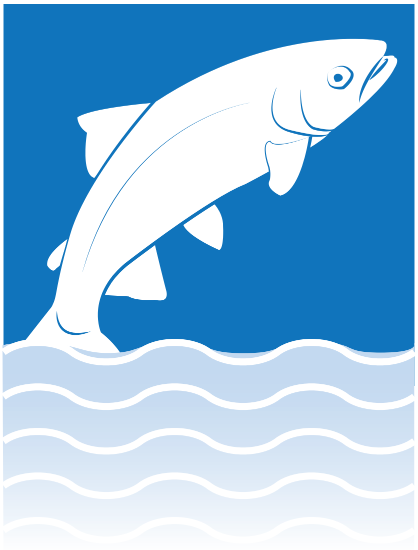
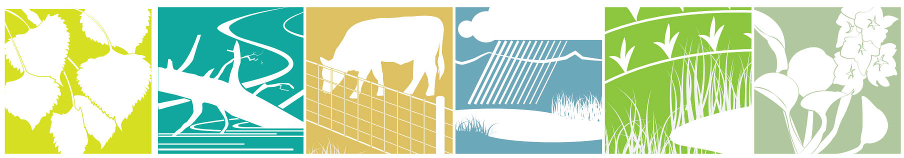


# Chapter 4
# Six Key Projects

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.

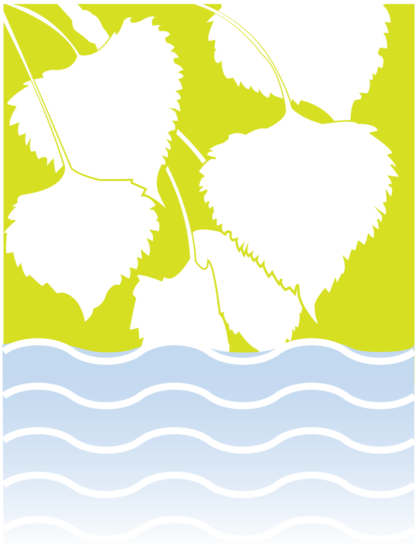
Each project offers a wide range of benefits to wildlife, stream health, and water quality. The table below identifies some of the specific benefits associated with each one.



| | 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 1*
# Removing an In-stream Barrier

*The removal of in-stream barriers has two primary objectives: improvement of passage for aquatic species and restoration of more natural hydrologic processes.*

### Background

Rivers and streams flowing into the Pacific Ocean along California's coast provide critical habitat for threatened aquatic species, most notably Coho salmon and steelhead. These anadromous fish depend on access to fresh water for breeding and rearing habitat to complete their life cycles. More than 13,000 barriers in California's coastal watersheds threaten the survival of these fish. Throughout California, in-stream barrier removal has the potential to restore 80% of the critical spawning and rearing habitat historically available to salmon and steelhead and other fish species.

## Benefits

***Improves passage for aquatic species.*** Many aquatic species, particularly anadromous fish, need to move between varying habitats along a stream course to support different life-history stages (Photo P1.1). Because in-stream barriers—even small culverts—limit or prevent this movement, their removal can allow these aquatic species to increase their numbers or even repopulate a stream from which they had been absent (Figure P1.2). In-stream barrier removal projects have resulted in the return of native fish within the first season of barriers being removed. There is a long-documented history of success improving habitat for aquatic species elsewhere in the U.S. through such barrier removal (i.e., Horowitz, Overbeck et al. 2001; O'Donnell 2001).

Photo P1.1 Barrier removal benefits include recovery of fish migration corridors Photo: ESNERR

