



Salmonid Recovery Guide

SALMONID HABITAT RESTORATION
for Washington State

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SALMONID RECOVERY GUIDE

Populations of wild-spawning salmonids have been on the decline since the late 19th Century. Over fishing, pollution and the destruction of habitat have each played a part.

This is one in a series of Salmonid Habitat Restoration How-To-Guides for projects in Washington State. It was written to help groups and individuals undertaking similar projects and presumes some knowledge of salmon, habitats and project planning.

Other guides in the series:

- Rearing Pens
- Culvert Replacement
- Nutrient Enhancement
- Live Plants
- Habitat Restoration
- Permitting
- Project Funding
- Streamside Incubation

In the 1990s the decline reached a low point—multiple species of salmonids were listed as threatened with extinction under the federal Endangered Species Act.

For salmon to continue to exist and recover, they need several things: adequate amounts of clean, oxygenated water; stable river corridors with suitable habitat forming structures; healthy habitats, both at sea and in freshwater areas; unimpeded access to and from freshwater spawning grounds; and adequate supplies of food and cover.

Mounting a system-level salmonid habitat restoration means meeting all of these needs. None of these measures will work when addressed alone. Each is dependent upon the others. And none of these projects is even possible without the proper funding or appropriate permitting to enact and sustain it.

AN OVERVIEW

Habitat restoration is a broad term covering a range of actions that create, or re-create, stream features critical to a healthy environment and fish population. The methods and techniques used in restoration work vary, and improve with experience and technology. But it is critical to take all parts of habitat recovery into consideration when restoring a stream. Every part needs to be functional in order to achieve the targeted results.

For example, raising salmon in an egg box or a rearing pen and releasing it into the wild is useless if the water doesn't hold the nutrients necessary for growth and survival. Mounting a nutrient enhancement project is useless if the juvenile salmon can't make it downstream to the saltwater, or if they can't return as adults to spawning grounds. Clearing river channels is meaningless if the adult fish return to riverbeds that, thanks to erosion, no longer make sufficient spawning habitat.

Fisheries scientists and others who study streams and habitats regularly update their knowledge, and techniques and beliefs change as monitoring data and other information trickles in over time. Habitat restoration is a long-term process that requires a view of the big picture.

While various state and federal government agencies are concerned with fisheries and habitats, none has the overall, all-encompassing view of "salmon habitat" as its mission or goal. There is no agency devoted to salmon. Much of the onus of responsibility, then, falls to volunteer groups and nonprofits such as Fish First.

Ultimately, successful restoration projects are long-term, and meant to bridge the gap between a spoiled habitat and nature taking its course to remedy it. Habitat is restored, and repopulated by salmon, over time—such work requires patience and vision. By returning streams to normal parameters and complexities, restoration groups can speed the natural process up and give nature a head start.

Because of this, restoration design is part science and part philosophy. Projects have a better chance at success if they build upon the experiences of other successful projects, and to succeed at all they must play to a location's natural strengths.

All habitat restoration projects should be designed in conjunction with experienced personnel, should take into consideration historical data of the target location, and should be performed in collaboration with local and regional fish and wildlife agencies. When planning to rehabilitate a habitat, consider every aspect well in advance of kickoff to better ensure success.

Recovery work has to start somewhere. For Fish First, it began as an effort to return declining fish populations to Washington's Lewis River system to historical levels. The group started with five men who lived and fished along the Lewis and were increasingly aware of the dwindling numbers of salmon and steelhead in the stream.

Since the early 1990s, the group has grown into a nonprofit organization with a board of directors and dozens of successful projects under its belt. Each year, between December and June, volunteers release more than 140,000

Chinook salmon and 70,000 steelhead raised from fry in net pens.

In hopes that other groups would continue their work in other regions of the state and country, Fish First authored this series of manuals detailing salmonid restoration projects to share its volunteers' experience. This guide is an overview of what is required for a system-level salmon restoration project. For more information on specific projects, please see the appropriate manuals, referenced throughout this guide.

