent of stream scour and sediment deposition processes (Reckendorf 2010).

A wood transport budget aids project managers in understanding the processes and rates of natural wood recruitment, including its storage, transport, and decay (Benda 2002; Lisle 2002; Wooster and Hilton 2004). Creating a wood transport budget begins with an assessment of the potential of the existing riparian forest to produce LWM of adequate size and quantity. In areas of the state where endangered-species recovery plans have been completed, studies may already exist to inform wood transport budgets without completing often-expensive new analyses.

Expertise Needed

Hydrologist. A hydrologist should perform a baseline assessment and hydrological analysis to determine if the project can meet its goals. Expertise in predictive modeling is important given the potential changes in hydrology that come from emplacement of LWM.

Biologist. A biologist familiar with the affected aquatic biota is necessary for performing a baseline analysis of desired and undesired species and to determine the best course of action given biotic targets. Expertise in aquatic ecosystems is important; when a particular species is being targeted for restoration or control as part of a larger restoration effort, expertise in this species is also important.

Water quality scientist. A water quality scientist can assist with understanding baseline conditions for water quality and designing the project in such a way that it maintains or improves water quality. If specific water quality impairment is targeted, the scientist should be familiar with management and monitoring measures for that issue.

Engineer. An engineer works closely with the project hydrologist to advise on wood placement and, if it is determined to be necessary, how to secure the wood in place. Experience with regional hydrological patterns is advisable.

Forester. This expert should work closely with the engineer and biologist to provide guidance on wood load, wood recruitment possibilities, and safe access to the site.

Implementation

A variety of site-specific characteristics including project objectives, funding, wood sources, and site access are some of the factors that guide project design and decisions about materials and installation.

Design

Determining what size wood to use is an important aspect of project design. Different sized LWM will differ in the amount of time it persists in the stream (Lisle 2002). A standard rule is that LWM length should be approximately two times the width of the channel. Small channels (<10 m width) can form pools around smaller pieces of wood (<20 cm), such as alder logs. Large to intermediate channels require greater diameter logs to form pools (>60 cm).

The California Department of Fish and Wildlife *Salmonid Manual*, along with numerous scientific studies, provide detailed information on appropriate wood size (Flosi et al. 1998; Lisle 2002; Leicester 2005).

Appropriate installation methods for large wood material placement will vary depending upon the project location, downstream considerations, watershed characteristics, and goals. Traditionally, many large wood material placement projects included fixed or cabled structures, sometimes in conjunction with boulders. At the Soquel Demonstration Forest in Santa Cruz County and all along the North Coast of California, unanchored large woody material is increasingly gaining favor as a way to effectively improve salmonid habitat along longer lengths of streams.

Unanchored wood placement, where appropriate, involves the reintroduction of unsecured or wedged large wood along stream channels. This practice begins by directionally falling streamside trees into the channel where riparian shade is sufficient, or by translocating large wood from outside of the riparian zone with heavy equipment. Once the wood has been placed into the stream, it may be left unsecured and allowed to move with the natural flow of the stream.

It may be determined during the planning phase that anchored wood placement is required; this is a more involved practice and requires additional materials and techniques. Natural boulders may be used as brace points, but most commonly steel cables, wire rope, rebar, and bolts are employed. The decision about whether to use secured or unsecured wood should be made in the planning phase, as it affects the materials used and the final cost of the project.

The Engineer Research Development Center, a branch of the U.S. Army Corps of Engineers has published a guide to emplacing large woody materials in streams for the purposes of restoration. This document is an excellent resource for learning what goes into the planning, engineering, and implementation of this project (Fischenich and Morrow 2000).

Materials

Large woody material may consist of logs, root balls, or felled trees. Each type of material can be used on its own or they can be used in combination. The most important consideration is longevity, and this varies with size and tree species. For example, conifer species such as redwood last longer than hardwood species such as willow or alder. Ideally, materials are available from the project site. However, if materials must be imported, site access and cost must be considered.

As noted above, if the LWM is be secured, materials such as steel cable, re-bar, and bolts will be required.

Adaptive Management

Preserving and encouraging the growth of recruitment trees in the riparian forest is part of the adaptive management strategy. Ideally a restored riparian/riverine system becomes self-supporting: LWM placement protects streambanks, allowing trees to grow, which ultimately supplies more LWM to the system. The possible management implications of preserving LWM input, transport, and presence within the stream channel is reviewed in the 1992 report of the California Board of Forestry and Fire Protection's Technical Advisory Committee (California Board of Forestry and Fire Protection Technical Advisory Committee 2007).

Further management practices are reviewed and outlined in K. J. Gregory and R. J. Davis's article in *River Research and Applications* (Gregory and Davis 1992).

Monitoring

Data on location of placement of LWM, anchoring or non-anchoring techniques, and size of wood should be collected when the LWM is put into place. Subsequently, it is recommended that a monitoring program collect data on movement of the LWM, the biological effects of its placement, and the creation of pools and bars of gravel and sand. The success of future LWM placement depends on the sharing of data to continually improve the use of this restoration practice throughout California.

Maintenance

Seasonal maintenance will include removing excess debris or possibly adding additional wood after storms.

Potential Concerns

Habitat damage from large equipment. Large equipment may be used for transporting and placing logs and root balls. The use of large equipment can potentially damage riparian habitats and weaken streambanks. Loss of riparian vegetation can lead to loss of shade and recruitment of woody material as well as the introduction of non-native invasive plant species. Consider site access and identify the least impactful routes during the planning stage.

Bank failure. Streambank erosion is a naturally occurring process in a healthy riverine system. If not done properly, however, LWM placement can lead to undesired bank failure. Understanding historic channel flow and the hydrology of the system helps engineers and planners to better predict the outcomes of LWM placement (Reckendorf 2010). These studies guide the engineer in assigning placement sites and determining the size and types of woody material to be used.