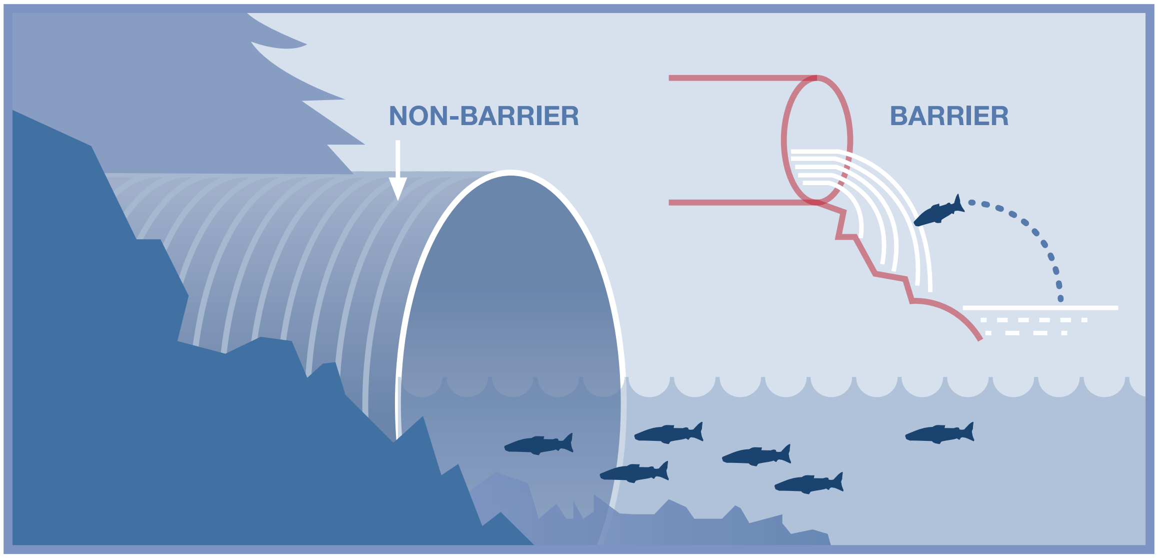



Figure P1.2 Even small barrier removal projects can have significant benefits for fish.  Luis Prado/DNR

***Restores natural stream processes.*** In-stream barrier removal restores natural hydrological processes both upstream and downstream of the site because it allows unimpeded stream flow and the transport of sediment and large woody material. After in-stream barriers are removed, sediment can more readily move downstream, restoring gravel and cobble habitat, which is crucial for the breeding success of anadromous fish. Allowing large woody material to be transported downstream also improves fish habitat. Beaches benefit from sediment flow after barriers are removed and the natural sinuosity of streams may be restored. In-stream barrier removal also restores riparian habitat by decreasing the unnatural water storage that typically occurs upstream of barriers and which inundates riparian habitats.

## Planning

Barrier removal needs to be considered as part of broader, watershed-scale planning. If in-stream barrier removal is determined to be appropriate, specific, project-level assessment of barrier removal effects on stream channels is necessary (see *Site Assessment* below).

The California Department of Fish & Wildlife, National Marine Fisheries Service, and the California Coastal Commission have catalogued the rivers and creeks that should be prioritized for barrier removal and have done much of the needed hydraulic analysis and species surveys of these waterways. The U.S. Department of Agriculture, Forest Service has also developed a useful on-line document: National Inventory and Assessment Procedure – For Identifying Barriers to Aquatic Organism Passage at Road-Stream Crossings.

# Advance Analysis

## Site Assessment

The watershed-scale planning that usually precedes identifying an in-stream barrier as a candidate for removal normally includes watershed-scale hydrological and biotic assessments. If such assessments have been completed, the need for further site-specific environmental assessments may be limited to a water and sediment flow analysis. This analysis predicts how the sediment trapped behind the barrier will be transported downstream and how this sediment transport combined with increased stream flow will cause changes in channel form.

Because bridges and historic irrigation systems greater than 50 years old may be classified under federal law as protected cultural resources, it may also be necessary to conduct a preliminary assessment of the age and status of any structures that would be removed as part of implementing this project.

## Seasonality

Work should take place between late spring and early fall in order to minimize impacts on water quality, stream habitat, and aquatic species. A hydrologist familiar with the region can identify appropriate seasonal dry periods and suggest the best times for construction. If the restoration project is taking place on a stream that does not dry down, it is necessary to consult with a fish biologist to plan to avoid negatively impacting any species of concern. In many streams where federally and/or state threatened, endangered, or sensitive aquatic species are present, specific regulations may dictate the range of dates in which work or disturbance to the stream channel and/or riparian corridor can be conducted. Project proponents should contact the California Department of Fish and Wildlife, the National Marine Fisheries Service (for projects in marine and anadromous waters) and the U.S. Fish and Wildlife Service (for projects in anadromous and fresh waters) for guidance. In addition, a California Department of Fish & Wildlife "Streambed Alteration Permit" must be obtained for any activity that will "substantially divert or obstruct the natural flow of any river, stream or lake; substantially change or use any material from the bed, channel, or bank of, any river, stream, or lake; or deposit or dispose of debris, waste, or other material containing crumbled, flaked, or ground pavement where it may pass into any river, stream, or lake."

## Expertise Needed

In addition to involving the experts listed below, it will be necessary to identify an entity or person who will be responsible for developing an adaptive management plan for the project (see below).

### Characteristics of a Fish-friendly Road Crossing Over a Stream

- The crossing width is at least as wide as the active channel.
- The culvert is able to pass a 100-year storm flow.
- The crossing bottom is buried below streambed level.
- Natural bed material is able to accumulate along the bottom of the crossing.

In general, a bridge is preferred over a culvert as it usually doesn't constrict a stream channel as much as a culvert

***Hydrologist.*** A hydrologist must perform a baseline assessment and a hydrological analysis. Expertise in predictive modeling is important given that the project is designed to cause changes in stream hydrology. A hydrological analysis can be and is frequently done by an engineer with the appropriate expertise.