BEGINNING A RESTORATION PROJECT

Before any work can be done, it needs to be both approved by the appropriate municipal, state and federal regulatory authorities and funded. Any restoration project should begin with obtaining permission and funding.

Permitting

Agency oversight overlaps in many cases. Most projects of this nature will require multiple permits. Proceeding on projects without the appropriate permitting can result in fines or jail time. However, it can also affect other groups planning similar work by souring relationships with the agencies whose cooperation is critical to success.

Applying for a permit is time-consuming, but largely a paperwork hurdle. For restoration groups planning multiple projects, the initial project is the most difficult. Much of the information required by applications repeats, which means that with each successful restoration project under your belt it gets easier to apply for and receive permits.

No special expertise or legal background is required for permit applications, although you will need to draw on materials prepared by hydrologists and other experts when designing and planning your project. For this reason, permit applications should be completed only after a project is designed and planned.

That said, consulting with agencies early in the design process can help mold the project to make it more attractive to the agencies and speed the permit approval process. A list of agencies can be found later in this guide.

It's also important to remember that not all permission comes in the form of permits. In many cases, projects will take place on or near private land. Obtaining landowners' permission in advance of a project is necessary, and opening communications with nearby landowners can go a long way toward smoothing out the path for a given project.

For more information, please see Fish First's *SALMONID HABITAT RESTORATION How-To-Guide for Washington State: Permitting*.

Project Funding

Habitat restoration work can be time- and labor-intensive. Materials can be costly. While many such projects rely on volunteers and in-kind donations to offset the cost, projects can not be undertaken without funding. Materials need to be bought. Contractors need to be paid.

Few of these projects are privately funded. Most are funded by grants. Federal, state and local agencies all are sources for such funding, and of-ten, local and state agencies act as pass-throughs for federal dollars. Properly orga-

nizing funding for a project requires strong project management skills and attention to detail

Project funding should begin in the earliest stages of project planning. Without funding, there is no project.

The nature of securing funding for projects means it is a part of the project best overseen by someone with project management experience, or at least someone detail-oriented. With funding and project timelines, calendar windows, and scheduling volunteers, employees, contractors, and agency collaborations, the task can be daunting.

It gets easier each time. Each successful project establishes credibility for an organization, and credibility means future funding is more likely to be approved. Successful projects also establish an identity for your organization, which can lead to contacts and collaborations for future work.

For more information, please see Fish First's *SALMONID HABITAT RESTORATION How-To-Guide for Washington State: Project Funding*.

RESTORING SALMONID HABITAT

Typically, Fish First's work consists of the following measures:

- Habitat Restoration
- Remote Streamside Incubation
- Nutrient Enhancements
- Rearing Pens
- Live Plants
- Stream Crossings

An overview of each type of project follows.

Habitat Restoration

While each of the project types listed above can be considered habitat restoration, actual habitat restoration work involves reshaping streambed and banks, re-channeling stream flow, planting vegetation, adding in-stream structure that re-balances the stream, and other actions to help bring an area back to historically healthy status.

Projects don't end with construction or installation. Monitoring should be scheduled and followed-up with regular maintenance or repair. This is true with structural installations, with plantings, and with all aspects of habitat restoration.

Cultivate good relationships with contacts in government agencies. Keep them up-to-date on your long-term plans. Not only will it help future projects, but you'll find experienced personnel with a lot of knowledge who can make or break your project and save you time, money and work.

When your project is completed, invite agency personnel to see it. They'll get confidence that you can do what you say you're going to do, and that you do it well. This will help green-light future projects.

For more information, please see Fish First's *SALMONID HABITAT RESTORATION How-To-Guide for Washing-*

ton State: Habitat Restoration.

Remote Streamside Incubation (Egg Boxes)

Improving habitat can only go so far toward restoring salmon stocks. Increasing the population of native fish through remote streamside incubators, or egg boxes, is a proven method of improving regional salmon returns in future years once a healthy habitat has been re-established.