Mobilization of large woody material. With large woody material placement there is the risk that the woody material could mobilize from the restoration site and endanger critical public works infrastructure downstream. Using very large wood can limit potential movement and downstream impacts. Keeping the rootball intact also reduces the threat to downstream infrastructure. If the mobilization of LWM poses a large risk, the wood can be secured or anchored at the site. There are numerous techniques for anchoring wood material and each should be considered carefully and with a complete understanding of what it entails.

Flooding. Increased wood in the system could lead to impoundments and thus trigger a rise in flood levels. Adding LWM to a system already wood-rich could create not only flooding but also stream diversions and impact surrounding habitat and infrastructure. To address this potential outcome, conservationists and planners should assess the site before introduction of LWM and determine the proper size and amount of wood to be added. Research suggests that the smaller wood pieces tend to cause the most significant flooding problems. Models for determining the loading targets for certain types of streams have been developed (Lisle 2002).

The Army Corps of Engineers Ecosystem Management Restoration Research Program technical report (Fischenich and Morrow 2000) addresses these and other potential problems associated with large woody material placement and provides suggested environmental protection measures.

Costs

Costs associated with large woody material placement can vary from site to site and are influenced by several factors, including site access, the need for large transport equipment, the type of trees used, and whether or not anchoring equipment is required.

As noted above, site analysis is necessary to determine the needed load for the system based on the hydrology of the river. The cost of employing experts should be accounted for when planning to implement this project.

Long-term costs can be greatly reduced by managing the surrounding riparian forest in a way that results in natural recruitment of LWM.

As part of a study of the effects of large woody materials placement on juvenile Coho recruitment (Cederholm et al 1997), the Washington State Department of Natural Resources estimated the costs associated with two different techniques for emplacing LWM. These estimates are shown in Table P2.2. The findings suggest that directional felling of trees into a stream is the most cost-effective way to get wood into the stream.

Table P2.2 Expenses for two different methods of large woody material placement

	Engineered section	**Directional falling section**
Total cost	$82,250.00	$6,450.00
Cost/m of channel	$164.50	$12.90

Source: Density and Size of Juvenile Salmonids in Response to Placement of Large Woody Debris in Western Oregon and Washington Streams (Roni and Quinn 2001)

When trees must be brought in to a site, there is a considerable additional cost. Timber cost varies from year to year and species to species. For example, Washington Douglas Fir is $100 per 1000 board feet and California Redwood costs about $510 for the same amount.

The NRCS Cost Share Practice Standard estimates that the materials cost of a LWM project using anchored wood is about $1,900.00 per acre and about $924.00 per acre for one using unanchored wood (these materials costs represent 50% of the total cost).

Case Study

Effect of LWM Placement on Salmonid Populations

Thirty Streams in Western Oregon and Washington

Between August 1996 and April 1999 thirty streams in western Oregon and Washington were sampled to study the response of salmonid populations to large woody material placement. The study indicated that LWM placement can lead to higher densities of juvenile coho during summer and winter and cutthroat and steelhead during the winter.

Many studies suggest that LWM placement plays a critical role in the rehabilitation of fish habitat in streams (Roni, Hanson et al. 2008). LWM creates pools, provides shade, increases habitat complexity, reduces sediment, and traps gravel, leading to an overall improvement in the streams' health and its value as fish habitat. These benefits have led to LWM placement becoming one of the most common stream restoration practices. This study sought to correlate these benefits to increased salmonid abundance.

Implementation

Paired treatment and reference reaches 75–120m long were selected in each of the thirty streams. The streams were selected based on physical and biological stream characteristics. It was important for reference and treatment reaches to have similar characteristics such as stream size, bankful width, channel type, and fish species composition in order to control "background noise."

During summer and winter surveys, the amounts of LWM and fish numbers were recorded in each stream. All natural and artificially placed LWM was counted and measured and categorized based on length, with, and function. Electrofishing was used in summer to census fish, and in the winter divers counted fish.

Results

Treatment and reference reaches were identical in length and other physical characteristics; however, there were some physical differences between the two that correlated with the increased LWM in the treatment reaches. LWM reaches had greater pool area, wetted area, and number of habitats. The study also found significantly higher densities of juvenile coho in summer and winter in the treatment reaches. The results of this study support previous findings that restoration projects that increase LWM and thus increase pool area and stream complexity provide the largest increase in fish populations.

Source: Density and Size of Juvenile Salmonids in Response to Placement of Large Woody Debris in Western Oregon and Washington Streams (Roni and Quinn 2001)

Related Resources

- The Wood for Salmon Workgroup has researched various methods for large woody materials placement. This organization has publications that address permitting concerns and suggests partners that can assist in this work (Warmerdam 2012).

Task Checklist

Design the project

- ☐ Contact landowner to discuss work
- ☐ Create a team of experts
- ☐ Describe objectives and purpose of restoration
- ☐ Develop adaptive management strategy
- ☐ Design LWM placement plan based on assessments
- ☐ Determine if wood will be anchored or unanchored
- ☐ Identify LWM source
- ☐ Identify access to sites
- ☐ Create work plan
- ☐ Contact regulatory agency to understand pertinent regulations
- ☐ Contract with subcontractors

Analyze the site

- ☐ Conduct geomorphic assessment
- ☐ Conduct biological survey
- ☐ Conduct hydrology study
- ☐ Conduct forestry survey

Prepare site for LWM placement

- ☐ Erosion control

Maintenance the first year

- ☐ Inspect for stream blockage
- ☐ Remove excess debris
- ☐ Add additional wood if needed

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