***Fish 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.*** A water quality scientist can assist with understanding baseline conditions for water quality and designing the project in a way that will maintain or improve water quality. If a specific water quality impairment is targeted, the scientist should be familiar with management and monitoring measures for that target.

***Engineer.*** An engineer is necessary for guiding the careful removal of barriers and potentially for engineering safe fish passages.

## Implementation

Materials and methods for removing in-stream barriers vary from site to site and are dependent on the scale of the project, the type of barrier being removed, and the size of the riparian area.

### Methods

Barrier removal may entail the rerouting of the river or stream during the construction period. Prior to commencing a project the stream should be netted above and below the construction site and any fish present removed from the site. The California Department of Fish & Wildlife and a fish biologist should oversee the fish removal and relocation process.

With fish safely removed, the stream may be diverted and dewatered in preparation for the barrier removal. Depending on the type of barrier to be removed the work may involve hand-held tools or heavy lifting equipment.

Removal of in-stream barriers may result in changes to channel morphology (NRCS 2007), and so some projects should include widening of the stream channel and the restoration of a natural stream bottom with boulders (for grade control).

If the barriers involve road crossings, the restoration work includes not only the removal of the barrier but also its replacement with a fish-friendly crossing and repair of the road affected by the project (see *Characteristics of a Fish-friendly Road Crossing Over a Stream*). If road removal and replacement is involved, permission for temporary closure should be obtained during the initial project planning stage.

### Materials

Possible materials needed include netting and electro-shock equipment for removing fish, large lifting and hauling equipment for removing the barrier, and replacement culverts, bridges, or boulders.

## Adaptive Management

Restoration practitioners who remove a barrier to improve fish passage should be prepared to make adaptive management decisions during the first few years after the project, and possibly longer. Of particular concern will be the new hydrological characteristics of the stream, sediment dispersal, debris movement, and possible erosion of streambanks.

### Monitoring

Annual and seasonal monitoring of stream flow, sediment deposition, water temperature, and physical habitat may be required to detect and document the significant changes in the hydrology and ecology of the stream that are to be expected in the first few years following the removal of a barrier. If targeted fish species are present, their populations and breeding behaviors should be monitored on a regular basis.

### Maintenance

If new structures have been put in, these passages must be checked periodically for debris and damage.

## Potential Concerns

***Water quality disturbance***. Initially, barrier removal may adversely affect water quality through the transport of sediment-bound contaminants residing in the upstream impoundment. The initial site assessment should inform the project managers of potential sediment contaminants present in the impoundment. In some cases, historical analyses of the watershed can help identify potential pollutant issues.


Photo P1.3 Installing culverts to improve water quality. Photo: ESNERR

***Increased sediment.*** Sediment transport increases after barrier removal and can cause immediate loss of fish habitat downstream due to accumulation and scouring (Catalano 2001). An understanding of the native fish and their life cycle assists in designing a project that avoids spawning seasons and allows time for natural river hydrology to evolve. Within one season new pools are created and sediment dislodged during construction clears. The likelihood of habitat-affecting sediment movement is one reason a qualified fish biologist should be involved in the planning stage and should monitor the project after completion.

***Habitat loss.*** Barrier removal may lead to the loss of valuable upstream aquatic habitats. Restoration practitioners must make decisions that evaluate and weigh the importance of each kind of ecosystem.

***Species shifts***. Upon removing a barrier, both native and non-native species are free to move upstream into areas from which they were once restricted. This shift in species abundance can lead to species of concern being displaced. While many anadromous species benefit from the expanded migratory range offered by in-stream barrier removal (Gardner 2011), other aquatic species may face increased competition and predation from these as well as invasive species. An analysis of riparian habitats and assessment of the local species informs decisions for addressing this concern. A California Department of Fish & Wildlife biologist can assess the presence of sensitive species in up-river waterways as well as the presence of any potential invasive species downstream. If invasive wildlife species are identified, a plan for their removal may be warranted. If complete eradication is not possible, increasing habitat heterogeneity through such methods as emplacement of large woody material (see Project 2) and boulders may offer protection for some species of concern. Other design options for mitigating the movement of invasives can be developed during the planning stage. In most instances the benefits of barrier removal to sensitive fish species outweigh the threats of invasive movement (Hart, Johnson et al. 2002).

## Costs

The costs associated with barrier removal vary depending on the scope and scale of the project. Costs are incurred in hiring experts and contractors, purchasing materials, traveling to and from the site, securing permits, and renting heavy equipment and/or hiring equipment operators.

A number of factors influence the final costs, including site accessibility, the type of materials needed, and whether or not it is necessary to replace the removed barrier with a functional equivalent.

Recent estimates of costs average around $110,000 per mile of habitat restored (Five Counties Salmonid Conservation Program 2012). See Table P1.4.