Remote streamside incubators, or egg boxes, mimic the natural spawning grounds where salmon eggs are hatched and incubated. Egg boxes are essentially finite spawning grounds self-contained within a barrel or similar tank installed alongside a stream and fed with stream water.

Gather as much information about a target stream in advance of permitting and planning a project. In the course of the research, you're likely to discover other information you may not have known to look for.

Such information-gathering is also likely to identify contacts and sources familiar with a stream who can help, or put you in touch with someone who can help, mount a project.

For more information, please see Fish First's *SALMONID HABITAT RESTORATION How-To-Guide for Washington State: Remote Streamside Incubation*.

Nutrient Enhancement

Hatching eggs into a stream without a sufficient nutrient base to support fry is pointless. The benefits that marine-derived nutrients provide to juvenile salmon cannot be overstressed. Juvenile salmon consume both salmon eggs and the bodies of adults after they have spawned. Current estimates suggest only 6-7 percent of marine-derived nitrogen and phosphorous historically available to salmon in the Pacific Northwest is currently available. This food limitation may be one of the main impediments to the restoration of salmon populations.

Because many of the streams in which salmon spawn and rear are inherently nutrient poor, the delivery of marine-derived nutrients may be crucial to survival of juvenile salmon and recovery of depleted salmon populations. Repopulation projects such as egg boxes are fruitless unless done in conjunction with habitat restoration and nutrient enhancement. If the habitat can't support the increased numbers of fish, mortality rates will rise. And if the stream doesn't have sufficient nutrients to support the new stocks, they won't survive their first year—much less their voyage to saltwater.

To supplement natural nutrients, additional nutrients are manually added to the stream using one of two sources—either actual salmon carcasses, or carcass analogs (pelletized fish meal).

Before undertaking a nutrient enhancement project, check with the appropriate local and federal agencies to ensure it is legal in your region. You'll also need to identify property owners where you plan to access streams, and secure their permission.

Nutrient enhancement projects should be done in collaboration with a local hatchery. Hatchery officials can provide any state or local permits needed for such projects, and have experience and expertise with local fish stocks.

They can also provide the raw materials for nutrient enhancement as well as helping determine the levels to which it should be carried out.

For more information, please see Fish First's *SALMONID HABITAT RESTORATION How-To-Guide for Washington State: Nutrient Enhancement*.

Rearing Pens

In addition to egg boxes, there are other methods of repopulating a stream with fish. Hatcheries have contributed in no small part to the survival of salmon as a species. However, hatchery fish are not the same as wild fish, and in many ways are considered inferior. To critics, hatcheries are a bandage for diminishing salmon stocks rather than a cure. For the successful survival of the species in the long term, wild fish must be able to repopulate native streams successfully. In the meantime we rely on hatchery fish to help propagate the species.

Moving juvenile salmon in numbers from hatchery net pens to offsite net pens works on multiple levels toward the goal of restoring salmon stocks. When and where such rearing pens are permissible, they can be effective both at ensuring a higher survival rate among returning hatchery fish.

For more information, please see Fish First's *SALMONID HABITAT RESTORATION How-To-Guide for Washington State: Rearing Pens*.

Live Plants

Salmon are known for their ability to return to the stream in which they were spawned to reproduce and complete their life cycle, an ability primarily attributed to olfactory cues. The fish "imprint" upon a stream sometime before they leave it to migrate to saltwater.

In some cases a natural event, such as a flood carrying juvenile salmon downstream of the grounds where they were spawned, can combine with upstream obstacles to cause salmon to imprint upon spawning grounds far downstream of where they were born. When they return years later to spawn, they forsake their natal grounds for the area upon which they imprinted.