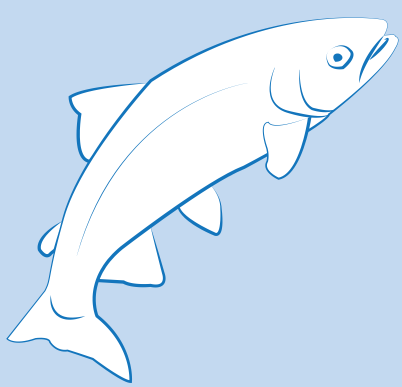
### Table P1.4: Project costs of a barrier removal project in Northern California

| | |
|---|---|
| County Engineering Staff | $3,984.81 |
| County Road Staff | $5,930.18 |
| Concreted-Rock Slope Protection Under Flatcar Bridge | $300.00 |
| Flatcar Bridge | $24,595.00 |
| Grade Control Boulders | $175.00 |
| Planting Trees | $560.00 |
| Rip Rap 1/2 Ton Rock | $12,161.63 |
| River Run Material Used to Recreate the Stream Bed | $1,467.94 |
| 25% of Base Contract Price (labor and equipment) | $55,897.50 |
| Concrete Footings for Flatcar Bridge | $2,100.00 |
| TOTAL PROJECT COSTS | $107,172.06 |

## Related Resources

- The California Department of Fish & Wildlife website offers numerous documents and resources regarding river and stream restoration, fish passage, and historical data available in reports on file. These resources include the *California Salmonid Stream Habitat Restoration Manual for Stream Passage* (Taylor and Love 2003). Part IX of this document is specifically focused on fish passage design (Flosi, Downie et al. 1998). The Passage Assessment Database is an on-going inventory of barriers to anadromous fish in California and is accessible from the Calfish website: https://nrm.dfg.ca.gov/PAD/Default.aspx

- The Five Counties Program (5C) includes Del Norte, Humboldt, Trinity, Siskiyou, and Mendocino Counties and was formed in 1997. The program has removed or modified 53 barriers, opening up 130 miles of stream and providing immediate benefits to salmon. 5C and American Rivers are two non-profits that support barrier removal with a grant program (Five Counties Salmonid Conservation Program 2012). Their websites and case studies offer excellent information and resources for riverine restorationists. http://5counties.org



# Case Study

## Yonkers Creek Migration Barrier Removal Project

*Wonderstump Road, Del Norte County*
*Five Counties Salmonid Conservation Program*

Located in Del Norte County, Yonkers Creek was identified by CDFW as a valuable tributary to Lake Earl and host to all native species of salmonid found in the region. A metal culvert at Wonderstump road was shown to be a migration barrier to local salmonids. The Yonkers Creek culvert was elevated approximately three feet above the surface on the outlet end, creating a jumping barrier for juveniles. Additionally, the culvert experienced high winter flow volumes that combined with the height to create a migration barrier to the upper reaches.

### Implementation

The project site was bordered by riparian vegetation both upstream and downstream. Access permission was obtained from the property owner and a road in the project area was closed to allow for access to the site and equipment operation. The final project design included removing the existing culvert and replacing it with a 30-foot-long corrugated steel culvert with a cross-sectional diameter of 28.3 square feet. A grade control structure was placed at the outlet to allow for backwatering during low flow seasons. During construction fish were removed both upstream and downstream of the site and fish screens placed to insure that no fish entered the site. Silt fencing was also placed downstream to protect water quality. Disturbed streambanks were revegetated after construction and bioengineering techniques were also utilized to aid in erosion control.

### Results

The removal of this barrier allows salmonids access to 9,000 feet of spawning and rearing habitat. The natural channel design also allows for year-round fish passage and increased fish habitat. Project design includes continued monitoring to evaluate the long-term impacts of this project.

The Five Counties Salmonid Conservation Program includes five northern California Counties that have agreed to collaborate on restoration projects in response to the federal listing of the Coho salmon as a threatened species. Their website offers valuable resources and case studies illustrating the work they are doing (http://www.5counties.org/).

# Task Checklist

## Design the project

- ☐ Contact landowner to discuss restoration work
- ☐ Create a team of experts
- ☐ Describe objectives and purpose of restoration work
- ☐ Define adaptive management strategy
- ☐ Design barrier removal plan based on assessments
- ☐ Contact engineer
- ☐ Identify access to sites
- ☐ 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
- ☐ Assess potential for the barrier to be considered a protected cultural resource

## Prepare site for barrier removal

- ☐ Re-route water
- ☐ Remove fish and/or offer alternative passage
- ☐ Stream channel widening
- ☐ Stream bottom restoration with rock addition
- ☐ Predict nature of sediment transport after removal

## Maintenance the first year

- ☐ Inspect for stream blockage
- ☐ Remove excess debris

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