Years of this happening have resulted in salmon re-turns being clustered in main river bodies, exposing them to threats and closing off more remote, historical habitat. Live planting is a method of returning fish to these upstream spawning grounds, and reopening their historical habitat. Such projects must be done in collaboration with fisheries biologists to determine the proper equipment and methods to ensure the safe handling of live fish.

Once fish have been live planted in a new area, the site should be monitored to ensure the plant was successful. This process is as simple as walking along the area downstream of the plant site and counting redds, or the spawning beds created by adult salmon, or waiting until the following summer and looking for juvenile fish.

On streams where culverts have been repaired or replaced and upstream grounds obstructed, the presence of any juvenile salmon upstream means the plant was successful.

Before undertaking a live planting project, check with the appropriate local and federal agencies to ensure it is legal in your region.

For more information, please see Fish First's *SALMONID HABITAT RESTORATION How-To-Guide for Washington State: Live Plants*.

Stream Crossings

Rebuilding spawning grounds, establishing a freshwater habitat, providing nutrients for juvenile fish and repopulating the species is meaningless if the salmon are unable to return to spawn, naturally restabilizing the population. Ensuring juvenile salmon can reach the saltwater, and that returning adults can reach the spawning beds where they were born, is critical.

On most small streams, crossings are either culverts or bridges designed to provide vehicle or pedestrian access. Poorly designed ones, however, act as obstructions, and can block the migration of fish up or down streams and change the geomorphic processes by which river channels form and maintain habit over time.

For example, they may block or constrict the passage of sediment and larger pieces of wood moved by river flow, and prevent channel migration, or the lateral movement of a river channel as it adjusts to balance erosion.

Some obstructions are naturally occurring. And not all obstructions or crossings are viable locations for culverts or bridges. In some cases the best way to benefit the fish habitat of a particular stream is to remove an existing crossing that has collapsed or become unnecessary, or was poorly built.

Building fish-friendly stream crossings requires an understanding of fishery biology, as well as a working knowledge of hydraulic engineering, hydrology and soils/structural engineering. For these reasons, such projects must be done in conjunction with experienced hydrologists and engineers.

For more information, please see Fish First's *SALMONID HABITAT RESTORATION How-To-Guide for Washington State: Culvert Replacement and Removal*.

AGENCY RESOURCES & CONTACTS

Salmonid restoration work involves partnerships and cooperation with a number of agencies and groups. Here's a partial list of links to help you find information on who you'll need to contact.

- U.S. Army Corps of Engineers
www.usace.army.mil
- National Marine Fisheries Service/National Oceanic and Atmospheric Administration
www.nmfs.noaa.gov
- Washington State Department of Ecology
www.ecy.wa.gov
- Washington State Department of Fish and Wildlife
www.wdfw.wa.gov
- Washington State Office of Regulatory Assistance
www.ora.wa.gov/

In addition, here's a partial list of funding sources to help get a salmonid restoration project started:

- Washington State Governor's Salmon Recovery Office
<http://www.governor.wa.gov/gfro>
- Washington State Salmon Recovery Funding Board
<http://www.iac.wa.gov/srfb/default.asp>
- Washington State Department of Ecology
www.ecy.wa.gov
- Washington State Department of Fish and Wildlife Salmon Recovery
<http://wdfw.wa.gov/recovery.htm>

Bibliography

A detailed bibliography citing additional resources used throughout the entire set of Fish First manuals follows.

- "River Course: Using Root Wads and Rock Vanes for Streambank Stabilization, Fact Sheet No. 4," North Carolina Stream Restoration Institute, North Carolina A&T State University Cooperative Extension. <http://www.bae.ncsu.edu/programs/extension/wqg/sri/rv-crs-4.pdf>
- "Stream Restoration Design Handbook," United States Department of Agriculture-Natural Resources Conservation Service, September 2005.
- "Stream Corridor Restoration: Principle, Processes and Practices," U.S.D.A., Revised 2001. http://www.nrcs.usda.gov/technical/stream_restoration/PDFFILES/ALL-SCRH-08-01.pdf
- "Fluvial Processes in Geomorphology," Leopold, L.B., Wolman, M.G., and Miller, J.B. Dover Publications, New York, NY, 1992.
- "A Framework for Analyzing the Hydrologic Conditions of Watersheds," U.S. Government Inter-agency Task Force, USDA Forest Service and U.S. Department of Interior Bureau of Land Management, Technical Note 405. 1998.
- "Manual of River Restoration and Natural Channel Design," Rosgen, D.L., Wildland Hydrology Institute, Pagosa Springs, CO. 1999.

The Washington Division of Fish and Wildlife maintains a thorough list of links to resources for habitat restoration, vegetation, bank protection and other information at:

- <http://wdfw.wa.gov/hab/ahg/weblinks.htm#restore>
- "Influences of Stocking Salmon Carcass Analogs on Salmonids in Yakima River Tributaries." Bonneville Power Administration Environment, Fish and Wildlife division
<http://www.efw.bpa.gov/Publications/P00005636-1.pdf>

The following documents provide technical information, plans and additional resources for designing and constructing stream crossings:

- "Design of Road Culverts for Fish Passage," Washington Department of Fish and Wildlife (Aquatic Habitats Guidelines).
<http://wdfw.wa.gov/hab/engineer/cm/>
- "Planning, Design and Construction of Fish Friendly Stream Crossings," U.S. Fish and Wildlife Service.
<http://www.fws.gov/midwest/fisheries/streamcrossings/>

- “National Inventory and Assessment Procedure For Identifying Barriers to Aquatic Organism Passage at Road-Stream Crossings,” U.S. Department of Agriculture Forest Service National Technology and Development Program.
<http://www.stream.fs.fed.us/fishxing/publications/PDFs/NIAP.pdf>
- “Fish Passage Through Culverts, an Annotated Bibliography,” Kemset Moore, Michael Furniss, Susan Firor, and Michael Love, Six Rivers National Forest Watershed Interactions Team, Eureka CA.
<http://www.stream.fs.fed.us/fishxing/biblio.pdf>
- “Improving Stream Crossings for Fish Passage: Final Report,” Humboldt State University and NOAA Fisheries, 2004. [http://www.stream.fs.fed.us/fishxing/NMFS%20Final%20Report%20\(No%20Appx%20A\).pdf](http://www.stream.fs.fed.us/fishxing/NMFS%20Final%20Report%20(No%20Appx%20A).pdf)
- “Field Stream Crossing Handbook,” British Columbia Ministry of Forests.
<http://www.for.gov.bc.ca/tasb/legsregs/fpc/FPCGUIDE/FishStreamCrossing/FSCGdBk.pdf>
- “Geomorphologic Impacts of Culvert Replacement and Removal: Avoiding Channel Incision,” Janine Castro, Geomorphologist, Oregon Department of Fish and Wildlife 2003.
<http://pacific.fws.gov/jobs/orojitw/document/pdf/guidelines/culvert-guidelines.pdf>
- “Design Considerations for Siting Grade Control Structures: Coastal Hydraulics Engineering Technical Note,” US Army Corps of Engineers 2001. <http://chl.wes.army.mil/library/publications/chetn/pdf/chetn-vii3.pdf>
- “Culvert Criteria for Fish Passage,” Located in the DFG Habitat Manual in PART IX, Appendix A, California Department of Fish and Game. 2003. <http://www.dfg.ca.gov/nafwb/pubs/2003/FishPassage.pdf>

In addition, at the following site you'll find links to various software packages designed specifically to help with the calculations necessary to plan and construct culverts, bridges and other stream crossings:

- <http://www.stream.fs.fed.us/fishxing/pointers.html#software>

The Fish Xing software also has a companion user manual that is an excellent reference independent of the software and available at the same site.

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Information in this document came from Fish First volunteers and contractors. It was made possible with the help of grants from Beneficial and HFC, members of the HSBC Group.

